Commonwealth of Pennsylvania

**DEPARTMENT OF TRANSPORTATION**

# SPECIFICATIONS

**Publication 408/2007**

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# Commonwealth of Pennsylvania
# DEPARTMENT OF TRANSPORTATION
# Publication 408/2007
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## PREFACE

**Contents:**
Publication 408/2007 contains current Construction Specifications for PENNDOT projects. This edition of Pub 408 is found in Hardcopy, Web, and CD-ROM Versions. Pub 408/2007 may be located on the PENNDOT website (go to: www.dot.state.pa.us/select: "Design/Construction"/ select "Construction" / then click on: "Construction Specifications"). The CD-ROM is obtained by subscription only. As on the Web, each new CD-ROM will contain all previous Edition/Change(s) in their entirety, with changed pages integrated.

**Standard Special Provisions (SSPs) and Master Construction Items that apply to Publication 408/2007:**
SSPs and Master Items are maintained in ECMS (Engineering and Construction Management System) and accessible on the Web to both PENNDOT Business Partners and Public Users. This is the only access provided to these documents and lists to all users. Public Users should go to the ECMS website (www.dot2.state.pa.us/ then go directly to "Design Admin" without logging in). "Design Admin" provides access to both Master Items and SSPs. Business Partners can login before selecting "Design Admin" if they want access to other more complete ECMS data and information applying to PENNDOT projects and schedules.

**Use of Dimension Values:**
Pub 408/2007 is a single set of Construction Specifications that contains all measurements in dual values, Metric followed by English in parentheses. This feature was used to facilitate the construction of individual projects using Metric or English dimensions, not a mixture. Prior to the initiation of a project's design the Department will specify the dimension value to be used throughout. Subsequently, dual values will not be indicated on design drawings, renderings, or in details and instructions that are project specific. Similarly, there will not be a mixing of values in formulating calculations or in presentation. In addition, to provide clarification, each project bid proposal will contain a Special Provision that will specify the dimension value to be used.

**Changes and their Effective Dates:**
The Web and CD-ROM versions will be updated with new pages on the occasion of each semiannual change, but only the Hardcopy version subscribers will receive Changes with separate copies of each new page for posting. However, each Transmittal Letter will indicate the most recent changes and will contain a list of the current changes and a Historical Index of all changes to date. The full specifics of each Change can be found within the Section to this Publication entitled: ***Change Letters and Indices to Publication 408/2007***. Effective date(s) are:

- Pub 408/2007, Initial Edition – projects let after April 2, 2007.
- Pub 408/2007, Change No. 1 (Pub 408/2007-1) – projects let after October 1, 2007.
- Pub 408/2007, Change No.2 (Pub 408/2007-2) – project let after April 1, 2008.
- Pub 408/2007, Change No. 3 (Pub 408/2007-3) – projects let after October 1, 2008.
- Pub 408/2007, Change No. 4 (Pub 408/2007-4) – projects let after April 1, 2009.
- Pub 408/2007, Change No. 5 (Pub 408/2007-5) – projects let after October 1, 2009.
- Pub 408/2007, Change No. 6 (Pub 408/2007-6) – projects let after April 1, 2010.

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# SECTION 100
# GENERAL PROVISIONS

## SECTION 101—ABBREVIATIONS AND DEFINITIONS OF TERMS

**101.01 MEANING OF TERMS—**These Specifications are generally written in the imperative mood. In sentences using the imperative mood, the subject, "the Contractor," is implied. Also implied in this language are "shall," "shall be," or similar words and phrases. In the Material sections, the subject may also be a Vendor, Fabricator, or Manufacturer, who may be supplying material, products, or equipment for use on the project. The word "will" generally pertains to decisions or actions of the Department or its Representative.

In these Specifications or on the drawings, the following words or similar words refer to actions of the Department or it's Representative, unless otherwise stated: "directed," "required," "permitted," "ordered," "designated," "prescribed." Also, the words "approved," "accepted," "acceptable," "satisfactory," "considered," or words with similar intent, mean by or to the Department or it's Representative, subject in each case to the final determination of the Secretary, and subject to further review, as permitted by law or permitted elsewhere in these Specifications.

In these Specifications, reference to a subsection of the Specifications includes all general requirements of the section of which the subsection is a part.

In these Specifications, the words "or equal," referring to a product, material, or process, mean "equal as determined by the Department or it's Representative."

In these Specifications, the words, "as indicated," or "indicated" mean "as indicated or indicated on the prepared contract plans."

**101.02 ABBREVIATIONS—**The following is a list of abbreviations used in these Specifications, in the proposal, and on the drawings. The list includes the meanings along with the abbreviations.

| | |
|---|---|
| AAN | American Association of Nurserymen |
| AAR | Association of American Railroads |
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| AGC | Associated General Contractors of America |
| AI | Asphalt Institute |
| AIA | American Institute of Architects |
| AISC | American Institute of Steel Construction |
| AISI | American Iron and Steel Institute |
| AITC | American Institute of Timber Construction |
| ANSI | American National Standards Institute |
| API | American Petroleum Institute |
| ARA | American Railway Association |
| AREA | American Railway Engineering Association |
| ASCE | American Society of Civil Engineers |
| ASLA | American Society of Landscape Architects |
| ASME | American Society of Mechanical Engineers |
| ASNT | American Society for Nondestructive Testing |
| ASTM | American Society for Testing and Materials |
| AWG | American Wire Gage |
| AWPA | American Wood Preservers Association |
| AWS | American Welding Society |
| AWWA | American Water Works Association |
| BOCM | Bureau of Construction and Materials |
| CFR | Code of Federal Regulations |

| | |
|---|---|
| CRSI | Concrete Reinforcing Steel Institute |
| CTC | Concrete Technology Corporation |
| DCNR | Pennsylvania Department of Conservation and Natural Resources |
| DEP | Pennsylvania Department of Environmental Protection |
| EBS | Electronic Bidding System |
| ECMS | Engineering and Construction Management System |
| EEI | Edison Electrical Institute |
| FHWA | Federal Highway Administration, U.S. Department of Transportation |
| FSS | Federal Specifications and Standards (General Service Administration) |
| HMA | Hot Mix Asphalt |
| ICEA | Insulated Cable Engineers Association |
| IEEE | Institute of Electrical and Electronic Engineers |
| IES | Illuminating Engineering Society |
| IMSA | International Municipal Signal Association |
| ISO | Insurance Services Organization |
| ITE | Institute of Transportation Engineers |
| JMF | Job Mix Formula |
| MTD | Materials Testing Division, Bureau of Construction and Materials, Pennsylvania Department of Transportation |
| MUTCD | Manual on Uniform Traffic Control Devices (FHWA) |
| NBFU | National Board of Fire Underwriters |
| NCSA | National Crushed Stone Association |
| NEC | National Electrical Code |
| NELA | National Electric Light Association |
| NEMA | National Electrical Manufacturing Association |
| NESC | National Electrical Safety Code |
| NFPA | National Fire Prevention Association |
| OSHA | Operations Safety & Health Administration |
| PCA | Portland Cement Association |
| PCI | Prestressed Concrete Institute |
| PENNDOT | Pennsylvania Department of Transportation |
| PEI | Porcelain Enamel Institute, Incorporated |
| PTM | Pennsylvania Test Method |
| QA | Quality Assurance |
| QC | Quality Control |
| RAM | Reclaimed Aggregate Material |
| RAP | Reclaimed Asphalt Pavement |
| RPS | Restricted Performance Specification |
| SAE | Society of Automotive Engineers |
| SRL | Skid Resistance Level |
| SSPC | Steel Structures Painting Council |
| TEOD | Traffic Engineering and Operations Division, Bureau of Maintenance and Operations, Pennsylvania Department of Transportation |
| UL | Underwriters Laboratories, Incorporated |
| UNC | Unified National Coarse |
| U.S.C. | United States Code |

**101.03 DEFINITIONS—**

**ACCEPTANCE CERTIFICATE—**The certificate of the Department, certifying that the project has been satisfactorily completed and accepted.

**ACTIVE WORK ZONE:** The portion of a work zone where construction, maintenance, or utility workers are on the roadway or on the shoulder of the highway and is adjacent to an open travel lane.

**ADDITIONAL WORK**—Work, of a type already provided by the contract and for which the contract has established a unit price.

**ADVERTISEMENT**—The public announcement, required by law, inviting bids for work to be performed or for materials to be furnished.

**AGENCY HEAD**—The Secretary.

**AIR TEMPERATURE**—The measured temperature in the degrees Celsius (°C) (Fahrenheit (F)) in the shade, not in the direct rays of the sun, and away from artificial heat.

**AWARD**—The Department's written acceptance of a bid.

**BID**—The offer of a bidder, using either a 3 1/2-inch diskette or the internet, to construct the project, at the prices bid or predetermined.

**BIDDER**—Any individual, firm, partnership, corporation, or joint venture, submitting a bid for the work contemplated and acting either directly or through an authorized representative.

**BRIDGE**—A structure, including supports, spanning and providing passage over a waterway, a railroad, a highway, or other obstruction; more than 6 m (20 feet) long, measured along the center of the roadway or railroad, between the faces of abutments. In the case of boxes or arches, the length is measured between the faces of the sidewalls and, in the case of multiple boxes, between the inside faces of the outside walls.

**BULLETINS**—Publications, prepared by the Department, indicating requirements for material and processes, listing approved material suppliers. A list of these bulletins follows:

**Bulletin 5**—Design Methods for Air-Entrained Portland Cement Concrete and Ready-Mixed Portland Cement Concrete (Publication 30)

**Bulletin 14**—Aggregate Producers (Publication 34)

**Bulletin 15**—Approved Construction Materials (Publication 35)

**Bulletin 25**—Specifications for Bituminous Materials (Publication 37)

**Bulletin 26**—Specifications for Paint and Allied Materials (Publication 38)

**Bulletin 27**—Bituminous Concrete Mixtures, Design Procedures, and Specifications for Special Bituminous Mixtures (Publication 27)

**Bulletin 41**—Producers of Bituminous Mixtures (Publication 41)

**Bulletin 42**—Producers of Ready-Mixed Concrete (Publication 42)

**BUSINESS PARTNER**—An individual, firm, partnership, or corporation that has a valid Registered Business Partner Identification Number issued by the Department through ECMS.

**CALENDAR DAY**—Every day shown on the standard calendar.

**CENTRAL OFFICE**—The central office of the Department in Harrisburg, Pennsylvania.

**CHIEF BRIDGE ENGINEER**—The Engineer in charge of bridge design for the entire Department, or authorized designee.

**CHIEF ENGINEER, HIGHWAY ADMINISTRATION**—The Engineer in charge of all highway activities in the central office, or authorized designee.

**CONTRACT**—The written agreement between the Department and the Contractor for the construction of the project. The contract includes the following: Proposal; Plans; Specifications; Agreement; Performance Bond; Payment Bond; Insurance Certificates; Notice to Proceed; and all work orders and supplemental agreements that are required to complete the construction of the project.

**CONTRACT ITEM (PAY ITEM)**—A specifically described unit of work for which a price is provided in the contract. Individual units in the component item schedule of a lump sum payment item are not considered contract items.

**CONTRACTING OFFICER**—The District Executive.

**CONTRACTOR**—The individual, firm, partnership, corporation, or joint venture awarded the contract; acting directly through agents or employees, or the Surety in case of default; or each participant in a joint venture.

**CROSS SECTIONS**—Graphic representations of the original ground and the proposed highway, at right angles to the centerline or base line.

**CULVERT**—Any structure, not classified as a bridge, that provides an opening under the roadway.

**DEPARTMENT**—Pennsylvania Department of Transportation.

**DISKETTE BID**—A bid submitted on a 3 1/2-inch diskette using the Department's EBS Expedite software.

**DISTRICTS**—Geographic divisions of the Department for the purposes of management, design, construction, and maintenance.

**DISTRICT EXECUTIVE**—The Engineer or Administrator in charge of an engineering district of the Department.

**DRAWINGS**—See PLANS.

**ENGINEER**—An individual licensed and registered under the Laws of the Commonwealth of Pennsylvania designated by the Deputy of Secretary for Highway Administration, acting directly or through a duly authorized representative, acting within the scope of the particular duties assigned or the authority given.

**EXPEDITE**—AASHTO's EBS software approved by the Department for bidding.

**EXTRA WORK**—Work arising from changes that result in a significant increase or decrease in the cost of performing the work and work having no quantity and/or price included in the contract, that is determined by the District Executive to be necessary or desirable to complete the project.

**FABRICATOR**—A firm, company, or individual supplying fabricated material for the project.

**FINAL SETTLEMENT CERTIFICATE**—The certification made by the Secretary to the State Treasurer; of the amount due in final payment and settlement of the contract, after making all legal and equitable additions and deductions, including the amounts previously paid.

**FINAL INSPECTION**—The inspection, conducted by the Representative, to determine if the project or any substantial portion thereof, has been satisfactorily completed, according to contract requirements.

**GRADE LINE**—The profile of the finished roadway surface along the proposed construction centerline or base line.

**HIGHWAY**—The area between right-of-way lines, and/or between limit of slope lines, as ordained and/or indicated.

**INSPECTOR**—The person authorized and assigned by the Representative to make inspections of contract performance and of material furnished.

**INSPECTOR-IN-CHARGE**—The person authorized by the Representative to be in immediate charge of inspecting the performance of work on the project.

**INVITATION FOR BIDS**—The advertisement for bids for work or material. The advertisement will state, with reasonable accuracy, the quantity and location of the work to be done, the character and quantity of the material to be furnished, and the time and place of the opening of bids.

**IN WRITING**—Communication between parties delivered or sent, and received, in the form of a written letter, e-mail, facsimile, telegram, or mailgram.

**JOB-MIX FORMULA**—A specific mixture of material established by test procedures, then adhered to during construction using the mixture.

**JOINT VENTURE**—A legal association of contractors, limited to three participants, formed for the purpose of bidding and executing a common contract. Prequalification is required of each contractor, as specified in Section 102.01.

**LABORATORY**—Testing laboratories of the Department, or any other designated testing laboratories.

**LOCAL TRAFFIC**—Vehicular traffic that originates or terminates within the project limits.

**LOT**—An isolated quantity of specified material from a single source, or a measured amount of specified construction, to be produced by the same process.

**MANUFACTURER**—A firm, company, or individual manufacturing material for the project.

**MATERIAL**—Substances specified for use in the project construction.

**MATERIALLY UNBALANCED BID**—A bid that generates a reasonable doubt that awarding a contract to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

**MATHEMATICALLY UNBALANCED BID**—A bid containing lump sum or unit prices, which do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.

**MILESTONE DATE**—The date on which a specific portion of physical contract work is to be completed, before the Required Completion Date of all contract work.

**MULTIPLE DEFICIENCY**—Deficiency in more than one characteristic within the same lot.

**NOTICE TO PROCEED DATE**—The date, established in writing by the Department, on which work is to begin.

**ONLINE BID**—A bid submitted via the internet using the Department's Engineering and Construction Management System (ECMS).

**PAVEMENT STRUCTURE**—The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and to distribute the load to the roadbed.

**PAYMENT BOND**—The approved form of security, furnished by the Contractor and the Surety, as a guaranty to pay promptly, or cause to be paid promptly, in full, such sums as may be due for all material furnished, labor supplied or performed, rental of equipment used, and services rendered by public utilities in, or in connection with, the work under contract.

**PERFORMANCE BOND**—The approved form of security, furnished by the Contractor and the Surety, as a guaranty on the part of the Contractor to execute the work, according to the terms of the contract.

**PLANS**—The approved documents or drawings, or exact reproductions of them, for construction of the project. The plans show the location, character, dimensions, approximate quantities, and other details of the prescribed work, including layouts, profiles, and cross sections; plans also include cited Standard Drawings. However, subsurface soil and geological data (e.g., the Soil Survey Report and Profile and Core Borings) are excluded from this definition.

**PREQUALIFICATION**—The system for establishing a qualification rating, determining the maximum amount of contract and one or more of the classified types of work on which a Contractor will be eligible to bid or subcontract, and the maximum amount the Contractor may have under contract and incomplete at any one time.

**PRINTOUT**—The processed data issued in printed form by a computer.

**PROFILE GRADE**—The elevation or gradient of a trace of a vertical plane intersecting the proposed surface, usually along the longitudinal centerline or base line of the roadway.

**PROJECT**—All of the work described in the contract.

**PROPOSAL**—The documents, designated by the Department, containing project requirements and other information upon which a bid for the project to be constructed is to be based. The proposal includes the Plans, Specifications, Special Provisions, referenced Standard Drawings, Addenda, and all other documents referred to therein, whether or not attached.

**QUALITY CONTROL (QC) PLAN**—A Contractor's or Vendor's prepared plan, submitted to and reviewed by the Representative, describing the proposed QC system. This plan contains, as a minimum, an inspection schedule, sample schedule, testing schedule, and required laboratory inspection reports.

**QUALITY CONTROL (QC) SYSTEM**—A system of controls, inspection, and tests, fully documented, providing reasonable assurance that all materials, products, and completed construction submitted for acceptance, conform to specifications.

**QUESTIONNAIRE**—The Department form on which the Contractor furnishes required information as to his or her ability to perform and finance the work.

**REPRESENTATIVE**—The authorized representative acting on behalf of the Secretary.

**REQUIRED COMPLETION DATE**—The date on which all physical contract work, including any authorized additional or extra work, is to be completed. The Required Completion Date is the completion date shown in the contract plus any time extensions issued in writing by the Representative less any time reductions issued in writing by the Representative.

**RESTRICTED PERFORMANCE SPECIFICATION (RPS)**—A presentation of required results, statistically verifiable as meeting specified criteria, and free of unnecessary construction limitations.

**RIGHT OF WAY**—The area that has been secured and reserved by the Department for highway purposes.

**ROADSIDE DEVELOPMENT**—Items for seeding, sodding, mulching, topsoiling, planting of ground covers, other planting, and items for erosion control.

**SECRETARY**—The Secretary of Transportation or a Deputy Secretary of Transportation of Pennsylvania.

**SHOP DRAWINGS**—See WORKING DRAWINGS.

**SINGLE DEFICIENCY**—Deficiency in one characteristic in a lot.

**SKID RESISTANCE LEVEL (SRL)**—The friction rating of a surface course material.

**SPECIAL PROVISIONS**—Additions and revisions to the Standard Specifications covering conditions pertaining to an individual project.

**SPECIFICATIONS**—This publication and all publications to which it refers. Also, special provisions and bulletins referred to in, or bound with, the proposal; together with all written agreements made or to be made, pertaining to the method and manner of performing the work, or to the quantities or qualities of material to be furnished under the contract.

**STANDARD DRAWINGS**—Approved drawings, showing standard details, produced to be used repeatedly on projects.

**STATE**—The Commonwealth of Pennsylvania.

**STRUCTURES**—Bridges, culverts, storm sewer appurtenances, slope and retaining walls, sign support structures, and other similar items.

**SUBCONTRACTOR**—Any individual, partnership, firm, or corporation, complying with the requirements of Section 102.01, who/which undertakes, with prior consent of the Department, the partial or total construction of one or more items of project work, under the terms of the contract, with and responsible to the prime Contractor by virtue of an agreement.

**SUBSTRUCTURE**—That part of the structure not deemed as superstructure.

**SUPERINTENDENT**—The Contractor's authorized representative in charge of the work.

**SUPERSTRUCTURE**—All portions of the bridge, above the bridge seat, including bearings, bearings and anchors sunk in the substructure, abutment backwalls, cheekwalls, shear blocks, bridge drainage down to but not including the drain box, and portions of the wings and appurtenances above the horizontal construction joint nearest the bridge seat.

**SUPPLIER**—A firm, company, or individual supplying material for the project.

**SURETY**—A corporate body, which is bound with and for the Contractor, for the satisfactory performance of the Contractor's work and for the prompt payment in full for material, labor, equipment rentals, and utility services, as provided in the bonds.

**TRAFFIC CONTROL PLAN**—A developed method or scheme for safely and efficiently moving traffic through or around a highway work zone.

**UTILITY ADJUSTMENT**— The act of placing, setting, replacing, resetting, relocating, adjusting, reconstructing, altering, or removing a Utility Infrastructure.

**UTILITY INFRASTRUCTURE**— A public or private facility or structure, whether or not owned by a utility, that is or will be in, on, under, or over the project site or a waste or borrow area designated in the proposal, and that either must be placed, set, replaced, reset, relocated, adjusted, reconstructed, altered, or removed in order for the contract work to be performed or otherwise interferes with the performance of the contract work.

**VALUE ENGINEERING**—The identification of the function(s) of a contract item, establishing the cost of the function(s), considering life cycle costs, and providing the required functions at the lowest cost with no reduction in required quality or performance.

**VENDOR**—A firm, company, or individual supplying material or services for the project.

**WORK**—The furnishing of material, labor, equipment, and other incidentals necessary or convenient to successful project completion, plus the fulfillment of all duties and obligations imposed by the contract.

**WORKING DRAWINGS**—Required shop drawings, erection plans, falsework plans, stress sheets, framework plans, cofferdam plans, bending diagrams for reinforcing steel, and any other supplementary plans or similar data, all prepared by the Contractor.

**WORK ORDER**—An order, signed by the Representative, authorizing the performance of additional or extra work, or extra work on a force-account basis, as specified in Sections 110.02 and 110.03.

**WORK ZONE:** The area of a highway where construction, maintenance, or utility work activities are being conducted and which should have traffic-control devices installed according to Title 67 of the Vehicle Code.

# SECTION 102—BIDDING REQUIREMENTS AND CONDITIONS

**102.01 PREQUALIFICATION OF CONTRACTORS AND SUBCONTRACTORS—**

**(a) General.** Unless otherwise stated in the proposal, contractors are required to prequalify before the date fixed for the opening of bids for State highway construction work. To do so, establish proof of competency and responsibility, according to 67 PA Code Chapter 457, Regulations Governing Prequalification of Prospective Bidders. Subcontractors are required to prequalify in the same manner, if listed in the proposal or if they subsequently undertake the partial or total construction of one or more items of work. To obtain a complete set of application forms, contact the Prequalification Officer, Contract Management Division, Bureau of Construction and Materials, Pennsylvania Department of Transportation, Harrisburg, Pennsylvania, 17120.

**(b) Business Partner Registration.** Unless otherwise stated, contractors are required to register with the Department as a business partner. To become a business partner, go to the Department's Engineering and Construction Management homepage. Instructions for registration are available on the website.

**102.02 CONTENTS OF PROPOSAL**—The proposal will specify the place for delivery of a bid; the date, time, and place of bid opening; and the location and description of the project to be constructed. The proposal will also show the approximate quantities of work to be performed and/or material to be furnished, the contract time in which the project is to be completed. The proposal will include any special provisions and attachments pertaining to the project.

**102.03 ISSUANCE OF PROPOSAL**—The proposal and plans will be furnished, upon written request, from the Department's Central Office or, if available, in the office of the District where the project is located. The prospective bidder will be required to pay the Department the amount stated in the Notice to Contractors, for copies of the proposal and for sets of plans. Also, the proposal and drawings will be available to bidders, for reference, at the Central Office, and at the office of the District where the project is located. Proposals and plans may also be available online through ECMS.

**102.04 INTERPRETATION OF APPROXIMATE ESTIMATE OF QUANTITIES**—The estimate of quantities, shown on the proposal, and in the contract, is approximate and is shown only as a basis for the calculation upon which the contract award is to be made. The Department does not assume any responsibility that the quantities will actually be required in the project construction, nor will the Contractor be allowed to plead misunderstanding or deception because of the quantity estimates or because of the character of the work, the location, or other conditions. The Department reserves the right to increase, to decrease, or to omit any of the quantities of work. An increase or decrease of the quantities of the items will not be sufficient grounds for granting an increase in the unit prices bid, except as specified in Section 110.02.

**102.05 EXAMINATION OF PROPOSAL, PLANS, SPECIFICATIONS, SPECIAL PROVISIONS, AND SITE OF WORK**—The Department's plans and specifications are complete and are prepared so any competent contractor is able to complete the proposed work. The bidder is required to carefully examine the proposal, plans, specifications, and project site before submitting a bid. The submission of a bid will be considered proof that the bidder has made such examination and understands the conditions to be encountered; the character, quality, and quantities of work to be performed; the material to be furnished; and the requirements of the plans, specifications, and proposal. The Department will make no allowance or concession for a bidder's failure to make the required examination.

The proposed slope lines shown on the cross sections are approximate and are subject to revision and change by the Representative, depending upon the stability of material encountered during construction.

Subsurface soil and geological information indicated is based upon soundings, dug test pits, and/or test borings. Such information concerning the character of subsurface material is of an exploratory nature and has been obtained, for the Department's use, as an aid in the project design. The information provided is representative of subsurface conditions only at the locations and depths where such information was obtained, and there is no expressed or implied agreement that uniformity of material exists between explored locations.

Preliminary construction schedules are intended to provide a general overview of the sequence of construction operations, based on currently available data. Such information is developed, for the Department's use, as an aid in the project design. Available construction scheduling information, if any, is being provided for informational purposes only. The Department makes no expressed or implied representation as to the completeness, accuracy, or correctness of the data, and accepts no responsibility for consequences resulting due to any actions undertaken based on the information provided. These schedules are not considered a part of the proposal.

## 102.06 PREPARATION OF BIDS—

**(a)** Submit properly completed bids for Department construction work in the electronic bidding format (i.e., online or diskette).

**(b)** Configure the electronic file for bidding to include Registered Business Partner Identification Number. For a joint venture bid, the lead joint venture will be required to furnish this information on behalf of the joint venture.

**(c)** Unless otherwise stated in the proposal, the Department will only accept bids from contractors who are prequalified on the date of the bid opening, as specified in Section 102.01, and who bid for work which, based on their available financial capacity and approved work classification codes, does not exceed their prequalification eligibility. Unless otherwise approved by the Chief Engineer, Highway Administration (Prequalification Office), prequalification eligibility with regard to work classification will be determined using the applicable Work Classification Code(s) shown on the Design Items Screen with the corresponding item number. If a bid item has multiple Work Classification Codes, the bidder must be prequalified for only one of the Codes listed. With regard to available financial capacity, prequalification eligibility will be determined by ensuring that the bidder's current maximum financial capacity exceeds the total amount of the bid, less any credit for subletting as specified in Section 108.01(a), plus the total amount of all uncompleted work a bidder has under contract at the time of bid opening.

**(d)** Execute bids as follows:

When an item in the bid contains a choice to be made by the bidder, indicate this choice, according to the specifications for that particular item. When preparing the bid, leave blank the unit price(s) of the alternate(s) that are not bid. Thereafter, no further choice will be allowed.

**1. Online Bid.** Submit an online bid via the ECMS website by using the business partner password of an authorized general partner or corporate officer properly designated to execute and attest to bids. For a joint venture bid, submit an online bid via the ECMS website by using the business partner password of an authorized general partner or corporate officer properly designated to execute and attest to bids of the lead joint venture.

**2. Diskette Bid.** As an alternate to online submission, submit a diskette bid by preparing the bid using the EBS Expedite software, furnished by the Department. Submit the completed EBS Expedite bid file on a 3 1/2-inch diskette along with the required signature page(s). Sign the signature page(s), in ink. Type or legibly print the name of each signer under the signature.

If the bidder is a partnership, only one signature of an authorized general partner will be required.

If the bidder is a corporation, the signatures of authorized corporation officers, properly designated to execute and attest to contracts, are required. If the above signatures are not those of such authorized officers, either attach a current power of attorney or submit a current power of attorney annually to the Department.

For a joint venture bid, each participant is required to complete one signature page, as shown in the postscript at the bottom of the page.

**(e) Anti-Collusion Requirements.** The authorized signer of the bid, under penalty of perjury as provided in 18 Pa. C.S.A. Section 4904, or if applicable, 18 U.S.C., Section 1020, certifies that he or she is authorized to make and does make the following statement on behalf of the bidder:

1. The bid item prices and the total bid amount have been arrived at independently and without consultation, communication, or agreement for the purpose of restricting competition with any other contractor, bidder, or potential bidder.

2. Neither the item prices nor the total bid amount, and neither the approximate bid item prices nor approximate total bid amount, have been disclosed to any other firm or person who is a bidder or potential bidder, and they will not be disclosed before bid opening.

3. No attempt has been made or will be made to solicit, cause, or induce any firm or person to refrain from bidding on this project, or to submit a bid higher than this bid, or to submit any intentionally high or noncompetitive bid or other form of complementary bid.

4. The bid submitted by the bidder is made in good faith and not pursuant to any agreement or discussion with, or inducement from, any firm or person to submit a complementary or other noncompetitive bid.

5. The bidder has not offered or entered into a subcontract or agreement regarding the purchase of materials or services from any firm or person, or offered, promised, or paid cash or anything of value to any firm or person, whether in connection with this or any other project, in consideration for an agreement or promise by any firm or person to refrain from bidding or to submit a complementary bid on this project.

6. The bidder has not accepted or been promised any subcontract or agreement regarding the sale of materials or services to any firm or person, and has not been promised or paid cash or anything of value to any firm or person, whether in connection with this or any other project, in consideration for this firm's submitting a complementary bid, or agreeing to do so, on this project.

7. The authorized signer of the bid has made a diligent inquiry of all members, officers, employees, and agents of the bidder with responsibilities relating to the preparation, approval, or submission of this firm's bid on the project and has been advised by each of them that he or she has not participated in any communication, consultation, discussion, agreement, collusion, act, or other conduct inconsistent with any of the statements and representations made in this Statement.

8. No attempt has been made to take any action in restraint of free competitive bidding in connection with the bid.

9. It is understood that if any incidents resulting in conviction or being found liable are specified in Section 102.06(e)10, the Pennsylvania Anti Bid Rigging Act, 73 P.S. 1611 et. seq. provided that it does not prohibit a governmental agency from accepting a bid from or awarding a contract to that person, but may be a ground for administrative suspension or debarment at the discretion of a governmental agency under rules and regulations of that agency.

10. The bidder, its affiliates, subsidiaries, officers, directors, and employees are not aware that they are currently under investigation by any governmental agency and have not in the last 3 years been convicted or found liable for any act prohibited by State or Federal law in any jurisdiction, involving conspiracy or collusion with respect to bidding on any public contract, except as indicated on a separate page attached to the bid document.

The authorized signer of the bid hereby states that he or she understands and acknowledges that the above representations are material and important, and will be relied on by PENNDOT, in awarding the contract for which the bid is submitted. He or she and their firm understands that any misstatement in this statement is and shall be

treated as fraudulent concealment from PENNDOT of the true facts relating to the submission of bids for this contract.

**(f) Contract Unit Price.** Wherever an identical item number and description are used more than once, provide the same unit bid price for each bid entry. If the bidder provides different bid prices for an identical item number and description, the bid may be rejected.

**102.08 BID GUARANTY FOR EXECUTION OF CONTRACT—**

Bid guaranty is associated and supported by the bidder's prequalification requirements.

**102.09 DELIVERY OF BIDS**—Submit bid(s) to the location designated, before the hour of the opening date shown in the proposal.

Electronic online bids will not be accepted after the time for the opening date of the bids shown in the proposal. Bid(s) received after the time for opening of bids will be returned unopened to the bidder.

**102.10 WITHDRAWAL OR REVISION OF BIDS—**

**(a) Withdrawal of Bids Before Bid Opening.** Each bidder who submits a bid waives any right to withdraw it, except as provided herein. Bidders will be given permission to withdraw any bid, after it has been submitted to the Department, if the bidder electronically withdrawals or makes the request in person or by an accredited personal representative, by telephone, or in writing to the Secretary. Deliver requests for withdrawal to the Secretary's office before the time set for opening bids.

A bidder may withdraw any bids, which have not been read, after having been declared the apparent low bidder on any other project. In withdrawing bids, make the withdrawal request to the official in charge of the bid opening, either in person or by an authorized representative, before any such bids are read. Provide satisfactory credentials, showing authority to act for the interested bidder, at the time that the official in charge requests that any contemplated withdrawals be made. The bid withdrawn by such a request will be returned to the bidder or the bidder's representative, and will not be considered by the Department.

**(b) Revision of Bids Before Bid Opening.** A bidder will be allowed to revise a bid after it has been submitted, if the bidder electronically withdraws the bid, or appears in person or provides an accredited personal representative to make the revision. Present all such requests to the Secretary's office expeditiously so that the revision can be completed and the bid resubmitted before the time set for opening bids.

**(c) Withdrawal of Bids After Bid Opening.** Withdrawal of erroneous bids after the bid opening but before award based on bid mistakes will be allowed by the written determination of the Secretary when the bidder requests relief and presents credible evidence that the reason for the lower bid price was a clerical mistake as opposed to a judgment mistake and was actually due to an unintentional arithmetical error or an unintentional omission of a substantial quantity of work, labor, material, or services made directly in the compilation of the bid . The request for relief and the supporting evidence must be received by the Secretary's office within three business days after the bid opening but before the award of the contract.

The Secretary will not allow a withdrawal of a bid if the withdrawal of the bid would result in the awarding of the contract on another bid of the same bidder, its partner or a corporation or business venture owned by or in which the bidder has a substantial interest. No bidder who is allowed to withdraw a proposal shall supply any material or labor to or perform any subcontract or other work agreement for any person to whom a contract or subcontract is awarded in the performance of the contract for which the withdrawn bid l was submitted without the written approval of the Secretary.

**102.11 JOINT VENTURE**—A joint venture bid will be considered a bid by each of the participants, jointly and individually, for the entire contract performance as a joint venture, according to the proposal terms and conditions.

In the proposal, contract, specifications, drawings, or any writing constituting a part of these, the term "Bidder" or "Contractor," or any other term intending to refer to "Bidder" or "Contractor," as defined in Section 101, will include and mean each participant in any joint venture.

Designate in the bid, where specified, the items in whole or in part, to be undertaken by each participant and their total respective proportionate amounts.

Each participant will be evaluated for prequalification work classifications and capacity, based on the items designated, as specified in Section 102.01.

**102.12 OPENING OF BIDS**—Bids will be opened and announced publicly at the time, on the date, and at the place shown in the proposal. Bidders and/or their authorized representatives and other interested persons are invited to be present.

In case of an emergency, which causes evacuation of the building at the time of the bid opening, the official in charge of the bid opening will publicly announce any necessary changes in the time of depositing, opening, and announcing of bids.

**102.13 DISQUALIFICATION OF BIDDERS AND REJECTION OF BIDS—**

**(a)** The following may be considered sufficient reasons for bidder disqualification and the rejection of the bids(s):

**1.** submittal of more than one bid for the same work from an individual, a firm, a partnership, an association, a subsidiary, an affiliate, or a corporation under the same or different name;

**2.** evidence of collusion among bidders. Any participant in such collusion will receive no recognition as a bidder for future work of the Department until the participant has been reinstated as a qualified bidder;

**3.** lack of competency, of adequate machinery, plant, or of other equipment;

**4.** inability, in the judgment of the Department, to promptly complete the project, because of uncompleted work;

**5.** failure to pay, or satisfactorily settle, all bills due for material furnished, for labor supplied or performed, for rental of equipment used, and for services rendered by public utilities;

**6.** failure to comply with any Department prequalification regulations;

**7.** judgment of default under a previous contract;

**8.** contractor currently debarred by Federal or State Authority; or

**9.** material or intentional failure to comply with contract, drawings, or specifications, or material or intentional failure to adequately maintain and control traffic during construction on a previous contract.

**(b)** In addition to rights under 67 Pa. Code, Chapter 457, the Secretary reserves the right to reject any or all bids if, in his or her judgment, the rejection is in the State's best interest.

**1.** In addition, bids will be rejected for any of the following reasons:

**1.a** failure to submit the bid using the electronic format furnished or approved by the Department;

**1.b** failure to properly sign the bid, the required affidavits, or certificates, or any other required documents as specified in the proposal;

**1.c** completed EBS Expedite bid file is unreadable;

**1.d** failure to include a price for each item on the bid schedule, except in the case of alternate bidding; in alternate bidding, failure to include a price for one of the required alternate items on the bid schedule; or

**1.e** the inclusion of conditions or qualifications not provided for in the proposal.

**2.** In addition, bids may be rejected for the following reasons:

**2.a** the proposal was not furnished or approved by the Department;

**2.b** part of the bid is detached;

**2.c** the bid contains omission(s) or alteration(s), addition(s) not specified, or deviation(s) of any other kind;

**2.d** the bid is materially unbalanced;

**2.e** the bid is not submitted under the name listed on the prequalification certificate;

**2.f** the bidder provides different bid prices for an identical item number and description;

**2.g** failure to submit Minority and/or Women Business Enterprise Participation Requirements as specified in the proposal; or

**2.h** failure to submit Disadvantage Business Enterprise Participation Requirements as specified in the proposal.

**2.i** failure to electronically acknowledge all addendums in the EBS Expedite bid file

# SECTION 103—AWARD AND EXECUTION OF CONTRACT

**103.01 CONSIDERATION OF BIDS**—After the bids are opened, the total bid amount and the name of the apparent low bidder will be publicly announced. Bids will then be promptly verified and, if determined by the Secretary to be satisfactory, the results of the determination of the lowest responsive and responsible bidder will be made available to the public.

A Diskette Bid will supercede all Online Bids regardless of the time or order the bids were submitted.

**(a) Submission of Component Item Schedule.** The apparent low bidder is required to complete and submit a Component Item Schedule for each lump sum item requiring a Component Item Schedule (CIS) in the bid, providing quantities and unit prices for the component items associated with that lump sum pay item. The completed CIS becomes part of the contract.

The proposal will include a CIS for each applicable "as-designed," lump sum item. When the proposal indicates that an equivalent structure or facility of an alternate design may be constructed in lieu of the "as-designed" structure or facility and the alternate design is bid, the necessary CIS must be prepared by the bidder.

The apparent low bidder is required to submit CIS electronically using the ECMS website after the bid opening. If the CIS is not submitted within 14 calendar days after the bid opening, the contract may be awarded without the CIS. No payments will be made for any item of work until the CIS is submitted and approved.

In the event a deficiency is discovered in the information provided on the CIS, the bidder will be notified to correct the deficiency. In the event the apparent low bid is rejected, the next lowest bidder will be notified to prepare and submit the CIS in the manner as specified herein.

**103.02 AWARD OF CONTRACT**—When a bid received has been determined by the Secretary to be satisfactory, a contract will be awarded in writing to the lowest responsive and responsible bidder within 60 days from the opening date of the bids. Thirty-day extensions of the award date may be made by the mutual written consent of the Representative and the lowest responsive and responsible bidder. The Department will base the award exclusively on the total in the bid schedule and on compliance with all the bidding requirements. No prices will be negotiated due to any extensions.

Contract award on a joint venture bid will place upon the joint participants complete liability, jointly and individually, for contract performance.

Contracting corporations, which are chartered in a state other than Pennsylvania, as well as individuals or firms doing business under fictitious names, are required to register with the Secretary of the Commonwealth and obtain a certificate authorizing them to do business in Pennsylvania, before they can be awarded a contract.

**103.03 CANCELLATION OF AWARD**—The Secretary reserves the right to cancel the award of any contract at any time before its approval by the Chief Counsel, the General Counsel, and/or the Attorney General, or their designees, when such cancellation is in the best interests of the State. In the event of such cancellation, payment will be made only for the documented costs of insurance and surety bonds required under Sections 103.04 and 103.05. No payment will be made for damages of any other kind including, but not limited to, lost profits.

**103.04 SURETY BONDS**—When awarded the contract, furnish a Performance Bond, with sufficient surety or sureties, in an amount equal to 100% of the contract price. Have the bond specify that the contracted work will be completed in a manner satisfactory to the Secretary. Have the bond state that the State is not liable for any expenses incurred through the failure to complete the work as specified, nor liable for any damages growing out of the carelessness of the Contractor, the Contractor's employees, or subcontractors. Also furnish a Payment Bond in the amount of 100% of the contract price. Have a corporate surety, legally authorized to transact business in the State and satisfactory to the Secretary, execute both bonds. If the Secretary decides the bond surety is unsatisfactory, promptly furnish any additional required security to protect the State's interests and the interests of all persons, firms, or corporations who/which have furnished material, provided equipment on rental, or supplied/performed labor or services on, or in connection with, the performance of the work for this contract.

Have participants in a joint venture submit a single Performance Bond and a single Payment bond, each signed by both the joint participants and by their surety. These bonds are to cover their joint and individual liability.

**103.05 EXECUTION AND APPROVAL OF CONTRACT**—Sign the awarded contract and return it to the Secretary of Transportation, Harrisburg, Pennsylvania, within 10 days after notification by the Secretary. With the contract, include properly executed surety bonds and an insurance certificate or certificates, listing the project number, naming the State as an additional insured party, and proving property damage and public liability insurance is adequate to cover any loss that might accrue.

Procure only occurrence-based insurance coverage and so note on the certificate or demonstrate exhaustive efforts to purchase such insurance where it is unavailable. If able to demonstrate factual impossibility of obtaining occurrence-based insurance, then purchase insurance in a form and amount to be determined by the Department.

**(a)** When the joint bidder returns the signed contract for a joint venture, to be signed by the Secretary, a certified copy of a resolution of the board of directors of each participating corporation must be included. Have the resolution authorize the joint venture with the other party participant(s) for the specific contract. Have the corporation also submit a copy of its corporate powers. Have the participants in any joint venture make the designation in writing, addressed to the Secretary, with a copy directed to the Deputy Secretary for Highway Administration.

The designations are as follows:

**1.** The name of the person who will be in charge of the project for the joint contractors. Give this person complete authority to speak for and bind the joint contractors in all matters relating to the contract. It is this person to whom all notices, orders, directions, and determinations concerning the project may be given by the Secretary or the Representative. Notices, orders, directions, or determinations given to this designated person, or to one of the joint contractors, will be considered to have been given to all parties.

No change in the person designated to be in charge of the project will be recognized by or be binding upon the Secretary or the Representative, until the participants in the joint venture give written notice of such change. In the event of the death or disability of the person in charge of the project, it is the responsibility of the joint contractors to advise the Secretary or the Representative, in writing, over their joint signatures, of such death or disability within 24 hours after the occurrence, and then to designate a successor.

**2.** A mailing address for the receipt of all estimates, acceptance and final settlement certificates, payments, notices, orders, directions, and determinations for the performance of the work. The mailing address will be considered the joint contractors' address and any communications directed to such address will be considered to have been received by the joint contractors.

All checks for the payment of estimates and the final settlement certificate will be made to the order of the joint contractors in the same form in which they have signed the contract and will be mailed to the designated mailing address.

Change of the mailing address will not be recognized by or be binding upon the Secretary or the Representative, until written notice, signed by the joint contractors, has been received by the Secretary or the Representative.

**(b)** No bid will be considered binding upon the State or fully executed until the form and legality of the contract is approved by the Chief Counsel, the General Counsel, and/or the Attorney General, or their designee. If any proposal includes work to be contracted with more than one agency, the contracts will be entered into as specified in the proposal.

**103.06 FAILURE TO EXECUTE CONTRACT**—If the contract, together with the Surety Bonds and the Insurance Certificate(s) providing adequate insurance coverage, as provided in Section 103.05, is not properly executed and returned, liquidated damages may be assessed and/or the Contractor's prequalification may be suspended according to 67 PA Code, Chapter 457, Regulations Governing Prequalification of Prospective Bidders.

**103.07 CANCELLATION OF CONTRACT**—The contract may be cancelled by either party if the notice to proceed date is not within 30 days of award of the contract. Extension(s) of the 30-day period will be made only by mutual written consent of the parties to the contract provided such written consent is given before the expiration of the 30-day period. Prices will not be renegotiated. The Secretary also reserves the right to cancel the contract any time before the Notice to Proceed date. If the contract is cancelled, payment will be made only for the documented

costs of insurance and surety bonds required under Sections 103.04 and 103.05. No payment will be made for damages of any other kind including, but not limited to, lost profits.

**103.08 ASSIGNMENT OF ANTI-TRUST CLAIMS**—It is recognized that in actual economic practice, overcharges by suppliers resulting from violations of State or Federal antitrust laws are in fact borne by the State. As part of the consideration for the award of the contract, and intending to be legally bound, the Contractor assigns to the State all right, title, and interest in and to any current claims or claims hereafter acquired under State or Federal anti-trust laws relating to the subject matter of the contract.

# SECTION 104—SCOPE OF WORK

**104.01 INTENT OF PLANS AND SPECIFICATIONS**—The intent of the plans and specifications is to prescribe a complete project undertaken according to the contract. Therefore, according to the contract, furnish material, equipment, tools, labor, and incidental work complete in place, unless otherwise provided, and be responsible for the complete supervision, performance, and completion of the work.

**104.02 ALTERATION OF DRAWINGS OR WORK**—The Department reserves the right to order, at any time during the progress of the work, increases or decreases in quantities and alterations in the construction drawings or specifications, including alterations in the grade or alignment of the road or structures. Any such order will be in writing by the Representative. Also, should any item contained in the proposal and contract be found unnecessary for the proper completion of the work, a written order will be given to eliminate such item from the contract. Such increases, decreases, eliminations, and/or alterations will not invalidate the contract, nor release the surety.

If the aforementioned changes in quantities or alterations of the construction drawings will significantly increase or decrease the cost of performing the work directly affected, perform such work only when authorized in writing, as specified in Section 110.03(a). Payment for such work will be made under Section 110.03.

With the exception of advance warning signs, detour signs, work zone traffic control devices, and other items specified in the contract, perform no work beyond the limits of the project, except as authorized in writing by the Deputy Secretary for Highway Administration.

When an item of work is eliminated, reimbursement of actual expenses will be made as specified in Section 110.03(d). If the aforementioned changes in the quantities or alterations of the drawings are of such magnitude as to require a change in the time to complete the project, a time adjustment will be made as specified in Section 108.06.

**104.03 EXTRA WORK**—Anticipate that extra work might be necessary in order to complete the project as contemplated. Perform extra work according to the specifications and only when authorized in writing, as specified in Section 110.03. Compensation will be made as specified in Section 110.03.

**104.04 VALUE ENGINEERING**—Value engineering applies to cost reduction proposals that are initiated, developed, and submitted to the Department for modifying the plans, the specifications, or other contract requirements. These provisions do not apply to a proposal unless it is identified as a value engineering proposal at the time it is submitted. The Department is not required to accept or act upon submitted value engineering proposals.

Value engineering proposals are those that would require a change in the contract and would result in either no cost increase or a net cost savings to the Department. They are initiated by the Contractor who proposes to provide the function of an improved product or service at the same cost or a lower cost, and to accomplish the original purpose of the project without impairing essential functions and characteristics.

Submit the following minimum information with each proposal, allowing enough time for Department investigation and implementation without interfering with the project schedule:

- a description of the difference between the existing contract requirements and the proposed change, with the comparative advantages and disadvantages of each;
- an itemized list of the contract requirements which are to be changed if the proposal is adopted, with a recommendation for making each change;
- a detailed estimate of the net savings in construction costs that will result from the adoption of the proposal;
- a prediction of any effects the proposed change will have on other Department costs, such as maintenance and operations, and rehabilitation;

- a statement of the deadline for adopting the change in order to obtain maximum cost reduction during the remainder of the contract, noting any effect on the Required Completion Date or any specified Milestone Date(s) and any other schedule impacts; and

- the contract items of work affected by the proposed change, including any quantity changes, as well as any extra work items to be established, including prices and back-up data.

When preparing the detailed estimate of the net savings in construction cost that will result from the adoption of the proposal, the cost of the new work must include any increase in future maintenance or operational costs. One-half of the engineering and development costs incurred may also be included in the cost of the new work.

The Department reserves the right to make the changes, without compensation, if a value engineering proposal is based upon, or similar to, standard specifications, standard special provisions, or standard drawings adopted before the award date for the contract.

The Department will judge the acceptability of a value engineering proposal and the estimated net cost savings to be realized from adoption of all or any part of the proposal. In evaluating the estimated net cost savings, the Department may disregard the contract bid prices if, in the judgment of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted. Within 30 calendar days after receipt of the required minimum information, as specified herein, the Department will review and provide notification of its acceptance or rejection of the value engineering proposal.

If the proposal is accepted in whole or in part, such acceptance will be by a letter from the District Executive or the Chief Engineer, Highway Administration, as applicable. If the approval of the Department is conditional, the letter will note the conditions. The letter will serve as authorization for the District to process a contract work order to incorporate the necessary changes in the plans and specifications to permit the value engineering proposal, or any part of it accepted, to be put into effect.

Continue to perform the work according to the requirements of the contract until the Department processes a work order incorporating the value engineering proposal, in whole or in part.

Acceptance and/or preparation of the value engineering proposal and performance of the work will not extend the Required Completion Date and/or any specified Milestone Date(s) unless a request for an adjustment is submitted, as specified in Section 108.03(b), and approved by the Representative.

The Department reserves the right to adopt all, or any part, of a value engineering proposal for general use on other contracts.

Value engineering proposals that are either identical or similar to previously submitted proposals, will be eligible for consideration and compensation under the provisions of this section if the previously submitted proposals were not adopted for general application to other contracts administered by the Department.

Compensation for the Contractor's share of the actual net cost savings associated with a value engineering proposal will be as specified in Section 110.07.

**104.05 CLEANING OF PROJECT SITE**—Remove silt and other deposits from newly constructed culverts, inlet, outlet and parallel ditches, bridges, and other drainage structures, including stream channels. Clean and remove surplus and discarded material, equipment, and temporary structures from the project and adjacent properties, including waste and borrow areas. Remove debris and objectionable material from areas used or disturbed by the construction operations on, or within sight of, the highway. Remove paint marks or spills, stains, rust marks, oil, or any other unsuitable marks, as directed. Restore waste and borrow areas, as specified in Section 105.14.

Maintain the vegetation within the constructed slope limits, including waste and borrow areas, and leave the project in a presentable condition.

The project will not be considered complete until the above work has been completed.

**104.06 DISPOSAL OF EXISTING HIGHWAY STRUCTURES AND MATERIAL WITHIN THE PROJECT**—Satisfactorily remove and dispose of all existing highway structures and material which are not to remain in place or to be used in the new construction. Unless otherwise directed, dispose of these structures and material off the project site. However, if indicated, the Department will retain drainage pipes, drainage grates or castings, guide rail posts, guide rail, bridges not under the authority of the Department, and/or portions of Department bridges. Such structures on all other highways become the property of the local authorities having jurisdiction. If the local authorities do not want to retain any portion or portions of structures or material under their jurisdiction, then remove and dispose of them off the project site.

**104.07 MAINTENANCE OF EXISTING ROADWAY**—The Department reserves the right to enter upon a project and, at its own expense, maintain the existing roadway. Notwithstanding the performance of such work by the Department, continue to comply with all the provisions specified in Sections 105.13 and 901.

**104.08 UNEXPECTED HAZARDOUS WASTE**—The encountering of hazardous waste will be considered a differing site condition, as specified in Section 110.02(b), unless the presence of such waste is indicated in the proposal or contract. Hazardous waste is defined as material meeting the definition of a hazardous waste or Toxic Substance Control Act, Regulated PCB Waste, as specified in 40 CFR 260 or 25 PA Code, Chapters 260 to 270, Hazardous Waste Regulations.

If unexpected hazardous waste is encountered at the site, the Representative will investigate the conditions, determine the extent of the affected area, and authorize the Contractor, in writing, to remove and dispose of the waste. Payment for such work will be made as specified in Section 110.03.

The Contractor will not be required to perform or arrange for any work relating to the removal and disposal of unexpected hazardous waste. If the Contractor elects not to perform authorized waste removal and disposal work, notify the District Executive of that decision, in writing, within 2 working days of receipt of the Representative's written authorization. Cooperate fully with the Department and any authorized remediation Contractor, as specified in Section 105.07.

# SECTION 105—CONTROL OF WORK

## 105.01 AUTHORITY OF THE REPRESENTATIVE—

**(a) General.** The work will be subject at all times to the inspection of the Representative. Do not restrict or hinder this inspection.

To prevent disputes and litigation, the Representative will:

- determine the quantity of the kinds of work and the quality of material for which payment will be made under the contract;
- determine the answer to questions in relation to the project and its construction; and
- decide differences concerning the performance of the work covered by the contract.

All such determinations, decisions, directions, and explanations needed to complete, explain, or make definite any provisions of these Specifications and Plans will be given promptly, in writing, to the Contractor.

As a condition precedent to filing a claim for additional compensation because of any determination, decision, direction, or explanation of the Representative, submit notice of intent to claim to the District Executive, in writing, within 10 days of the determination, decision, direction, or explanation. This notice of intent will give the Department the opportunity to investigate the claim and to maintain and document information for future resolution or litigation of the claim.

File the claim in writing with the Contracting Officer within 6 months after it accrues and not thereafter. Attach to the claim a copy of the previously submitted notice of intent to claim. The Contracting Officer will attempt to settle and resolve the claim with the Contractor. The Contracting Officer, at his or her discretion, will conduct a claim review meeting to attempt to settle and resolve the claim with the Contractor. If a claim review meeting is held, it will be attended by representatives of the Contractor and such Department representatives as the Contracting Officer considers appropriate.

If the claim is not resolved by agreement between the Contracting Officer and the Contractor, the Agency Head will promptly issue a decision in writing, which will be delivered by registered mail to the Contractor. The decision of the Agency Head will state the reasons for the decision and will inform the Contractor of its right to administrative and judicial review as provided in Chapter 17 of 62 PA C.S. The Agency Head decision will be final and conclusive unless the Contractor files a claim with the Board of Claims within 30 days of receipt of the decision.

**(b) Authority to Suspend Work.** The Representative may suspend the work, wholly or in part, for the following reasons:

- failure to carry out orders;
- failure to comply with any provisions of the contract; or
- unforeseen conditions not anticipated in estimating the contract time necessary for the completion of the work.

Written notification will be given of the suspension and the reason(s) for the suspension.

**(c) Review and Acceptance.** Review and acceptance by the Department as specified, stated, or indicated in the contract will be made on the basis of limited, general inspections.

It is understood that, because of such limited reviews, ultimate responsibility for the satisfactory completion of the project, including but not limited to:

- the quality of all materials;
- the quality of all workmanship;

- compliance with all terms of the contract;
- sufficiency, correctness, and accuracy of all working or shop drawings; and
- sufficiency of all QC Plans,

rests solely with the Contractor. Notwithstanding review and/or acceptance, save and hold harmless the Department from the consequences of all defective work as well as all defects, errors and omissions in the working or shop drawings, QC Plans, and plans of every other kind prepared by the Contractor.

**105.02 DRAWINGS**—The following drawings, when applicable, are required to perform the work:

**(a) Contract Drawings.** These drawings will be furnished. They show roadway lines, grades, and typical cross sections; location and design of structures; related construction features and details; and construction quantities. Keep one set of the drawings available on the project.

**(b) Standard Drawings.** Section 101.03

**(c) Working Drawings.** Prepare these drawings to supplement the plans. They include falsework drawings, field sketches, erection diagrams, erection stresses and loads, and other details, as necessary to construct the project. Submit two copies of the drawings to the Representative, for review and acceptance, before beginning work on the item involved. All drawings for load-bearing falsework submissions are to be signed and sealed by a Professional Engineer, registered in the State.

**(d) Bridge Shop Drawings.** Prepare these drawings unless otherwise specified. Prepare drawings in pencil or ink on metric size A1, 594 mm x 841 mm (22-inch by 36-inch) acceptable drafting medium with a 40 mm (1 1/2-inch) margin on the left and 15 mm (1/2-inch) margins on the other three sides. Use at least size 30 metric, 3 mm high (Leroy lettering template 120). Lettering may be by hand. Make details clear and uncluttered, suitable for microfilming. When complete, coat the drawings, with suitable anti-smear spray. Show county, route, segment and offset, station, contract number, design drawing number, name of Contractor, and name of Fabricator. Show complete details, dimensions, material, camber diagrams, and welding details and sequences. Submit two sets of prints to the District Executive, or to an agent designated by the District Executive, for review and acceptance; for bridges carrying railroads, submit two additional sets. One set will be returned with corrections noted. Continue to resubmit until accepted. After acceptance, submit eight sets of full-size final prints, or six sets of 1/2-size prints plus two sets of full-size prints (or more if directed). If the quality of the 1/2-size prints is unacceptable, furnish full size prints upon request and without delay, at no additional cost to the Department. After erection is complete, but before project completion, submit final tracings showing as-built conditions, or two copies of microfilm of the final tracings, to the District Executive.

**105.03 CONFORMITY WITH DRAWINGS AND SPECIFICATIONS—**

**(a) General.** Perform work within reasonably close conformity to the lines, grades, dimensions, and indicated details, and/or as specified.

**(b) Determination by the Representative.**

**1. Restricted Performance Specifications.** The Representative will determine acceptability of material or construction. When material or construction is not within specification limits, acceptance will be as specified within the individual specification sections, except where test result variations are so great that the material or construction is unacceptable.

**2. Other Than Restricted Performance Specifications.** For each individual case, the Representative will determine the limits of reasonably close conformity; the judgment given will be final and conclusive.

If it is determined that material or the finished product in which the material was used is not within reasonably close conformity, but that reasonably acceptable work has been produced, the Representative will then

determine if the work will be accepted and remain in place. In this event, written documentation will be provided for acceptance by required contract modification, and/or to provide for an appropriate adjustment in the contract price for such work or material.

If it is determined that material or the finished product is not within reasonably close conformity and has resulted in an inferior or unsatisfactory product, remove or replace it.

**(c) Certification of Falsework Adequacy.** Have a Professional Engineer, registered in the State, certify that the falsework system has been assembled as shown on the Professional Engineer's signed and sealed falsework drawings prepared as specified in Section 105.02(c). Submit the certification to the Representative before placing loads on the falsework.

**105.04 COORDINATION OF PLANS AND SPECIFICATIONS**—Perform the work according to the intent of the Plans and Specifications. Do not take advantage of any error on/or omission in the Plans or discrepancy between the Plans and Specifications. In the event such an error, omission, or discrepancy is discovered, immediately notify the Department. Failure to notify the Department will constitute a waiver of all claims for misunderstandings, ambiguities, or any other reasons resulting from the errors, omissions, or discrepancies. If requested, corrections and interpretations necessary for the fulfillment of the Plans and Specifications will be made. Do not use scaled measurements where dimensions on the drawings are given or can be computed.

In case of a discrepancy among the contract documents, the following order of precedence will apply:

(1) Special Provisions
(2) Plans (excluding cited Standard Drawings)
(3) Specifications (other than Special Provisions)
(4) Standard Drawings

If any Special Provisions or information on the Plans conflict with these Specifications, the Special Provisions or information on the Plans will govern. If a conflict exists between any portion of the Plans designed specifically for this project and any portion of the Standard Drawings, the former will govern.

If necessary, the District Executive will determine and order, in writing, any modifications or changes in the Plans, Standard Drawings, or Specifications to update, adjust, accept, or complete the work contemplated by the contract as specified in Section 104.02. Wherever reference specifications or publications are specified, comply with the issue or edition (including interim AASHTO specifications and ASTM tentative designations) in effect on the date bids are opened, unless the date or year of the reference specification or publication is indicated or specified. If there is a conflict between a cited title and a cited section number, the title will take precedence over the section number.

**105.05 RESPONSIBILITY OF CONTRACTOR—**

**(a) General.** Keep direct control of the contract and see that the work is properly supervised and is performed satisfactorily and efficiently. Supervise the work personally or appoint a competent superintendent or representative to be on the project at all times. Give this superintendent or representative the authority to receive orders and directions; to execute orders and directions without delay; and to make arrangements for all necessary material, equipment, and labor.

Keep on the project, at all times, a copy of the plans, a copy of the specifications, and a copy of the contract, and a copy of all subcontracts.

The Department is not responsible for the Contractor's satisfactory completion of the contract work as a consequence of the presence of Department representatives or inspectors and their inspection.

**(b) Work By Others.** For work to be done without the supervision of the Department, investigate the work and anticipate its execution and completion. The Department will not be liable for failure to anticipate the time of performance and completion of such work, except in those cases where, upon timely request, the Department has agreed to cooperate.

**(c) Gratuities and Penalties.** Do not give or offer, or allow agents, employees, or representatives to give or offer, either directly or indirectly, money, property, entertainment, or other valuable things, to any employee or representative of the Department for any reason, purpose, or cause, or as an inducement, bribe, or reward for doing or omitting to do any act, or for showing any favor or disfavor in relation to any matter relating to the contract. Any

such action will constitute a violation of the contract. Upon satisfactory proof to the Secretary of such violation, the Department may terminate performance of the work and take steps to complete the project, as specified in Section 108.08.

**105.06 UTILITY INFRASTRUCTURE AND UTILITY ADJUSTMENTS –**

**(a) Utility Infrastructure and Utility Adjustments Interfering with Contract Operations.** Before submitting a bid for the project, examine the project site and any waste or borrow sites designated in the proposal to determine the location of all Utility Infrastructure and the need for any Utility Adjustments. The Department has indicated in the contract documents such Utility Infrastructure and Utility Adjustments as have been brought to its attention. The Department is not responsible for waste and borrow areas not designated in the contract documents. Accept the responsibility and risk relating to the conditions to be encountered regarding Utility Infrastructure and Utility Adjustments that are indicated in the contract documents or that can be ascertained from a careful pre-bid examination of the project site for any waste or borrow sites designated in the proposal.

Upon execution of the contract, inform all public service companies, individuals, and others owning or controlling any facilities or structures within the limits of the project, which may have to be relocated, adjusted, or reconstructed, of the plan of construction operations. Give due notice to the responsible party in sufficient time for that party to organize and perform such work in conjunction with or in advance of construction operations.

Cooperate with the Utility Infrastructure owners and the owners of all waste and borrow areas not on the project site. Make arrangements for Utility Adjustments necessary to perform the work as indicated in the contract documents. Arrange and perform contract work in and around such Utility Infrastructure in accordance with recognized and accepted engineering and construction practices and in a manner that assists the Utility Infrastructure owners in their required Utility Adjustments.

Refer to the provisions of Act 287-1974, as amended by Act 187-1996, which specifies project responsibilities in regard to public health and safety during excavation and demolition operations in areas of underground utilities.

**(b) Delays in the Performance of Work.** No additional compensation will be paid because of an impact to the contract work from Utility Infrastructure and Utility Adjustments unless the Contractor establishes, to the satisfaction of the District Executive and the Chief Engineer, that the impact was unforeseen and unforeseeable by a reasonable contractor; that losses could not have been avoided by the judicious handling of forces, equipment and plants, or by reasonable revisions to the schedule of operations; and that the impact has resulted in a documented increase in the cost of performing the contract work, in which case only delay damages will be paid as specified in Section 111.

The following are conditions precedent to the right, if any, of the Contractor to an adjustment in compensation:

- Attend a coordination meeting(s) that will be scheduled and conducted by the Department before beginning construction. The meeting(s) will include all Utility Infrastructure owners. At this meeting(s), be prepared to discuss: the project schedule; all project milestones and required completion dates and all activities related to Utility Infrastructure and Utility Adjustments and; how the project schedule differs from the utility relocation schedule prepared by the Department during project design. Incorporate appropriate information from this meeting(s) into the project schedule as specified in Section 108.03(b) or the Scheduling Special Provision, if applicable. The Department will provide a record of the meeting(s).

- Furnish all schedule updates specified in Section 108.03(b) or the Scheduling Special Provision, if applicable, to all affected Utility Infrastructure owners.

- Comply with the requirements specified in Section 111.

**(c) Utility Adjustments by Others.** When required, owners or lessees are to bring railway tracks to the established line and grade. Utility Adjustments are to be performed by the owners of the Utility Infrastructure, unless otherwise indicated. Check the line and grade before base or pavement is placed adjacent to or around such Utility Infrastructure.

**(d) Damage to Utility Infrastructure.** Compensate the owner for all cost of repairing, replacing, or resetting any Utility Infrastructure damaged or disturbed by contract construction as specified in Section 107.12.

Coordinate with the railroad company to provide accepted measures for protection of railroad tracks and ballast from debris, silt, or other foreign matter.

Provide required means of protection, maintenance, cleaning, repair, and replacement of ballast. This work will be subject to the approval of the Railroad's Chief Engineer or authorized representative.

**105.07 COOPERATION BETWEEN CONTRACTORS**—The Department reserves the right to contract for and perform other work on or near the work covered by the contract.

If separate contracts are awarded within the limits of, or adjacent to, any one project, conduct the work to avoid interfering with or hindering the progress or completion of the work being performed by other contractors. As directed, cooperate with contractors working on the same project. Satisfactorily join work with and in proper sequence with the work of others.

Assume all liability in connection with the contract. Protect and save harmless the Department from all damages or claims that may arise because of inconvenience, delay, or loss experienced because of the presence and operations of other contractors working within or outside the same project limits.

**105.08 CONSTRUCTION SURVEYING—**

**(a) Projects that Do Not Include a Construction Surveying Pay Item.** If the project plans and specifications do not indicate a separate pay item for Construction Surveying, control stakes will be furnished and placed, offset from the proposed roadway base line, and a grade sheet will be furnished showing the horizontal and vertical measurements from the stakes to the base line and grade of the roadway as planned, including adjusted alignment and grades, as directed, to meet conditions. Where the highway is to be constructed on a grade of more than 4%, an offset stake will be set on each side of each designated grade point. The stakes will be on a direct line through the grade point or base line, or otherwise, as may be required. Slope stakes will be placed adjacent to the top of cut and toe of embankment slopes where these points are more than 2 m (5 feet) vertically above or below the finished grade line. Applicable base line, abutment, pier, sidewall, and wingwall stakes, together with offset, reference, and grade stakes for bridges, arches, slab and box culverts, including metal plate and pipe culverts and other special structures, will also be placed, as required, to facilitate and control the work.

Employ a Professional Land Surveyor or Professional Engineer, registered in the State, qualified in the use of plans, cross sections, and specifications, to establish lines and grades, as may be required. Assume full responsibility for dimensions and elevations taken from the control stakes and the setting of lines and grades.

Furnish templates and other material and place additional stakes and markers necessary for control and guidance of construction operations. Also, furnish the Inspector with any assistance required for checking lines, grades, and measurements established (other than by the Department) and necessary for the performance of the work. The Department does not assume responsibility for the performance of the work as a consequence of this checking.

Preserve survey points and stakes, as placed. If any of these surveying controls are disturbed or destroyed by construction operations, the cost to the Department for replacement will be charged against and deducted from money due or to become due.

**(b) Projects that Include a Construction Surveying Pay Item.** If the project plans and specifications indicate a separate pay item for Construction Surveying, perform the work as specified in Section 686.

**105.09 AUTHORITY AND DUTIES OF INSPECTOR-IN-CHARGE**—The Inspector-in-Charge will have immediate responsibility for administering the performance of work on the project.
In case a dispute arises concerning material to be furnished or the manner of performing the work, the Inspector-in-Charge will have authority to reject material or suspend the work until the question at issue can be referred to and be decided by the Representative. A rejection of material or suspension of work will be confirmed by written notice from the Representative.

**105.10 INSPECTION OF WORK**—The work will be subject to the inspection of the Representative or authorized assistants. Provide them access to the work and furnish them with every reasonable facility for determining whether

the work being performed or which has been completed is according to the requirements of the plans, specifications, and contract, except as otherwise provided. Provide all labor and equipment necessary for such examination.

Should the work thus exposed or examined prove satisfactory, the uncovering or removing and restoring of the uncovered or removed work will be paid for, as specified in Section 110.03, except the incidental work for testing the depth of base and surface courses and pavement will not be paid for separately. Should the work exposed or examined prove defective or unsatisfactory, promptly uncover or remove and satisfactorily restore the defective or unsatisfactory work, at no expense to the Department.

When any unit of government or political subdivision, or any public or private corporation, is to pay a portion of the cost of the work covered by the contract, the respective representatives will have the right to inspect the work. Such inspection will not make any unit of government or political subdivision, or any public or private corporation, a party to this contract and will in no way interfere with the rights of either party to this contract.

**105.11 DUTIES OF THE INSPECTOR**—Authorized inspectors, who perform their duties under the direction of the Representative, will be assigned to the project.

Execute work under the observation and subject to examination of an inspector(s); carry out such work during the normal working hours of the day, unless specifically directed otherwise. If work is performed during nighttime hours with permission, provide sufficient artificial lighting to assure proper inspection and workmanship.

The inspector is not authorized to do the following: revoke, alter, enlarge, relax, or release any requirements of the specifications; approve or accept any portion of the work; or issue instructions contrary to the plans and specifications.

The presence of the inspector during the performance of any work on the project will not relieve the Contractor of the responsibility for work that is later determined by the Representative to be defective.

**105.12 DEFECTIVE WORK AND MATERIAL**—If any work and/or material does not meet the requirements of the plans and specifications, or is not within reasonably close conformity, as determined by the Representative, such work and/or material will be declared defective.

Unless otherwise specified, repair, as directed, or remove and replace defective work and/or material at no expense to the Department.

**105.13 MAINTENANCE OF PERFORMED WORK—**

**(a) Maintenance of Performed Work.** Maintain performed work, making continuous and effective efforts, with adequate equipment and forces, to keep the roadway or structures in satisfactory condition at all times during construction. Provide such maintenance, at no additional cost to the Department, until relieved of responsibility for further physical work, maintenance, and third party liability as specified in Section 110.08(a).

If, at any time, performed work is not maintained, the Department reserves the right to perform such work as may be considered necessary for traffic accommodation and to deduct the cost thereof from money due or to become due the Contractor.

Provide removals, renewals, restorations, and repairs as required to remedy damage to performed work occurring before relief of Contractor responsibility as specified in Section 110.08(a). Perform such work, according to the terms and conditions of the contract, at no expense to the Department. If, as determined by the Representative, the damage is due to unforeseeable causes beyond the control of the Contractor and occurs despite satisfactory maintenance precautions taken, such work will be paid for, at the Department's expense, as specified in Section 110.03.

**(b) Maintenance During Temporary Suspension of Work.** If the work is temporarily suspended, wholly or in part, for a sustained or indefinite period, satisfactorily store all materials and take every precaution to prevent damage or deterioration of preformed work. Provide suitable drainage for the roadway by constructing temporary shoulders; by opening culverts, inlets, and parallel ditches; and by erecting temporary drainage structures where necessary.

During suspension, the entire project under contract, or any section, may be opened to traffic, as directed. If opened to traffic, maintain the roadway in satisfactory condition and maintain local traffic as specified in Section 902. Perform such work at no expense to the Department, except as specified in Section 902.4. During work

suspension, remove all protective devices installed on the project. However, if directed, maintain protective devices in certain areas.

If work is suspended in part, the Representative will have the authority to direct that other parts or items of work be performed.

Satisfactorily protect the ends of any sections of rigid-type base course, pavement, or wearing surface opened to traffic during a temporary, partial suspension of work. Maintain this protection, remove it when no longer required, and satisfactorily dispose of protective material.

During any period of work suspension, properly and continuously maintain, in an acceptable growing condition, all living material in newly established plantings, seedings, and soddings furnished under the contract. Take adequate precautions to protect new tree growth and other desirable vegetative growth.

**105.14 BORROW AREAS AND WASTE AREAS—**

**(a) Non-Designated Areas.** Locate proposed areas for obtaining borrow material and/or areas for disposal of waste material, when required. Situate areas so cross sections may be taken by the Department to measure the volume of material removed or deposited. Before cross sectioning borrow areas, remove topsoil and stockpile it for replacement when removal of borrow material has been completed.

Review proposed areas with the Representative for approval to negotiate a "Borrow and/or Waste Agreement." Obtain waterway and/or other required permits as applicable. Prepare and submit an Erosion and Sediment Pollution Control Plan to the Conservation District for approval. Negotiate with the owner(s) of property to be obtained by using the Department's standard "Borrow and/or Waste Agreement," available from the District Executive . This standard agreement may be modified to cover unusual or special conditions, provided such conditions are acceptable to the Department. Submit one copy of the executed agreement to the Representative for review and acceptance. Do not proceed with work in the area until such review and acceptance is completed and until written notification of the acceptance is received.

Also submit one copy of applicable permits and of the approved Erosion and Sedimentation Control Plan to the Representative before starting work.

Have the agreement provide for cleaning and leaving the premises and area in a well-drained and, if required, smoothly graded condition, blending into the existing topography. Scarify, lime, fertilize, seed, and mulch any disturbed areas with material, and formulae, at rates typical for the project. When directed, satisfactorily remove and dispose of surplus material.

Perform the clean fill determination for all borrow materials entering the construction right-of-way by completing and submitting the Environmental Due Diligence Form EDD-VI, and, if necessary, Form EDD-VII to the Department for acceptance.

**(b) Designated Areas.** If the Department has previously selected areas from which to obtain borrow or areas in which to deposit waste, the proposal will specify the location(s).

For such designated area(s), complete the standard agreement as specified above for Non-Designated Areas. The Department will provide all applicable permits and Erosion and Sediment Pollution Control Plans.

**105.15 ARCHEOLOGICAL AND HISTORICAL FINDINGS—**In areas where remains of prehistoric people's dwelling sites or where artifacts of historical or archeological significance are encountered, discontinue construction operations in the general area. Contact will be made with the State Historical and Museum Commission to determine how to proceed. When directed, satisfactorily excavate the site to preserve the artifacts encountered, then remove them for delivery to the custody of the Pennsylvania Historical and Museum Commission. In the event construction operations are halted or delayed because of archeological or historic findings, appropriate adjustments will be made in the contract time as specified in Section 108.06. Such site excavation will be considered extra work as specified in Section 104.03.

**105.16 COAL OR VALUABLE MINERAL FINDINGS**—If coal or other valuable minerals are uncovered, during prosecution of the work, that are not addressed by contract special provisions, store and handle the coal and other valuable minerals according to the directions of the Representative.

Do not claim or assume ownership rights.

If direction is given to handle and dispose of the material in a manner other than as unsuitable material, the contract time and contract price may be adjusted as specified in Section 110.02.

# SECTION 106—CONTROL OF MATERIAL

**106.01 GENERAL**—Use material complying with the requirements of these specifications. At the pre-construction conference, submit a list of material to be sampled and tested by the Contractor and a list of material to be sampled and tested by the Department.

Refer to the provisions of Act 226-1968, concerning the purchase of aluminum and steel products produced in a foreign country, except for those projects, which are partially or totally financed with Federal funds.

According to the provisions of Act 3-1978, as amended by the Act 161-1982, and the Act 144-1984, use or furnish only steel products produced in the United States in the performance of the contract or any subcontract.

Following contract execution, furnish to the Department a complete statement of the project construction material's origin, composition, and manufacture.

With each shipment of steel products delivered to the project site, except fabricated steel (see Section 1105.01(e)6), provide the Inspector-in-Charge the following:

- For unidentified steel products, documentation such as invoices, bills of lading, and mill certification that the steel was melted and manufactured in the United States.

- For a steel product identifiable from its face, certification that Section 4 of the Act has been complied with.

The provisions of this act will not be waived unless the Secretary has determined, under authority granted in Section 4(b) of the act, that a certain steel product or products is not produced in the United States in sufficient quantities to meet contract requirements. Such a determination will be set forth in the proposal, or in an addendum to the proposal.

Steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, otherwise similarly processed, or processed by a combination of two or more of these operations from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer, or any other steel-producing process. Included are cast iron products and machinery and equipment as listed in United States Department of Commerce Standard Industrial Classification 25, 35, and 37 and made of, fabricated from, or containing steel components. If a product, as delivered to the project, contains both foreign and United States steel, such product is considered to be a United States steel product only if at least 75% of the cost of the articles, materials, and supplies have been mined, produced, or manufactured, as the case may be, in the United States. On Federal-Aid projects, comply with the provisions specified in Section 106.10.

No payment will be made on the contract if unidentified steel products are supplied, until the hereinbefore requirements are met.

Any payments made that should not have been made may be recoverable from a manufacturer or supplier as well as from a contractor or subcontractor.

Any person who willfully violates the Act will be prohibited from submitting bids for any contract for a period of 5 years from the date of determination that a violation has occurred. In the event the person who violates the provisions of Section 4(A) is a subcontractor, manufacturer or supplier, such person will be prohibited from performing any work or supplying any materials to the Department for a period of 5 years from the date of determination that a violation has occurred.

If steel products are used as a construction tool and will not serve a permanent functional use in the project, compliance with Act 3-1978, as amended by the Act 161-1982, and the Act 144-1984, is not required.

When standard manufactured items are specified and these items are identified by unit mass (unit weight), section dimensions, or similar characteristics, their identification will be considered to be nominal masses (weights) or dimensions. Unless more stringently controlled by specified tolerances, industry established manufacturing tolerances will be accepted.

**106.02 MATERIAL—**

**(a) Preliminary Acceptance and Approval.** Have the source(s) of material supply approved before delivery to project.

**1. Preapproved Sources.** For any preapproved source of material supply, submit the following: source; description; and specified use. If a previously accepted source of material no longer provides the specified material, furnish material from another preapproved source as specified in Section 106.03(b)3.

**2. Other Sources.** If source of material is not preapproved, submit the following: source; description; specified use; QC Plan; and samples of the kind and quality specified, to the MTD with a copy to the Representative.

Do not deliver material from the unapproved source to the project until written acceptance is received from the Representative. The Department reserves the right to obtain samples of the material provided by the Contractor for laboratory testing to verify compliance with specifications.

**(b) Inspection.** Inspect material delivered to the project and stockpile the material passing inspection for use. Do not incorporate questionable material, until material is tested by MTD and accepted in writing by the Representative. The Department reserves the right to reject questionable material delivered to the project when the MTD test results are not according to the specifications. Furnish assistance to the Inspector, as required to obtain samples.

Allow designated Department representatives to inspect material being used, or intended to be used, at any time before, during, or after material preparation, while being used during the progress of the work, or after the work has been completed. Furnish or arrange with producers or manufacturers to provide necessary material, labor, tools, and equipment for such inspection.

Inspections and tests, if made at any point other than the point of incorporation in the work, will not guarantee acceptance of the material. Inspection and testing performed by the Department will not relieve the Contractor's responsibility for QC.

## 106.03 TESTS AND ACCEPTANCE OF MATERIAL—

### (a) Restricted Performance Specifications.

**1. Responsibility.** The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Lot size will be specified. In the event that operational conditions cause work to be interrupted before the specified lot size has been achieved, the lot may be redefined by the Inspector. It is the intent of these specifications that each lot be evaluated based on the same number of samples. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOCM.

Independent Assurance sampling and testing will be administered by the BOCM.

**2. QC.**

**2.a** Maintain a QC system that provides reasonable assurance that materials, products, and completed construction, submitted for acceptance, conform to contract requirements whether self-manufactured, processed, or procured from subcontractors or vendors. When specified, submit for review, a plan of the QC system to be used. Have performed or perform the inspections and tests required to substantiate product conformance to contract requirements. Make the inspection and test results available for review throughout the

contract life. Procedures will be subject to the review of the Department before the work is started. Charts and records documenting QC inspections and tests are the property of the Department. Submit a QC Plan for use in compliance with the following guidelines, as a minimum:

**2.a.1 Raw Materials.** List the source of material along with methods of documentation and testing performed to assure the material quality.

**2.a.2 Production Control.** List lot size and samples required; include sample selection, labeling and test procedure; also include manufacturing phase.

**2.a.3 Product Testing.** List type and frequency of tests to be performed, along with method of documenting and reporting test results. List test equipment and calibration procedure (frequency) required. List procedure for retesting or rejecting items failing the tests. List the disposal methods and location for test samples and rejected lots.

**2.a.4 Personnel.** List the personnel in charge of QC and define their areas of responsibility.

**2.a.5 Packaging and Shipping.** List method of identifying, storing, loading, transporting, and unloading to assure safe delivery of acceptable material and products.

**2.a.6 Documentation.** List the procedures used for documentation and certification.

The QC Plan and process are subject to periodic review and inspection by the Department.

**2.b** Promptly record conforming and non-conforming inspection and test results on acceptable forms or charts. Keep these records complete and keep them available for inspection at all times during the performance of the work.

**2.c** Promptly correct any errors, equipment malfunctions, process changes, or other assignable causes which have resulted or could result in the submission of material, products, and completed construction not conforming to specification requirements.

**2.d** When required, provide or have provided and maintain measuring and testing devices necessary to ensure that material and products conform to contract requirements. In order to ensure continued accuracy, calibrate these devices at established intervals against Department standards.

**2.e** When required, make the measuring and testing equipment available to the Representative for use in determining conformance of material, products, or completed construction with contract requirements. In addition, make personnel available for the operation of such devices and for verification of the accuracy and condition of the devices. Have calibration results available at all times. The Department reserves the right to conduct periodic inspections of the measuring and testing devices to confirm both calibration and condition of operation.

**2.f** Failure to comply with the QC Plan may result in suspension of approval to provide material for Department use and/or removal from the approved list of material suppliers in the applicable bulletins.

**3. Acceptance Plans.**

**3.a Percent Within Tolerance.** The percentage of each lot within the specified tolerances will be determined by the following procedures:

**3.a.1** The "n" sampling positions on the lot will be located by use of the table of random numbers found in PTM No. 1.

**3.a.2** A measurement will be made at each location, or a test portion taken and the measurement made on the test portion.

**3.a.3** The lot ( X ) measurements are averaged to find $\overline{X}$.

$$\overline{X} = \sum_{i=1}^{n} \frac{X_i}{n}$$

**3.a.4** The Standard Deviation, "s," of the lot measurements will be determined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{n-1}}$$

**3.a.5** The Quality Index ($Q_U$) is found by subtracting the average (X) of the measurements from the upper specification limit (U) and dividing the result by "s."

$$Q_u = \frac{(u - \overline{X})}{s}$$

**3.a.6** The Quality Index ($Q_L$) is found by subtracting the lower specification limit (L) from the average and dividing the result by "s."

$$Q_L = \frac{(\overline{X} - L)}{s}$$

**3.a.7** The percentage of material that will fall within the upper tolerance limit (U) is estimated by entering Table A or Table B with $Q_U$, using the column appropriate to the total number of measurements (n). Use Table A if $Q_U$ has a negative value, or use Table B if $Q_U$ has a positive value.

**3.a.8** The percentage of material that will fall within the lower tolerance limit (L) is estimated by entering Table A or Table B with $Q_L$, using the column appropriate to the total number of measurements (n). Use Table A if $Q_L$ has a negative value, or use Table B if $Q_L$ has a positive value.

**3.a.9** In cases where both upper (U) and lower (L) tolerance limits are concerned, the percentage of material that will fall within tolerance limits is found by adding the percent ($P_U$) within the upper tolerance limit (U) to the percent ($P_L$) within the lower tolerance limit (L) and subtracting 100 from the sum.

$$\text{Total percent within limits} = (P_U + P_L) - 100$$

**3.a.10** When determining the percentage within tolerance when the calculated Quality Index (Q.I.) value is between two tabular values in Table A or Table B, the following procedure is used:

- The difference between the tabular Q.I. values on either side of the calculated value Q.I. value will be determined.
- The difference will be divided by 2 and the quotient added to the lower tabular Q.I. value, resulting in the interpolated Q.I. value.
- If the calculated Q.I. is equal to or greater than the interpolated value, the higher listed percent within tolerance will be used.
- If the calculated Q.I. is less than interpolated value, the lower listed percent within the tolerance will be used.

**TABLE A**
**Estimating Percent of Lot Within Tolerance**
**(Standard Deviation Method)**
**Negative Values of $Q_U$ or $Q_L$**

| Percent Within Tolerance | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 49 | 0.0361 | 0.0300 | 0.0281 | 0.0272 | 0.0267 |
| 48 | 0.0722 | 0.0600 | 0.0562 | 0.0545 | 0.0535 |
| 47 | 0.1083 | 0.0900 | 0.0843 | 0.0818 | 0.0802 |
| 46 | 0.1444 | 0.1200 | 0.1124 | 0.1091 | 0.1070 |
| 45 | 0.1806 | 0.1500 | 0.1406 | 0.1364 | 0.1338 |
| 44 | 0.2158 | 0.1800 | 0.1689 | 0.1639 | 0.1608 |
| 43 | 0.2510 | 0.2100 | 0.1972 | 0.1914 | 0.1878 |
| 42 | 0.2863 | 0.2400 | 0.2256 | 0.2189 | 0.2148 |
| 41 | 0.3215 | 0.2700 | 0.2539 | 0.2464 | 0.2418 |
| 40 | 0.3568 | 0.3000 | 0.2823 | 0.2740 | 0.2689 |
| 39 | 0.3912 | 0.3300 | 0.3106 | 0.3018 | 0.2966 |
| 38 | 0.4252 | 0.3600 | 0.3392 | 0.3295 | 0.3238 |
| 37 | 0.4587 | 0.3900 | 0.3678 | 0.3577 | 0.3515 |
| 36 | 0.4917 | 0.4200 | 0.3968 | 0.3859 | 0.3791 |
| 35 | 0.5242 | 0.4500 | 0.4254 | 0.4140 | 0.4073 |
| 34 | 0.5564 | 0.4800 | 0.4544 | 0.4426 | 0.4354 |
| 33 | 0.5878 | 0.5101 | 0.4837 | 0.4712 | 0.4639 |
| 32 | 0.6187 | 0.5401 | 0.5131 | 0.5002 | 0.4925 |
| 31 | 0.6490 | 0.5701 | 0.5424 | 0.5292 | 0.5211 |
| 30 | 0.6788 | 0.6001 | 0.5717 | 0.5586 | 0.5506 |
| 29 | 0.7076 | 0.6301 | 0.6018 | 0.5880 | 0.5846 |
| 28 | 0.7360 | 0.6601 | 0.6315 | 0.6178 | 0.6095 |
| 27 | 0.7635 | 0.6901 | 0.6619 | 0.6480 | 0.6395 |
| 26 | 0.7905 | 0.7201 | 0.6919 | 0.6782 | 0.6703 |
| 25 | 0.8164 | 0.7501 | 0.7227 | 0.7093 | 0.7011 |
| 24 | 0.8416 | 0.7801 | 0.7535 | 0.7403 | 0.7320 |
| 23 | 0.8661 | 0.8101 | 0.7846 | 0.7717 | 0.7642 |
| 22 | 0.8896 | 0.8401 | 0.8161 | 0.8040 | 0.7964 |
| 21 | 0.9122 | 0.8701 | 0.8479 | 0.8363 | 0.8290 |
| 20 | 0.9342 | 0.9001 | 0.8798 | 0.8693 | 0.8626 |
| 19 | 0.9555 | 0.9301 | 0.9123 | 0.9028 | 0.8966 |
| 18 | 0.9748 | 0.9601 | 0.9453 | 0.9367 | 0.9315 |
| 17 | 0.9940 | 0.9901 | 0.9782 | 0.9718 | 0.9673 |
| 16 | 1.0118 | 1.0201 | 1.0125 | 1.0073 | 1.0032 |

**TABLE A (continued)**
**Estimating Percent of Lot Within Tolerance**
**(Standard Deviation Method)**
**Negative Values of $Q_U$ or $Q_L$**

| Percent Within Tolerance | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 15 | 1.0286 | 1.0501 | 1.0469 | 1.0437 | 1.0413 |
| 14 | 1.0446 | 1.0801 | 1.0819 | 1.0813 | 1.0798 |
| 13 | 1.0597 | 1.1101 | 1.1174 | 1.1196 | 1.1202 |
| 12 | 1.0732 | 1.1401 | 1.1538 | 1.1592 | 1.1615 |
| 11 | 1.0864 | 1.1701 | 1.1911 | 1.2001 | 1.2045 |
| 10 | 1.0977 | 1.2001 | 1.2293 | 1.2421 | 1.2494 |
| 9 | 1.1087 | 1.2301 | 1.2683 | 1.2866 | 1.2966 |
| 8 | 1.1170 | 1.2601 | 1.3091 | 1.3328 | 1.3465 |
| 7 | 1.1263 | 1.2901 | 1.3510 | 1.3813 | 1.3990 |
| 6 | 1.1330 | 1.3201 | 1.3946 | 1.4332 | 1.4562 |
| 5 | 1.1367 | 1.3501 | 1.4408 | 1.4892 | 1.5184 |
| 4 | 1.1402 | 1.3801 | 1.4898 | 1.5500 | 1.5868 |
| 3 | 1.1439 | 1.4101 | 1.5428 | 1.6190 | 1.6662 |
| 2 | 1.1476 | 1.4401 | 1.6018 | 1.6990 | 1.7615 |
| 1 | 1.1510 | 1.4701 | 1.6719 | 1.8016 | 1.8893 |

**TABLE B**
**Estimating Percent of Lot Within Tolerance**
**(Standard Deviation Method)**
**Positive Values of $Q_U$ or $Q_L$**

| Percent Within Tolerance | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 99 | 1.1510 | 1.4701 | 1.6719 | 1.8016 | 1.8893 |
| 98 | 1.1476 | 1.4401 | 1.6018 | 1.6990 | 1.7615 |
| 97 | 1.1439 | 1.4101 | 1.5428 | 1.6190 | 1.6662 |
| 96 | 1.1402 | 1.3801 | 1.4898 | 1.5500 | 1.5868 |
| 95 | 1.1367 | 1.3501 | 1.4408 | 1.4892 | 1.5184 |
| 94 | 1.1330 | 1.3201 | 1.3946 | 1.4332 | 1.4562 |
| 93 | 1.1263 | 1.2901 | 1.3510 | 1.3813 | 1.3990 |
| 92 | 1.1170 | 1.2601 | 1.3091 | 1.3328 | 1.3465 |
| 91 | 1.1087 | 1.2301 | 1.2683 | 1.2866 | 1.2966 |
| 90 | 1.0977 | 1.2001 | 1.2293 | 1.2421 | 1.2494 |
| 89 | 1.0864 | 1.1701 | 1.1911 | 1.2001 | 1.2045 |
| 88 | 1.0732 | 1.1401 | 1.1538 | 1.1592 | 1.1615 |
| 87 | 1.0596 | 1.1101 | 1.1174 | 1.1196 | 1.1202 |
| 86 | 1.0446 | 1.0801 | 1.0819 | 1.0813 | 1.0798 |
| 85 | 1.0286 | 1.0501 | 1.0469 | 1.0437 | 1.0413 |
| 84 | 1.0118 | 1.0201 | 1.0125 | 1.0073 | 1.0032 |
| 83 | 0.9940 | 0.9901 | 0.9782 | 0.9718 | 0.9673 |
| 82 | 0.9748 | 0.9601 | 0.9453 | 0.9367 | 0.9315 |
| 81 | 0.9550 | 0.9301 | 0.9123 | 0.9028 | 0.8966 |
| 80 | 0.9342 | 0.9001 | 0.8798 | 0.8693 | 0.8626 |
| 79 | 0.9122 | 0.8701 | 0.8479 | 0.8363 | 0.8290 |
| 78 | 0.8896 | 0.8401 | 0.8161 | 0.8040 | 0.7964 |
| 77 | 0.8661 | 0.8101 | 0.7846 | 0.7717 | 0.7642 |
| 76 | 0.8416 | 0.7801 | 0.7535 | 0.7403 | 0.7320 |
| 75 | 0.8164 | 0.7501 | 0.7227 | 0.7093 | 0.7011 |
| 74 | 0.7905 | 0.7201 | 0.6919 | 0.6782 | 0.6703 |
| 73 | 0.7635 | 0.6901 | 0.6619 | 0.6480 | 0.6395 |
| 72 | 0.7360 | 0.6601 | 0.6315 | 0.6178 | 0.6095 |
| 71 | 0.7076 | 0.6301 | 0.6018 | 0.5880 | 0.5846 |
| 70 | 0.6788 | 0.6001 | 0.5717 | 0.5586 | 0.5506 |
| 69 | 0.6490 | 0.5701 | 0.5424 | 0.5292 | 0.5211 |
| 68 | 0.6187 | 0.5401 | 0.5131 | 0.5002 | 0.4925 |
| 67 | 0.5878 | 0.5101 | 0.4837 | 0.4712 | 0.4639 |
| 66 | 0.5564 | 0.4800 | 0.4544 | 0.4426 | 0.4354 |
| 65 | 0.5242 | 0.4500 | 0.4254 | 0.4140 | 0.4073 |

**TABLE B (continued)**
**Estimating Percent of Lot Within Tolerance**
**(Standard Deviation Method)**
**Positive Values of $Q_U$ or $Q_L$**

| Percent Within Tolerance | n=3 | n=4 | n=5 | n=6 | n=7 |
|---|---|---|---|---|---|
| 64 | 0.4917 | 0.4200 | 0.3968 | 0.3859 | 0.3791 |
| 63 | 0.4587 | 0.3900 | 0.3678 | 0.3577 | 0.3515 |
| 62 | 0.4252 | 0.3600 | 0.3392 | 0.3295 | 0.3238 |
| 61 | 0.3912 | 0.3300 | 0.3106 | 0.3018 | 0.2966 |
| 60 | 0.3568 | 0.3000 | 0.2823 | 0.2740 | 0.2689 |
| 59 | 0.3215 | 0.2700 | 0.2539 | 0.2464 | 0.2418 |
| 58 | 0.2863 | 0.2400 | 0.2256 | 0.2189 | 0.2148 |
| 57 | 0.2510 | 0.2100 | 0.1972 | 0.1914 | 0.1878 |
| 56 | 0.2158 | 0.1800 | 0.1689 | 0.1639 | 0.1608 |
| 55 | 0.1806 | 0.1500 | 0.1406 | 0.1364 | 0.1338 |
| 54 | 0.1444 | 0.1200 | 0.1124 | 0.1091 | 0.1070 |
| 53 | 0.1083 | 0.0900 | 0.0843 | 0.0818 | 0.0802 |
| 52 | 0.0722 | 0.0600 | 0.0562 | 0.0545 | 0.0535 |
| 51 | 0.0361 | 0.0300 | 0.0281 | 0.0272 | 0.0267 |
| 50 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

**3.b Resampling of Lot.** It is the intent of these specifications that lots will meet specification requirements at the time of submission. If permitted, nonconforming lots that can be corrected may be reworked and sampled.

**3.c General Basis of Adjusted Payment.** The related adjusted percentage of contract price will be determined by the method designated in the appropriate specification section.

**(b) Specifications, Other than Restricted Performance.**

**1. Responsibility.** The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department's specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include QC sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing QC sampling and testing. Perform QC sampling and testing and report results to the Inspector.

Do not incorporate any material into the work that is determined to be outside the specification limits.

Obtain and test samples according to the Department's PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

QA sampling and testing will be performed or witnessed by the BOCM.

Independent Assurance sampling and testing will be administered by the BOCM.

**2. QC.** Section 106.03(a)2. and as follows:

Provide a plan of the QC system to be used for all construction work requiring acceptance testing by the Department, including QC test frequencies and action points to initiate corrective measures. Submit a copy of the QC Plan to the Project Engineer, to be maintained at the Department's project field office, before the start of work. A QC Plan is not required for items specified in Section 901.

**3. Certification.** Maintain the original copy of Form CS-4171, supplied by the Department, along with all component certifications, at the last manufacturer's, fabricator's, or producer's location for a period of not less than 3 years from the date of the last shipment to the project. Make files available for inspection and verification by a Department Representative. Do not incorporate any material in the work until certification arrives on the project, unless otherwise approved. To avoid delays, have noncertified material tested and approved by MTD.

Notify suppliers that certification file must be maintained for purchased materials to provide an audit trail to the manufacturer, fabricator, or producer. Notify manufacturers, fabricators, and producers that all component certifications for purchased materials must be maintained at their place of business for a period of 3 years from the date of the last shipment to the project and available for inspection by the Department.

Include the following information for certifications including Form CS-4171 on file with the last manufacturer, producer, or supplier.

- Material Identification and Quantity.
- Lot Number.
- Specification Reference (ASTM or AASHTO) and/or test data for the material shipped.
- BUY AMERICA Certification for Iron, Steel, or Coating application if applicable.
- Signature and title of a legally responsible person in the manufacturing firm. The legally responsible person's name is also to be printed or typed next to or below his or her signature.

Submit a copy of Form CS-4171, with each shipment of material to the project.

Accept responsibility for all certifications for all materials arriving at the project. Materials of questionable quality delivered to the project will be sampled, tested, and approved by MTD before incorporation in any work. Random samples may be taken by the Representative, from the material at the source, delivered to the project, or at the place of the last manufacturer's, fabricator's, or producer's location, before delivery. Random QA samples may also be taken by the Department for material delivered to the project, place of supply, or at the place of the last manufacturer, fabricator, or producer, before delivery. The random samples will be sent to the MTD for testing.

Material provided by Producers listed in Bulletin 15, Approved Construction Materials, is approved for use only in its intended application(s). Producers will be assigned a Level of Certification, based on their ability to comply with the specifications, as follows:

- LEVEL 1—Test material at the minimum frequency identified in the approved QC Plan. Ship on the basis of certification.
- LEVEL 2—Test material at an increased frequency, as identified in a revised QC Plan, coordinated with the BOCM. Continue to ship on the basis of certification. Submit an action plan to demonstrate how material and processes are to be controlled to ensure the product consistently meets specification requirements.
- LEVEL 3—Test material at LEVEL 2 frequency and arrange for additional testing at the LEVEL 2 frequency by an independent laboratory. Correlate test results from in-house and independent lab and continue to ship on the basis of certification.

- LEVEL 4—Test material at LEVEL 2 frequency and arrange for additional testing at the LEVEL 2 frequency by an independent laboratory. Correlate test results from in-house and independent lab. Certify that the material meets specifications; submit samples to MTD for verification; and ship only after notification of acceptable lot test results from the BOCM. Failure to advance above this level of certification will result in the Department's initiating action for suspension/removal from Bulletin 15 according to the State's Contractor Responsibility Program.

The BOCM will determine the Level of Certification for each Producer. Producers will initially be assigned a LEVEL 1 certification until performance dictates a reevaluation.

**106.04 USE OF MATERIALS FROM WITHIN THE PROJECT**—With written permission, material found in the excavation areas and meeting the Department's specifications may be used in the project construction. Material used will be paid for, as specified in Section 110.01. However, replace any portion removed with suitable material, if required to complete the embankments. The replaced quantity will be 110% of the volume of stone or gravel removed and 100% of the volume of sand and other material removed. Do not use reserved material, as specified in Section 104.06, or as indicated in the proposal.

**106.05 STORAGE OF MATERIAL—**

**(a) General.** Store material to assure preservation of specified quality and fitness for the work.

Stored material, even though accepted before storage, may again be inspected before use in the work. Locate stored material to facilitate prompt inspection and control.

Do not use private property for storage purposes without written permission of the owner or lessee. Make copies of this permission available to the Department. Restore storage sites to conditions acceptable to property owners and the Department.

**(b) Storage of Aggregates.** Provide a separate stockpile for each aggregate size and type at cement concrete plants.

Do not use aggregates that become segregated or mixed with earth or foreign material.

If divided aggregate bins are used for storage or for proportioning, take measures to prevent mixing of aggregates.

Provide an area for storage of aggregates for use in Portland cement concrete and bituminous concrete. Store aggregates on one of the following constructed according to standard practice:

- Bituminous concrete base course, 100 mm (4 inches) minimum depth.
- Class C concrete, or better, 100 mm (4 inches) minimum depth.

**(c) Control of Aggregates.** Have aggregates available for use in cement concrete at the proportioning plant in enough time before batching to allow inspection and testing. Handle the aggregates so they may be field tested and accepted, before storing them with previously accepted aggregates. Batch fine and coarse aggregates separately. Properly control uniformity of moisture and uniformity of gradation. Provide a system of water sprays, then use when required, to maintain coarse aggregate moisture control.

During cool and cold weather concrete production, maintain aggregates required for individual concrete placements, whether stored in proportioning bins or stockpiles, at a temperature of not less than 4 °C (40F) before and during batching operations, for a sufficient length of time to eliminate the presence of frost in or around the aggregate particles.

**(d) Storage of Reinforcement.** Satisfactorily store reinforcement above ground, in a clean and dry condition on a platform, in an orderly manner, plainly marked to facilitate inspection.

**106.06 HANDLING AND TRANSPORTATION OF MATERIAL—**

**(a) General.** Carefully handle material to preserve quality and fitness for the work and to prevent loss, segregation, or inconsistency in quantities after weighing or measuring for incorporation in the work.

**(b) Aggregates.** In dry batching operations, measure aggregates or weigh before placing in the compartments of the vehicle, unless otherwise specified or permitted. Clean the vehicles and provide tight batch partitions at least 100 mm (4 inches) higher than the batched aggregate level being hauled, to prevent any spillage from one compartment to another.

**(c) Bulk Cement.** Bulk cement may be used, as specified in Section 701.

If bulk cement is used, transport to the mixer in acceptable metal, rubber, or plastic, watertight containers or compartments.

**(d) Bag Cement.** If bag cement is used, dump the contents of the correct number of bags required for each batch into the mixer skip. If permitted, bag cement may be transported from storage to the mixer by placing the correct number of bags per batch on the batched aggregate in the aggregate compartments. When transported, the bag cement may be dumped on the aggregate after having been checked by the inspector, and if done not more than 30 m (100 feet) from the mixer. Bag cement that is allowed to lie on the batched aggregates longer than 2 hours, or cement dumped on the batched aggregate longer than 1 hour, will be rejected.

**106.07 UNACCEPTABLE MATERIAL—**

**(a) Restricted Performance Specifications.**

**1. Acceptance or Rejection.** Following the application of the appropriate acceptance plan, the Representative's decision will be final as to the acceptance, rejection, or acceptance at an adjusted price of sampled lots.

**2. Disposition of Lots.** If permitted, lots not conforming to specifications may be reworked and resubmitted for acceptance sampling. For nonconforming lots that are not adaptable to correction by reworking, remove and replace them, have them accepted without payment, or have them accepted at an adjusted price as stated in the specifications or, if not stated, as directed.

**(b) Specifications, Other than Restricted Performance.** Material not conforming to the requirements of the specifications, whether in place or not, will be rejected. Remove such material promptly from the site of the work, unless otherwise directed. Do not return rejected material to the work site until defects have been corrected and the material has been accepted for use.

**106.08 DEPARTMENT FURNISHED MATERIAL—**The Department will furnish material, if specified in the proposal, in the quantities required. Material will be delivered or made available at the point specified.

The cost of handling and placing material after delivery will be included in the contract price for the item.

After delivery and acceptance by the Contractor, the cost of replacing material due to shortages, deficiencies, or damage, including demurrage charges, will be deducted from money due or to become due.

**106.09 PENNSYLVANIA TRADE PRACTICES ACT—**This section does not apply to projects which are partially or totally financed with Federal funds.

**(a) General.** Pursuant to the PA Trade Practices Act, Act 226-1968, the Department will not specify, purchase, or permit to be furnished or used in any contract aluminum or steel products as set forth below made in the countries set forth below.

The Department may utilize the discretionary waiver provision of Act 3-1978 as to steel products. As to aluminum products, if the sole source is from a banned country relief may be permitted under the Statutory Construction Act, 1 PA C.S. 1901 et seq.

**1. Brazil.** Welded carbon steel pipes and tubes; carbon steel wire rod; tool steel; certain stainless steel products including hot-rolled stainless steel bar; stainless steel wire rod and cold-formed stainless steel bar; pre-stressed concrete steel wire strand; hot-rolled carbon steel plate in coil; hot-rolled carbon steel sheet; and cold-rolled carbon steel sheet.

**2. Spain.** Certain stainless steel products, including stainless steel wire rod, hot-rolled stainless steel bars, and cold-formed stainless steel bars; pre-stressed concrete steel wire strand; certain steel products, including hot-rolled steel plate, cold-rolled carbon steel plate, carbon steel structural shapes, galvanized carbon steel sheet, hot-rolled carbon steel bars; and cold-formed carbon steel bars.

**3. South Korea.** Welded carbon steel pipes and tubes; hot-rolled carbon steel plate; hot-rolled carbon steel sheet; and galvanized steel sheet.

**4. Argentina.** Carbon steel wire rod and cold-rolled carbon steel sheet.

**106.10 BUY AMERICA PROVISIONS AND CONVICT PRODUCED MATERIALS**—This section only applies to projects partially or totally financed with Federal funds.

**(a) Buy America Provisions.** Furnish steel or iron materials, including coating for permanently incorporated work according to 23 CFR 635.410 and as follows:

- Pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States is acceptable for use in domestic manufacturing process for steel and/or iron materials.

- All manufacturing processes of steel or iron materials in a product, including coating; and any subsequent process that alters the steel or iron material's physical form or shape, or changes its chemical composition; are to occur within the United States. This includes rolling, extruding, machining, bending, grinding, drilling, and coating. Coating includes all processes that protect or enhance the value of the material, such as epoxy coatings, galvanizing or painting.

- Provide certification to the Inspector-in-Charge, that all manufacturing processes for steel and iron materials in a product, including coating, have occurred in the United States; certify as specified in Section 106.01.

Products manufactured of foreign steel or iron materials may be used, provided the cost of such products as they are delivered to the project does not exceed 0.1% of the total contract amount, or $2,500, whichever is greater.

**(b) Convict Produced Materials.** Pursuant to 23 CFR 635.417, materials produced by convict labor after July 1, 1991 may not be used for Federal-aid highway construction projects, unless produced at a prison facility which had been producing convict-made materials for Federal-Aid construction projects before July 1, 1987.

Material produced by convicts who are on parole, supervised release, or probation from a prison may be incorporated in a Federal-Aid highway construction project.

# SECTION 107—LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

**107.01 LAWS TO BE OBSERVED**—At all times, observe and comply with the following, and post as required: all Federal, State, and local laws, ordinances, and regulations that have appropriate jurisdiction over the project and affect the conduct of the work or that apply to employees on the project; and all orders or decrees that have been or may be enacted by any legal bodies or tribunals having authority or jurisdiction over the work, material, employees, or contract. Protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, including violations by Contractor employees.

**107.02 PERMITS, LICENSES, AND TAX RESPONSIBILITY—**

**(a) Permits and Licenses.** Purchase and submit copies of permits and licenses. At the job site, post notices necessary for the proper and lawful performance of the work according to such permits and licenses. Do not start work until signing and submitting all documentation required to become a transferee/co-permitee for all applicable permits required for the project.

**(b) Tax Responsibility.** Ascertain the possible existence, scope and coverage of any local subdivision tax, sometimes called an occupation tax, wage tax, income tax, franchise tax, or excise tax on the construction operations within the limit of the political subdivision imposing such tax. Also indemnify and save harmless the State and its agents from liability for the collection and payment of any taxes assessed and levied by the constituted authority, including upon Contractor agents, employees, and/or representatives in connection with the performance of work on the project.

**(c) Vehicle Registration.** Attention is directed to 75 P.S. 1302(a) and 1303(a), (b), which requires vehicles to be registered in Pennsylvania when used on a project which is being built under traffic or where the vehicles are operated on a public highway opened to traffic.

**107.03 PATENTED DEVICES, MATERIAL, AND PROCESSES**—If any design, device, material, or process covered by letters of patent or copyright is used, provide for use by suitable legal agreement with the patentee or owner. Indemnify and save harmless the State or political subdivision from any claims for infringement, by reason of the use of any patented design, device, material, process, or any trademark or copyright, and indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of any infringement, at any time during the performance or after the completion of the work. These provisions also apply to the surety.

**107.04 RESTORATION OF SURFACE OPENED BY PERMIT**—Do not allow any opening to be made within the right of way unless a valid permit is presented authorizing the opening. For such an opening, made before the date upon which the work provided for in the contract is finally accepted, repair at the time and in the manner directed in writing by the District Executive.

**107.05 FEDERAL-AID PROVISIONS**—If the Federal Government pays any portion of the project costs, observe the Federal laws pertaining to the project, as well as the rules and regulations made according to such laws. Work will be subject to the inspection of the appropriate Federal agency.

Such inspection will not make the Federal Government a party to the contract and will not interfere with the rights of either party to the contract.

**107.06 SANITARY PROVISIONS**—Provide and maintain, in a neat and clean condition, sanitary facilities for the exclusive use of personnel on the project. Dispose of all wastes, both sewage and wastewater, in a manner approved by the DEP. As required, obtain permits from local municipalities to install temporary toilet facilities.

**107.08 OCCUPATIONAL SAFETY AND HEALTH**—Comply at all times with applicable Federal, State, and local laws, provisions, and policies governing safety and health, including the Federal Construction Safety Act (Public Law 91-54), Federal Register, Chapter XVII, Part 1926 of Title 29 CFR, Occupational Safety and Health Regulations for Construction, and subsequent publications updating these regulations.

Take any other needed action or proceed as directed, to protect the life, health, and general occupational welfare of personnel employed on the project.

If, in the Representative's opinion, employees are exposed to extraordinary conditions which could or do constitute a hazard, modify such equipment, devices, and job procedures to ensure protection against the hazard or to reduce the risk to the employees engaged in project work.

All areas of a project will be hard hat areas. Require all persons within the project limits to wear protective headgear, including persons in cement concrete and bituminous concrete plants operated exclusively for a project, even though the plant(s) may be remotely located.

At the preconstruction conference, submit a written project safety program and procedure to document lost time due to accident for Department review. Give special emphasis to providing safeguards for any specially or unusually hazardous operations and health hazards. Include initial indoctrination and continuing instructions for all employees to enable them to perform work in a safe manner. Include in the instruction project safety practices, manner of reporting accidents, availability of medical facilities, and explanation of individual responsibility for accident-free operations.

For multi-season projects with a contract amount $\geq$ $5,000,000, provide and maintain one scoreboard safety sign 1200 mm (4 feet) wide by 900 mm (3 feet) high to identify the number of days worked on the project without a lost time accident. Imprint on the sign, the name of the Contractor and an appropriate safety message. Prominently display the following on the sign in 100 mm (4-inch) letters:

a. Contractor's name and address.
b. "(***) Days Worked Since Last Lost-Time Injury"

NOTE: "(***)"—indicates space for three removable numbers. Number displayed to include subcontractors.

Place the sign in a prominent location at the project site. Update the sign at least bi-weekly.

Immediately take corrective action, upon notification by the Representative of any noncompliance with the provisions of this section. Upon receipt of this notice, failure or refusal to promptly comply will cause a written order to be issued, stopping all or part of the work until the corrective action has been taken. Claim for an extension of time, costs, or damages because of the time lost due to any such stop orders will not be considered.

Require all persons to wear orange or strong yellow-green (or fluorescent versions of these colors) vest, shirt, or jacket while in work zones adjacent to traffic.

**107.09 RAILWAY-HIGHWAY PROVISIONS**—Conform to regulations stipulated in the Pennsylvania Public Utility Commission's order when work is indicated to be performed within, or adjacent to, the right of way or trackage belonging to, or upon which a common carrier operates. Observe strict adherence to all requirements pertaining to the work, safety, and movement of trains; to public and personal liability insurance; and to any other related matters.

If it is necessary to use crossings other than those indicated, make arrangements for the use of the crossings.

**107.10 BRIDGES OVER NAVIGABLE WATERS**—Conduct work on navigable waters according to the requirements of permits issued by the U.S. Army Corps of Engineers or U.S. Coast Guard, whichever is applicable.

**107.12 CARE OF PUBLIC AND PRIVATE PROPERTY**—Do not damage overhead and underground facilities and structures or property within or adjacent to the project. Use special care in the performance of the work in order to avoid interference or damage to operating utilities or plants; however, where there is any possibility of interference or damage, make satisfactory arrangements with responsible corporate officers of the utilities or plant, covering the necessary precautions to be used during the performance of the work. Make these arrangements, subject to review, before work is started.

Protect all land monuments and property markers which are to be affected by the construction until they have been correctly referenced by the Department. Beyond the construction area, reset monuments and markers which are disturbed by contract operations, either during the construction of the project or otherwise, when and as directed.

Promptly make restitution for or satisfactorily repair or restore damaged public or private property. Protect trees to be left standing. If these existing trees to be left standing are damaged, satisfactorily repair or replace them, at no expense to the Department, or compensate the Department for the damage by an equitable monetary amount as determined by, or agreed with, the Department.

**107.13 PUBLIC USE LANDS**—In performing work within or adjacent to public use lands, namely National or State Forests, State Gamelands, Wildlife or Waterfowl Refuges, recreation areas, parklands, and historic sites, comply with all applicable rules and regulations of the authority having jurisdiction.

Cooperate with the National or State Forest Officer or Supervisor and authorized subordinates in observing sanitary laws and in exercising every reasonable precaution to prevent and suppress forest fires and vandalism.

Do everything reasonable to prevent and suppress forest fires. Notify a forest supervisor, as soon as possible, of the location and extent of any fire observed. Before starting indicated work affecting stream channels, verify that the Department has the approval of the DEP and/or the DCNR.

**107.14 RESPONSIBILITY FOR DAMAGE CLAIMS**—Furnish insurance certificate(s), as specified in v Section 103.05, to indemnify and save harmless the State, the Department, and all of its officers and employees from all suits, actions, or claims of any character, name, and description, brought for or on account of any injuries or damages received or sustained by any person, persons, or property during the performance of work by the Contractor, whether the same is due to the use of defective material, defective workmanship, neglect in safeguarding the work or public interests, or by or on account of any act, omission, neglect, or misconduct of the Contractor, or any Subcontractors, Fabricators, Manufacturers, or Vendors.

Also indemnify and save harmless the State, the Department, and all of its officers and employees from cases arising as specified in Sections 105.05 and 107.16, or from any claims for amounts arising or recovered under the Workers' Compensation Law, or any other law, bylaw, ordinance, order, or decree.

**107.15 OPENING SECTIONS OF PROJECT TO TRAFFIC**—The Representative will have the authority to order, in writing, any substantially completed section of the project opened to traffic when seasonal, local, or other conditions relating to the project or public convenience justify such action; however, such opening will not be held to be an acceptance or a waiver of any provisions of the specifications or the contract.

Furnish, place, and maintain necessary traffic control devices, as directed, at the Department's expense, as specified in Section 110.03. Conduct the remainder of construction operations so as to cause the least obstruction to traffic.

Any section of the project opened before project completion will be subject to the applicable requirements specified in Section 110.08(a).

After opening a section of the project to traffic, any damage to satisfactorily completed work items within the section which occurs due to vehicles, other than construction vehicles and equipment engaged on the project, and not to defective materials and/or workmanship, and which occurs despite satisfactory precaution taken, will be replaced or repaired, as directed, at the Department's expense, as specified in Section 110.03.

**107.16 CONTRACTOR'S RESPONSIBILITY FOR WORK—**

**(a) Responsibility for Performed Work.** The terms and conditions of the Contract will be in effect until the work is completed and accepted by the Department, as evidenced by the dated acceptance certificate issued by the Department. However, the Contractor will be relieved of responsibility for further physical work, maintenance, and third-party liability as specified in Section 110.08(a). The issuance of the acceptance certificate does not relieve the Contractor and Surety from continuing liability for latent defects, as specified in Section 107.16(b).

**(b) Responsibility for Latent Defects.** The Representative will determine if a defect is a latent defect. The Contractor and the Surety continue to be liable for all latent defects; however, the Surety is liable only until the performance bond is released. Satisfactorily repair or correct latent defects at no expense to the Department. If defects cannot be satisfactorily repaired or corrected, provide reimbursement for any expenses or damages incurred by the State because of latent defects. Failure to satisfactorily correct latent defects, or to reimburse the State for expenses or damages incurred as a result of latent defects, will be considered sufficient cause to suspend or remove prequalification, according to 67 PA Code Chapter 457, regulations governing prequalification of prospective bidders, provided that any adjudication regarding such latent defects is final.

**(c) Responsibility During Temporary Suspension of Work.** Should the work be temporarily suspended, wholly or in part, according to the provisions specified in Section 105.01(b), written notification will be given of the suspension and the reason(s) for the suspension.

If the work is temporarily suspended, wholly or in part, due to the fault of the Contractor, the Required Completion Date and any specified Milestone Date(s) will not be changed, unless otherwise directed by the Chief Engineer, Highway Administration.

After a whole or partial suspension, upon receipt of written notice from the Representative, actively resume work according to the detailed schedule of operations.

**107.17 CONTRACTOR'S RESPONSIBILITY FOR PUBLIC OR PRIVATE FACILITIES AND STRUCTURES—**Cooperate with others in the performance of corrective project work, as specified in Section 105.06.

The Department will cooperate in the issue of notices and will participate in all essential field conferences relating to the facilities and structures.

**107.18 FURNISHING OF RIGHT OF WAY**—The Department will be responsible for securing all necessary rights of way in advance of construction. Any exceptions will be indicated in the proposal and contract.

**107.19 PERSONAL LIABILITY OF PUBLIC OFFICIALS**—In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, no liability may be placed upon the Secretary, Engineer, or their authorized representatives, either personally or as officials of the State. In such matters, they act solely as State agents and representatives.

**107.20 NO WAIVER OF LEGAL RIGHTS**—The Department, the Secretary, the Engineer, or the Representative will not be prevented by an erroneous

- measurement,
- computation,
- estimate, or
- certificate

made or given by them or any agent or employee of the Department, under any provision or provisions of the contract at any time, either before or after the completion and acceptance of, and payment for the roadway, from showing at any time that any

- measurement,
- computation,
- estimate, or

- certificate

is untrue or incorrectly made in any particular or that the work or material or any part does not conform to the specifications and contract.

The Department will have the right to reject the whole or any part of the work or material, should any

- measurement,
- computation,
- estimate,
- certificate, or
- payment

be discovered or be known to be inconsistent with the contract terms or otherwise improperly given. The Department will not be prevented, notwithstanding any

- measurement,
- computation,
- estimate,
- certificate, or
- payment

from demanding and recovering from the Contractor or surety, such damages as it may sustain by the failure to comply with the terms of the specifications and contract or on account of any overpayment(s) made on any estimate or certificate.

Neither the payment on any estimate or certificate signed by the Department nor any extension or remission of contract time nor any possession taken by the Department or its employees, will operate as a waiver of any portion of the Contractor of any power herein reserved by the Department or any right to damages herein provided, nor will any waiver of any breach of contract held to be a waiver of other or subsequent breach.

The terms of this contract will not be waived or modified by any verbal communication between the Contractor and Department personnel.

**107.21 WORKERS' COMPENSATION INSURANCE**—Carry Workers' Compensation Insurance or file a proper Certificate of Exemption as provided for by the Workers' Compensation Act and execute a valid affidavit in accepting provisions of the Workers' Compensation Act as supplied with the contract.

**107.22 MINIMUM WAGE SPECIFICATIONS AND RATES—**

**(a) Requirements.** According to the provisions of the Pennsylvania Prevailing Wage Act 43 P.S. 165-1, and the implementing Regulations of the Pennsylvania Department of Labor and Industry, comply with the prevailing minimum wage predetermination requirements, as specified in the proposal, specifications, and contract.

**(b) Responsibility for Payment of Wages.** Accept responsibility for all wages paid or due to any employees engaged upon the project under contract, as mandated by the Pennsylvania Prevailing Wage Act, various applicable Federal acts, and the contract. Do not attempt to pass such responsibility elsewhere. Do not require employees to refund, directly or indirectly, any part of such wage(s). Where classification, reclassification, or additional classifications of workers are made according to the Pennsylvania Prevailing Wage Act and its regulations, make no

claim against the Department for additional compensation for such classification, reclassification, or additional classification.

If after a contract has been awarded, it is decided, because of unforeseen construction development, to list an additional classification and wage rate, the Department, with or without application by the Contractor, will make written request for a wage determination by the Secretary of Labor and Industry.

No person may be employed on the project under contract, except according to the classification set forth in the decision of the Secretary of Labor and Industry.

**(c) Certification and Payment of Rate of Wage.** According to the provisions of the Pennsylvania Prevailing Wage Act and various applicable Federal acts, including their implementing regulations, file with the Department a weekly statement and a final statement at the conclusion of project work under contract, certifying that all employees have been paid wages in conformity with the provisions of the contract, as prescribed by the regulations of the Pennsylvania Department of Labor and Industry, implementing the Pennsylvania Prevailing Wage Act. If any wages remain unpaid, list on the statement the amount of wages due to each employee. Certify that, directly or indirectly, no refunds are received from any employee of any such minimum wage(s), other than deductions authorized by the Pennsylvania Wage Payment and Collection Law, 43 P.S. 260.1. Use forms furnished by the Department and submit the forms to the District Executive within 7 days after the regular payment date of the payroll period. Payment of the current and semifinal estimates and final settlement certificate will be withheld if such certification is not submitted, using the proper form, within the prescribed time limit.

**(d) Posting.** Post a notice(s) in the manner and form prescribed by the current regulations of the State Department of Labor and Industry. This notice is to be clearly legible and to be placed in a prominent and easily accessible place at the project site under contract, as well as at places where employees are paid their wages.

**(e) Records and Inspection.** Keep accurate records of employment and wage payments, including all the information required by the regulations of the State Department of Labor and Industry implementing the State Prevailing Wage Act, as amended. Keep time cards of employees, as required by the cited regulations and act. In addition, keep the original signed indentures for each apprentice and the approvals of the Pennsylvania Apprenticeship and Training Council. Preserve the records for 2 years from the date of payment and keep open at all reasonable hours, for inspection by the Department and by the State Secretary of Labor and Industry. Make these records easily accessible within the State within a period of 7 days from the date on which the State Secretary of Labor and Industry requests in writing that such records be made available. For the purpose of such inspection, furnish the authorized inspectors of the Department every assistance in determining the wages paid in compliance with the regulations.

**(f) Penalties.** Failure to comply with the Pennsylvania Prevailing Wage Act and its regulations will result in withholding money due or to become due on the project contract. It will also result in termination of the right to proceed with the project work under contract and/or other penalties prescribed by law.

**(g) Federal-Aid Projects.** All Federal-Aid Projects are subject to the implementing rules and regulations of the various Federal departments. Accordingly, the contract provisions and the penalties prescribed for their violations, both of which are required to be incorporated verbatim in all contracts for such Federal-Aid Projects, will be set forth in the proposal and the contract applicable to each project.

## 107.23 HAULING RESTRICTIONS—

**(a) General.** Accept responsibility for all hauling done on the project and on adjacent highways, in connection with the contract. Hauling restrictions on highways will be according to the applicable sections of the Pennsylvania Vehicle Code, Act of 1976, No. 81.

Before submission of the bid, if truck delivery of long bridge members (in excess of 21 m (70 feet)) is contemplated, obtain, in writing, a determination if a Department's hauling permit can be issued for the routing from the proposed source(s) of supply to the project.

Without written permission, do not move and/or operate heavy-duty construction grading and hauling equipment over existing or new pavements, subbase, base and surface courses, and structures which will remain in service.

No special permits will be required for the transfer of oversize or overweight equipment or vehicles from one work area to another work area within the project limits. However, correct any damage caused by the transfer of equipment or vehicles.

If, in special cases, further restrictions are necessary, such restrictions will be indicated and/or specified in the proposal.

**(b) Mass (Weight) Limits and Weighing.**

**1.** Do not operate on public highways any vehicles which are in excess of the registered, gross, and/or axle mass (weight) limits established in Chapter 49 of the Vehicle Code, 75 PA C.S. Chapter 49, or as posted by the Department.

**2.** Submit to weighing by Department weigh teams when requested. If, as a result of such a weighing, it is determined that a vehicle owned or leased by the Contractor or any Subcontractor has been operated on public highways carrying a mass (weight) in excess of the above registered, gross or axle mass (weight) limits, the sum of $50 for each 225 kg (500 pounds) or part thereof of such excess mass (weight) will be deducted as liquidated damages from money due or to become due. These liquidated damages are attributable to inherent damage to the highway which is not readily ascertainable and do not relieve the Contractor of responsibility to pay ascertainable damage as may be required in other sections of these Specifications.

**3.** When a weight slip shows that a vehicle delivering material to the project exceeds limits specified in Section 107.23(b), the Contractor will be assessed liquidated damages as specified in Section 107.23(b)2. Weighing by a Department Weigh Team will not be required.

**107.24 ACCESSIBILITY OF FIRE HYDRANTS**—Make necessary arrangements with the local authorities to provide fire protection at all times. Keep the fire hydrants adjacent to the work readily accessible to fire apparatus and do not place material or other obstructions within 5 m (15 feet) of any hydrant.

**107.25 DISCRIMINATION ON ACCOUNT OF RACE, COLOR, RELIGIOUS CREED, ANCESTRY, SEX, AGE, OR NATIONAL ORIGIN PROHIBITED IN CONNECTION WITH EMPLOYMENT—**

**(a) General.** Do not discriminate against any individual, who is qualified and available to perform the work to which the employment relates, by reason of race, color, religious creed, ancestry, sex, age, or national origin.

**(b) Penalties.** Failure to comply with the above provisions, prescribed in greater detail in 15 P.S. 7306, and modified by Pennsylvania Human Relations Act 43 P.S. 951, may result in the deduction of money due or to become due for each violation. A second or subsequent violation will result in cancellation or termination of the contract upon which the violation occurred, and forfeiture of all money due or to become due, and other penalties prescribed by law.

**(c) Federal-Aid Projects.** In addition to the above, the requirements specified in Section 107.22(g) also apply.

**107.26 SELECTION OF LABORERS AND MECHANICS**—This Section does not apply to projects which are partially or totally financed with Federal funds.

**(a) Veteran Preference.** In employment on public works, provisions of 51 P.S. 492.1 require a preferential rating, similar to that given to State employees, to any soldier making application for employment and on intended discharge for reduction in force. The word “soldier,” as used in the cited act, means a person who served in the armed forces of the United States or in any official women's organization, during any war or armed conflict in which the United States was engaged, and who has an honorable discharge from such service.

**107.27 WATERWAY REGULATIONS AND WATER POLLUTION CONTROL—**

**(a) Waterway Regulations.** Conduct indicated work in waterways, flood plains or their hydrologically connected wetlands according to the requirements of permits or approvals issued by the U.S. Army Corps of Engineers, the U.S. Coast Guard, the DEP, the DCNR, and/or the Pennsylvania Fish and Boat Commission, whichever is applicable. Do not conduct work, including borrowing or wasting material other than indicated, in waterways, floodplains or their hydrologically connected wetlands before obtaining the required permits or approvals.

**(b) Water Pollution Control.** Comply with all applicable State and Federal laws and regulations preventing the pollution of surface water and ground water resources.

**(c) Act 247.** According to Act 247, enacted by the General Assembly of the Commonwealth of Pennsylvania and approved by the Governor on October 26, 1972, the statutes, rules, and regulations concerning anti-pollution measures have been enumerated in Appendix C, Designated Special Provision 9. Include in the bid price all costs of complying with the terms of the listed statutes, rules, and regulations. No separate or additional payment will be made for such compliance. In the event that the listed statutes, rules, and regulations are amended, or if new statutes, rules, or regulations become effective, perform all additional and/or extra work deemed necessary, as ordered in writing and directed by the Representative, as specified in Section 110.03.

Determine what local ordinances, if any, will affect the project work. Check for any county, city, borough, or township rules or regulations applicable to the area in which the project is being constructed, and, in addition, for any rules or regulations of other organizations having jurisdiction, such as chambers-of-commerce, planning commissions, industries, or utility companies who have jurisdiction over lands which the project occupies. Include any costs of compliance with local controls in the prices bid, even though documents of such local controlling agencies are not listed herein. No separate or additional payments will be made for complying with existing, amended or new local ordinances, directives, or controls.

**107.28 EROSION AND SEDIMENT POLLUTION CONTROL PLANS AND PERMITS**—Install and maintain erosion and sediment pollution control devices as indicated or submit an alternate plan for accomplishing equal or better temporary and permanent erosion and water pollution control. If an alternate plan is submitted, do not start work until the plan is approved by the County Conservation District and the Department. If a National Pollutant Discharge Elimination System Permit is involved, do not start work until the plan is approved by the DEP and/or the DCNR or their designee and the Department.

**107.29 THIRD-PARTY LIABILITY**—Contracts covered by these specifications are not to be construed for the benefit of any person or political subdivision not a party to this contract, nor will this contract be construed to authorize any person or political subdivision not a party to this contract to maintain a lawsuit on or under this contract.

**107.30 SPECIFIC EQUAL EMPLOYMENT OPPORTUNITY RESPONSIBILITIES**—This Section only applies to projects which are partially or totally financed with Federal funds.

**(a) General.**

**1.** Equal employment opportunity requirements not to discriminate and to take affirmative action to assure equal employment opportunity, as required by Executive Order 11246 and Executive Order 11375, are set forth in Required Contract Provisions (Form FHWA-1273) and these requirements; imposed pursuant to 23 U.S.C. 140, as established by Section 22 of the Federal-Aid Highway Act of 1968. The Equal Opportunity Construction Contract Specifications set forth under 41 CFR 60-43 and the provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. The requirements set forth herein constitute the specific affirmative action requirements for project activities under this contract and supplement the equal employment opportunity requirements set forth in the Required Contract Provisions.

**2.** Work with the Department and the Federal Government in carrying out equal employment opportunity obligations and in their review of contract activities.

**3.** Comply with and have subcontractors (not including material suppliers) comply with the following minimum specific requirement activities of equal employment opportunity. The Equal Employment Opportunity Requirements of Executive Order 11246, as set forth in 23 CFR 633, are applicable to material suppliers as well as contractors and subcontractors. Include these requirements in every subcontract of $10,000 or more with such modification of language as is necessary to make them binding on the subcontractor.

**(b) Equal Employment Opportunity Policy.** Accept as operating policy the following statement which is designed to further the provision of equal employment opportunity to all persons without regard to their race, color, religion, sex, or national origin, and to promote the full realization of equal employment opportunity through positive continuing programs:

It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, or national origin. Such action includes: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, preapprenticeship, and/or on-the-job training.

**(c) Equal Employment Opportunity Officer.** Designate and make known to the Department contracting officers an equal employment opportunity officer (hereinafter referred to as the EEO Officer) who has the responsibility for and is capable of effectively administering and promoting an active company program of equal employment opportunity and who has been assigned adequate authority and responsibility to do so.

**(d) Dissemination of Policy.**

**1.** Make all company staff members related to the project who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, fully cognizant of, and have them implement, the company's equal employment opportunity policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To ensure that the above agreement is met, take the following actions as a minimum:

**1.a** Conduct periodic meetings of supervisory and personnel office employees before the start of work and then not less often than once every 6 months, at which time the contract equal employment opportunity policy and its implementation will be reviewed and explained. Have the meetings conducted by the EEO Officer or another knowledgeable company official.

**1.b** Give all new company supervisory or personnel office employees a thorough indoctrination by the EEO Officer or other knowledgeable company official covering all major aspects of the company's equal employment opportunity obligations within 30 days following their reporting for duty on the project.

**1.c** Instruct all company personnel who are engaged in direct recruitment for the project by the EEO Officer or appropriate company official in the company procedures for locating and hiring minority group employees.

**2.** In order to make the equal employment opportunity policy known to all company employees, prospective employees, and potential sources of employees, i.e., schools, employment agencies, labor unions (where appropriate), college placement officers, etc., take the following actions:

**2.a** Place notices and posters setting forth the equal employment opportunity policy in areas readily accessible to company employees, applicants for employment, and potential employees.

**2.b** Bring the equal employment opportunity policy and the procedures to implement such policy to the attention of company employees by means of meetings, employee handbooks, or other appropriate means.

**(e) Recruitment.**

**1.** When advertising for employees, include in all advertisements for employees the notation: "An Equal Opportunity Employer." Publish all such advertisements in newspapers or other publications having a large circulation among minority groups in areas from which the project work force would normally be derived.

**2.** Unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants, including, but not limited to, State employment agencies, schools, colleges and minority group organizations. To meet this requirement, through the company EEO Officer, identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to for company employment consideration.

In the event a valid bargaining agreement exists providing for exclusive hiring hall referrals, observe the provisions of that agreement to the extent that the system permits compliance with equal employment opportunity contract provisions. (The U.S. Department of Labor has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the Contractor to do the same, such implementation violates Executive Order 11246, as amended.)

**3.** Encourage present company employees to refer minority group applicants for employment by posting appropriate notices or bulletins in areas accessible to all such employees. In addition, discuss information and procedures with regard to referring minority group applicants with employees.

**(f) Personnel Actions.** Establish and administer wages, working conditions, and employee benefits and take personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, without regard to race, color, religion, sex, or national origin. Follow the following procedures:

**1.** Conduct periodic inspections of the project site to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

**2.** Periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

**3.** Periodically review selected personnel actions in depth to determine where there is evidence of discrimination. Where evidence is found, promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, take corrective action to include all affected persons.

**4.** Promptly investigate all complaints of alleged discrimination made to the company in connection with obligations under this contract, attempt to resolve such complaints, and take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, include in such corrective action such other persons. Upon completion of each investigation, inform every complainant of all of his/her avenues of appeal.

**(g) Training and Promotion.**

**1.** Assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

**2.** Consistent with company work force requirements and as permissible under Federal and State regulations, make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, provide 25% of apprentices or trainees in each occupation in their first year of apprenticeship or training. In the event the Special Provision for Trainees is provided under this contract, this subparagraph will be superseded.

**3.** Advise employees and applicants for employment of available training programs and entrance requirements for each.

**4.** Periodically review the training and promotion potential of minority group and women employees and encourage eligible employees to apply for such training and promotion.

**(h) Unions.** If reliance is made in whole or in part upon unions as a source of employees, use maximum effort to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. Actions either directly or through a contractor's association acting as agent will include the procedures set forth below:

**1.** Use maximum efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

**2.** Use maximum efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union is contractually bound to refer applicants without regard to their race, color, religion, sex, or national origin.

**3.** Obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information, so certify to the Department and set forth what efforts have been made to obtain such information.

**4.** In the event the union is unable to provide a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, or national origin, making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The U.S. Department of Labor has held that it is no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents meeting obligations pursuant to Executive Order 11246, as amended, and these requirements, immediately notify the Department.

**(i) Subcontracting.**

**1.** Use maximum efforts to solicit bids from and to utilize minority group subcontractors or subcontractors with meaningful minority group and female representation among their employees. Obtain lists of minority-owned construction firms from Department personnel.

**2.** Use maximum efforts to ensure subcontractor compliance with their equal employment opportunity obligations.

**(j) Records and Reports.**

**1.** Keep such records as are necessary to determine compliance with the company's equal employment opportunity obligations. Design the records kept to indicate:

**1.a** The number of minority and non-minority group members and women employed in each work classification on the project.

**1.b** The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women (applicable only to contractors who rely in whole or in part on unions as a source of their work force).

**1.c** The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees.

**1.d** The progress and efforts being made in securing the services of minority group subcontractors or subcontractors with meaningful minority and female representation among their employees.

**2.** Retain all such records for a period of 3 years following completion of the contract work and make them available at reasonable times and places for inspection by authorized representatives of the Department and the FHWA.

**3.** Submit to the Department a report each month after construction begins for the duration of the project, indicating the work hours, number of minority, women and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form EO-400, and according to the instructions included thereon. Form PR-1391 is to be submitted annually for the month of July, reflecting manpower figures for the project work force, for the last payroll period preceding the 31st of the month. If on-the-job training is being required by Special Provision for trainees, furnish Form EO-365 for each trainee employed, on a monthly basis, and Form FHWA-1409 semi-annually.

# SECTION 108—PERFORMANCE AND PROGRESS

## 108.01 SUBLETTING OR ASSIGNMENT OF CONTRACTS—

**(a) General.** Do not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion or rights, title, or interest, without the written consent of the Representative.

If consent is given, subletting a portion of the contract will be allowed; however, do not sublet a portion exceeding 50% of the original total contract price except as provided herein.

Use only prequalified subcontractors, classified for the type of work undertaken and not exceeding their assigned maximum capacity rating.

For prequalification capacity evaluation, the amount of subcontracted work will be charged solely to the subcontractor when the subcontractor and items of work to be undertaken are named in the bid on the page titled "List of Subcontractors for Financial Credit," and to both the prime contractor and the subcontractor when the subcontractor is named after the award of the contract.

Do not replace or cancel a subcontractor named in the bid without the approval of the Representative, which approval will not be unreasonably withheld.

Subcontracts or transfer of contract will not release Contractor liability under the contracts and bonds.

**(b) Specialty Items.** "Specialty Items," as identified in the proposal, may be performed by subcontract. The cost of any specialty items performed by subcontract may be deducted from the original total contract price before computing the amount of work allowed to be performed by subcontract.

**(c) Disadvantaged Business Enterprises (DBE).** For Federal-Aid contracts when requirements for DBE are included in the proposal, the cost indicated on the original Attachment A (Form EO-380) submitted for DBE's utilization may be deducted from the original total contract price before computing the amount of work allowed to be performed by subcontract, provided a completed Form D-431 has been submitted with the bid. In cases where specialty items and DBE involvement overlap, any cost deducted is restricted to a single assignment of either specialty item or DBE goal amount, but not both. The maximum amount of the DBE cost that may be deducted is equal to 40% times the difference between the original total contract price and the specialty items' cost.

**(d) Minority Business Enterprises (MBE) and Women Business Enterprises (WBE).** For contracts financed with other than Federal funds when requirements for MBE and WBE are included in the proposal, the cost of the Agreement Amount indicated on the original Form EO-16 submitted for MBE's and WBE's utilization may be deducted from the original total contract price before computing the amount of work allowed to be performed by subcontract, provided a completed Form D-432 has been submitted with the bid. In cases where specialty items and MBE/WBE involvement overlap, any cost deducted is restricted to a single assignment of either specialty item or MBE/WBE agreement amount, but not both. The maximum amount of the MBE/WBE cost that may be deducted is equal to 40% times the difference between the original total contract price and the specialty items' cost.

**(e) Subcontract Approval.** Do not allow any work on the project that is assigned to others (including services) to be performed until a copy of the executed subcontract (agreement or any other assignment of the contract), containing a copy of each provision that is a part of the prime contract and that has a statement requiring inclusion, has been reviewed and acknowledged by the Department to have satisfied these requirements and is available on the project to Department representatives for purposes of monitoring contract compliance.

**108.02 NOTICE TO PROCEED**—As soon as practical after approval of the contracts, bonds, and insurance certificates by the Chief Counsel, the General Counsel, or the Attorney General, or their respective designees, and subject to the provisions specified in Section 103.07, a written Notice to Proceed will be sent, specifying the calendar date on which to begin the work.

**(a) Requirements for Starting Work.** Begin work on the Notice to Proceed Date specified in the Notice to Proceed and complete all physical work, including any authorized additional or extra work, on or before the Required Completion Date.

**(b) Notice to Proceed Period.** The Notice to Proceed will be issued within 30 days after the award of the contract. Extension(s) of the 30-day period will be made only by mutual written consent of the parties to the contract provided such written consent is given before the expiration of the 30-day period.

## 108.03 PERFORMANCE AND PROGRESS—

**(a) Preconstruction Conference.** Before the Notice to Proceed and start of work, a preliminary conference will be held in the District Executive's office. The purpose of this conference will be to discuss the scope of the project work, to discuss all essential matters pertaining to the satisfactory project completion, and to resolve any questions regarding contract interpretation.

**(b) Construction Project Scheduling.** Prepare a complete Schedule that adheres to and incorporates all contract time requirements, shows work being completed on or before the Required Completion Date, meets any specified Milestone Date(s), and is in compliance with all contractual requirements.

If, between the date of the award of the contract and the Preconstruction Conference, circumstances beyond the control of the Contractor arise that may substantially affect the contract time, immediately contact the District Executive for a time adjustment. Make such request before the Notice to Proceed is issued.

The Representative may require that the Contractor attend a scheduling conference for the purpose of reviewing this specification and the applicable contract special provision for construction project scheduling (i.e., Narrative, Network, or Critical Path Method). This scheduling conference may be held in conjunction with the Preconstruction Conference. Be prepared to discuss the concepts and logic to be used in sequencing work activities for development of the construction Schedule.

Acceptance of the Contractor's Schedule or any revision(s) thereto, by the Department, will not constitute the Department's approval of or agreement with the sequence of operations, the durations of activities, the adequacy or propriety of resources, the identity of controlling operations, nor the feasibility or any other characteristics of the Schedule or its revisions.

Show all contracted work in the Schedule. Show the sequence and interdependence of activities for completion of all work. Consider and make appropriate scheduling and operational allowances for seasonal weather conditions and ambient temperatures.

Incorporate in the Schedule coordination with all entities (subcontractors, utilities, railroads, etc.) and adjacent or private contracts that could impact the Schedule. In addition to construction activities, include in the Schedule, at a minimum, the procurement, fabrication, and delivery of critical or special materials and equipment, and indicate restraints (i.e., relationships) between activities.

**1. Construction Scheduling Coordinator.** Have the individual responsible for supervising the work, as specified in Section 105.05(a), serve as the Construction Scheduling Coordinator or be responsible for and oversee all activities of the Construction Scheduling Coordinator.

**2. Project Control Meetings.** Project control meetings will be held on an as needed basis, as directed. During project control meetings, the Representative and the Contractor's superintendent will conduct a site visit and jointly review project progress. Submit, 2 working days before each project control meeting, a written report, in an acceptable format, that includes the following:

- Progress of project activities.
- Impacts on the current Schedule.
- Planned progress for the next 2 weeks.
- Other Schedule-related information, as required.

**3. Submittals.** Prioritize and schedule submissions to allow sufficient time for Department review. Make submissions at least 21 calendar days before information is needed for purchasing, fabricating material, or obtaining equipment, unless otherwise indicated or directed. The 21-calendar day review period will begin on the date the Representative receives the submission. Any delays caused by incomplete submissions, including drawings and designs, will be the responsibility of the Contractor.

**4. Adjustment of Required Completion Date or Specified Milestone Date(s).** If an event or occurrence, as specified in Section 108.06, warrants a time extension, submit a request to the Representative, in writing, within 10 calendar days of the event or occurrence. Include, with the time extension request, a revision to the Schedule in the form specified in the applicable contract special provision, at no additional cost to the Department. The Representative will respond to the request within 10 calendar days of receipt.

Submission of an initial Schedule, or a proposed revision thereto, that shows a change to the Required Completion Date and/or any specified Milestone Date(s) will constitute a request for a time extension or reduction and, if approved, will result in a corresponding change to the Required Completion Date and/or Milestone Date(s). The Representative will respond to the request within 10 calendar days of receipt. If the request for a time extension or reduction is approved, the Department will use the changed Required Completion Date and/or Milestone Date(s) for the purpose of monitoring progress, assigning resources, authorizing additional and/or extra work, processing contract adjustments associated with incentive/disincentive clauses, and assessing liquidated damages. Contractor imposed dates in the Schedule; other than the Required Completion Date, specified Milestone Date(s), and/or any contractually specified sequences; will not be binding on the Department.

**5. Recovery.** If the latest completion time for any work on the current Schedule results in an activity being delayed beyond the Required Completion Date or any specified Milestone Date(s), as adjusted if appropriate, the Representative may require the Contractor to submit a written description of the plan to recover all lost time and maintain the Required Completion Date or specified Milestone Date(s). If required, submit the written recovery plan within 7 calendar days of notification by the Representative. If the order of project operations is changed to the extent that the Contractor is no longer following the accepted Schedule, the Representative may require that a revision to the Schedule be submitted as specified in Section 108.03(b)4.

## 108.04 LIMITATION OF OPERATIONS—

**(a) Maintenance of Traffic.** Conduct the work in a manner and sequence that assures minimal interference to traffic.

**(b) Completion of Sections of Project.** Complete any designated section or sections of the project as indicated; as specified; or when directed, in writing, as specified in Section 107.15.

The Contractor will be relieved of responsibility for further physical work, maintenance, and third party liability only for work items within the section of the project which are satisfactorily completed at the time of, or subsequent to, opening of the section to traffic. The Contractor's responsibility for further physical work, maintenance, and third party liability remains for work items within the section of the project which are not satisfactorily completed at the time of, or subsequent to, opening of the section to traffic.

Release of Contractor responsibility is further contingent on the following:

- a final inspection of the section has been made as specified in Section 110.08(a);
- the Contractor's obligation under the contract to replace defective work or material is not relieved;
- the Contractor's responsibility for repairing any damage to satisfactorily completed work items within the section, which occurs due to construction operations, is not relieved; and
- any work done by the Department, on a designated section of the project that may have been satisfactorily completed, as provided, does not waive the rights of either party to the entire contract.

**(c) Maintenance of Existing Vegetation.** In order to maintain natural vegetation in all undisturbed areas, do not cross these areas with construction equipment or make any other use of these areas, except at allowed locations.

## 108.05 CHARACTER OF WORKERS; METHODS AND EQUIPMENT—

**(a) General.** Employ at all times sufficient labor and equipment for performing the work, as specified in Section 108.03.

**(b) Competence of Workers.** Employ only competent and efficient superintendents, forepersons, clerks, timekeepers, equipment operators, laborers, mechanics, or artisans for every kind of work. Whenever, in the Representative's opinion, any person is unfit to perform the task, does the work contrary to instructions, or exhibits improper conduct, discharge the person immediately and do not employ the person again on the project without written permission of the Representative. Failure to remove such person, as ordered, or failure to furnish suitable and sufficient personnel for the proper completion of the work, after being ordered to correct the deficiency, may result in suspension of the work, by written notice from the District Executive, until such orders are followed.

If the superintendent or representative on the project fails to cooperate with the Department's authorized representatives in any way, the District Executive will give a written order for dismissal and replacement of that superintendent or representative.

**(c) Equipment.** Furnish the type, condition, and quantity of equipment that meets the qualifications necessary for the proper execution of the work within the specified contract time. Maintain the equipment in good condition, subject to acceptance, before and during use in connection with the project. If special equipment, not normally used in highway construction, is required to be used, comply with Section 108.05(c)2.

**1. Alternate Method and/or Equipment.** If the contract specifies that construction be performed by the use of certain methods and equipment, use such methods or equipment, unless others are authorized. To use a method or type of equipment other than those specified, request authority to do so. Provide the request in writing and include a full description of the methods and equipment proposed to be used, with an explanation of the reasons for desiring to make the change. If acceptance is given, it will be on condition that construction work is performed in conformity with contract requirements. If, after trial use of the substituted methods of equipment, it is determined that the work produced does not conform to the contract requirements, discontinue the use of the substitute method or equipment. Complete the remaining construction with the specified methods and equipment. Remove the deficient work and replace it with work of specified quality, or take such other corrective action, as directed. No change will be made in the basis of payment for the construction items involved, nor in contract time, as a result of authorizing a change in methods or equipment under these provisions.

**2. Test of New Special Equipment.** A vendor or manufacturer of equipment not currently used may submit the necessary technical data concerning the item to the MTD. If the item warrants further investigation, the MTD may grant permission to the vendor to contact a contractor for the experimental use of the equipment on an appropriate project under construction. The experimental operation will be observed by representatives of the MTD and the District Executive's office, to obtain data necessary to substantiate a final recommendation to the Department.

**3. Roller Requirements.** Provide rollers, of the type(s) specified for the various items of construction, complying with the following:

**3.a** Three-wheel power rollers, with an unballasted load of not less than 52 N/mm (300 pounds per linear inch) of tread of rear wheels, having a manufacturer's certified metal mass (weight) of not less than 9 tonnes (10 tons).

**3.b** Tandem power-driven rollers, with a ballasted load of not less than 58 N/mm (330 pounds per linear inch) of tread of drive roll, having a manufacturer's certified metal mass (weight) of not less than 9 tonnes (10 tons).

**3.c** Tandem power-driven rollers, with a load of not less than 21 N/mm (120 pounds per linear inch) of tread of drive roll, having a manufacturer's certified metal mass (weight) of either not less than 4.5 tonnes (5 tons) or more than 7 tonnes (8 tons) or either not less than 7 tonnes (8 tons) or more than 9 tonnes (10 tons).

**3.d** Trench-type rollers that develop a minimum of 52 N/mm-width (300 pounds per inch-width) of compaction roll.

**3.e** Pneumatic-tire rollers, used to compact soils, subbases, and base courses, may be either single or multiple-axle type and may be equipped with pneumatic tires of equal size and diameter on any one axle. Uniformly inflate tires so that air pressure does not vary more than 35 kPa (5 pounds per square inch). Use rollers of

sufficient mass (weight) and dimensions that, when loaded, will cause the pneumatic tire wheels to exert a ground pressure of not less than 52 N/mm (300 pounds per inch) of width of tread, as measured on a hard surface.

**3.f** Pneumatic-tire rollers, used to compact hot bituminous mixtures of a self-propelled type. Use rollers having not less than seven wheels mounting smooth tread pneumatic tires, not less than 205 mm x 390 mm (7 1/2 inch by 15 inch) size, each tire capable of exerting an average contact pressure through a range from 415 kPa to 655 kPa (60 pounds per square inch to 95 pounds per square inch). Use rollers with wheels equally spaced along both axles and so arranged that those on one axle track midway between those of the other, with the wheels on one or both axles arranged to oscillate in pairs or to be individually sprung.

Use rollers equipped with power steering and fluid drive or a torque converter, capable of turning or reversing on the hot material without surface scuffing or displacement, and provided with means of wetting and cleaning the tires during operation, to prevent adhesion of hot bituminous mixture to the tires.

Make provision for checking tire pressures during operation. Keep the tires uniformly inflated at the designated pressure and with the difference in pressure between any two tires not to exceed 35 kPa (5 pounds per square inch).

In operation, adjust the tire pressure and wheel load, as required, to provide an average contact pressure of from 415 kPa to 655 kPa (60 pounds per square inch to 95 pounds per square inch) over the surface, to conform to the requirements of both the particular application and the material being compacted.

Equip the roller with means of adjusting the wheel load by ballasting and provide tires with a ply-rating that supports the maximum operating wheel load, at the specified maximum contact pressure.

Furnish copies of the roller manufacturer's charts or tabulations, showing the contact areas and average contact pressures for the full range of both tire inflation pressures and tire loadings for each type and size of compactor tire furnished. Also, furnish copies of the calibration table or chart for the ballast box, showing both the volume of the box in cubic meters (cubic feet), for at least each 75 mm (3-inch) increment of depth, and the empty or tare mass (weight) of the roller.

**3.g** Tamping rollers with an operating mass (weight) of not less than 1725 kPa (250 pounds per square inch) of cross-sectional area on each tamping foot, face, or end.

**3.h** Vibratory rollers of a self-propelled type, with the necessary frequency and amplitude to achieve required density without objectionable undulations, material pickup, or other surface defects. Use a vibrator drive that automatically stops when the roller changes direction or stops.

**4. Other Compaction Equipment.** Permission may be given for the use of other types of vibratory and/or compaction equipment designed for, and capable of accomplishing, compaction and consolidation at least equivalent to the rollers specified.

**5. Material Transfer Vehicle (MTV)** Provide a Material Transfer Vehicle (MTV) to be used as an intermediate and separate motorized, self-propelled unit between the haul vehicle and the bituminous paver as follows:

- Provide adequate covers of sufficient size to protect the material in the MTV, under all conditions.
- Capable of transferring the material from the haul vehicle to the paver hopper at a uniform and continuous rate to allow the continuous movement of the paver.
- Equipped with remixing augers for remixing the bituminous material before transferring to the paver hopper.
- Free of petroleum oils, solvents, or other material, which adversely affect bituminous concrete.

In addition, equip the bituminous paver with a manufactured hopper insert to provide a mass flow of material directly to the slat conveyors of the paver. Deliver mixture through the MTV at the correct laying temperature as specified in Section 409.2(e) Table A, and free from lumps of chilled material.

**108.06 TIME EXTENSIONS AND REDUCTIONS**—A time extension or time reduction may be granted by the Department as a result of the following events or occurrences, provided the required written request and supporting Schedule revision are submitted to the Representative as specified in Section 108.03(b)4.

- The anticipated Notice to Proceed Date in the proposal has not been reasonably met. Such time extension will only be made if it is requested by the Contractor within 10 days after the Notice to Proceed is issued and the anticipated Notice to Proceed Date in the proposal has not been reasonably met through no fault of the Contractor.

- Progress on one or more controlling operations is adversely affected by an act or omission of the Department that is not the fault of the Contractor, all of which will be determined by the Representative.

- Satisfactory project completion requires work in greater or lesser quantities than those indicated in the contract for one or more controlling operations.

- The District Executive, in writing, eliminates an item of work or reduces the quantity of an item of work and the elimination or reduction affects progress on one or more controlling operations.

- The District Executive, in writing, authorizes additional or extra work, which affects progress on one or more controlling operations.

- A strike or labor dispute that causes, despite all reasonable efforts by the Contractor to avoid it, a shutdown of the entire project or of one or more controlling operations as specified in Section 108.10.

**108.07 LIQUIDATED DAMAGES—**

**(a) Construction Engineering Liquidated Damages.** For each day that any physical work remains uncompleted after the Required Completion Date, the sum per day specified in the following schedule, unless otherwise stated in the proposal, will be deducted from money due or to become due. This deduction will not be as a penalty, but as Construction Engineering Liquidated Damages.

| **Original Contract Amount** | | **Schedule of Daily Charges For Construction Engineering Liquidated Damages** |
|---|---|---|
| From More Than | To and Including | Per Calendar Day |
| $ 0 | $ 400,000 | $ 350 |
| 400,000 | 1,000,000 | 700 |
| 1,000,000 | 5,000,000 | 925 |
| 5,000,000 | 10,000,000 | 1,200 |
| 10,000,000 | 15,000,000 | 1,500 |
| 15,000,000 | | 1,975 |

In the event the Contractor is declared in default, as specified in Section 108.08, Construction Engineering Liquidated Damages will be charged as provided by this section. If the total amount chargeable as Construction Engineering Liquidated Damages exceeds the amount payable to the Contractor or the surety, the excess is to be paid to the State by the Contractor or the surety.

**(b) Road Users Liquidated Damages.** When indicated in the proposal, Road Users Liquidated Damages will be charged for each day that the roadway is not opened to unrestricted traffic after the specified Milestone Date. The sum per day will be deducted from money due or to become due. This deduction will not be as a penalty, but as Road Users Liquidated Damages.

In the event the contractor is declared in default, as specified in Section 108.08, Road Users Liquidated Damages will be charged in the amount indicated. If the total amount chargeable as Road Users Liquidated

Damages exceeds the amount payable to the Contractor or the surety, the excess is to be paid to the State by the Contractor or the surety.

**(c) Work Zone Liquidated Damages.** A sum of no less than $1,000 per 24 hour period will be charged as work zone liquidated damages for failure to comply with Maintenance and Protection of Traffic requirements and drawings or other contract traffic control requirements. This deduction will not be as a penalty, but as work zone liquidated damages.

**108.08 DEFAULT AND TERMINATION OF CONTRACT**—In the following paragraphs, the word "Contractor" also means the surety, in case of default, and completion of the contract by the surety.

**(a) Delay, Neglect, or Default.** The Contractor may be declared in default for the following reasons:

- failure to begin work within the time specified in the Notice to Proceed;
- failure to perform the work with sufficient labor, equipment, or material to ensure the completion of the specified work according to the contract terms;
- unsatisfactory performance of the work;
- failure or refusal to remove material, or to repair or remove and replace any work, rejected as defective or unsatisfactory;
- discontinuing work without approval;
- failure to resume work, which has been discontinued, within a reasonable time after notice to do so;
- insolvency or bankruptcy;
- commission of any act of bankruptcy or insolvency;
- making assignment for the benefit of creditors;
- failure or refusal within 10 days after written notice by the Secretary, to make payment or show cause why payment should not be made, of any amounts due for material furnished, labor supplied or performed, for equipment rentals, or for utility services rendered, as covered by the Payment Bond;
- failure to protect, to repair, or to make good any damage or injury to property, as specified in Section 107.12; and
- not performing work in an acceptable manner for any cause.

The Secretary, upon written notice from the District Executive or upon other proof satisfactory to the Secretary, and after having given written notice to the Contractor and the surety of such delay, neglect, or default on the part of the Contractor, will have power and authority, without violating the contract to:

- declare the Contractor in default;
- take the completion of the work out of the hands of the Contractor;
- appropriate or use any or all material and equipment of the Contractor assembled for the project;
- enter into a contract or contracts for the completion of the work, according to the contract; or

- use such other methods that will be expedient for the completion of the contract in a satisfactory manner.

**(b) Completion by Surety.** The Secretary may elect to take the performance of the work from the Contractor. The Secretary may at that time notify and require the surety to complete the contract according to its terms. Also, require the surety to render within 3 months from the completion certificate date, but before payment on the final certificate, a detailed statement of the costs of the completion of the work, including receipts and disbursements of all funds received and paid on account. However, the responsibility of the surety extends only to the limit of the bond amount.

**(c) Completion by Department Forces.** The Secretary may elect to take the performance of the work from the Contractor and fulfill the contract with Department forces. At that time and in the State's name, the Secretary may take all right, title and interest in and to the equipment and material owned by the Contractor and assembled for use in the execution of the contract, and may use them for completion.

**(d) Settlement of Contract.** If the contract completion by any of the methods specified results in financial loss to the State, the Secretary may dispose of any of the remaining equipment and material taken over as specified in Section 108.08(a) or (c), without further legal process and in the manner that may be considered in the State's best interests. Any equipment or material not required for completion or recoupment of loss, or for legal charges against the contract, or any balance remaining from the disposition of material and equipment after deducting losses by the State, or any legal charges against the contract, will be turned over to the party legally or equitably entitled to them.

In the event the contract is completed by Department forces, all proper costs and legal charges incurred by the Department in connection with the contract will be deducted from money due or to become due to the Contractor. The Department will credit the Contractor with the amount realized from the disposal of equipment or material.

If legal charges against the contract and the expense incurred by the Department in connection with contract completion by any of the methods specified, less the credits herein provided for, exceed the sum which would have been payable under the contract for the completed work, the Contractor or the surety are liable to the State for the excess amount.

If such legal charges and expenses are less than the contract value of the completed work, the difference will be paid to the Contractor or such difference may be paid to the surety, in an amount not exceeding the total amount which has been paid by the surety on its obligations under the Performance Bond and the Payment Bond. In this event, the surety is required to furnish evidence satisfactory to the Secretary that such payments have been made and that any balance remaining after payment to the surety will be paid to the Contractor.

**(e) Termination Clause.** The State may, by written notice, with the approval of the FHWA where applicable, terminate the contract or any portion because of any of the following conditions:

- the Contractor is prevented from proceeding with the construction contract as a direct result of a President's Executive Order with respect to the occurrence of war or in the interest of national defense;

- the State or the Contractor is prevented from proceeding with the construction contract as direct result of an Order of a Court of competent jurisdiction;

- funds necessary for the project completion become unavailable;

- for the Department's convenience, the Department has determined that such termination will be in the State's best interest; or

- all of the work of any controlling operation is delayed for more than 90 consecutive calendar days, for any cause beyond the responsibility of the Contractor. The Secretary may enter into an Agreement with the Contractor or may terminate the contract by written notice to the Contractor. If an agreement is entered into, it will be executed by the Contractor and the Secretary, approved by the Surety and the Chief Counsel, the General Counsel or the Attorney General, or their designees.

When the contract, or any portion is terminated before completion of all items of contract work, payment will be made for each unit of work fully completed at the contract unit price and payment for each partially completed

unit of work will be as mutually agreed or at the percentage of the contract unit price that the cost of the partially completed unit is of a fully completed unit with a maximum allowable of 100%. No claim for lost profits or damages of any kind will be allowed for the termination.

Acceptable material, obtained by the Contractor for the work, will be purchased from the Contractor at actual cost, as shown by receipted bills and actual cost records, at such points of delivery as may be designated.

Termination of any portion of the contract does not relieve the Contractor of responsibilities for the completed work, nor will it relieve the surety of its obligation for any claim arising out of the performance of the work.

**108.09 NONCOMPLIANCE BY THE CONTRACTOR**—In addition to the elective measures the Secretary may take for violation of the contract, as specified in Section 108.08, the Secretary will also have the discretionary right to take any or all of the following actions if the Contractor fails, neglects, or refuses to comply with the requirements specified in Sections 105.03, 107.12, 107.16(c), 110.03(d), or 901:

- The Secretary may shut down the work until the requirements of the violated section are met. In this event, no remission will be made in contract time for the period for which the work is shut down.

- The Secretary may withhold payment of estimates for work completed until the requirements of the violated section are met.

- The Secretary may enter upon the project and perform all work necessary to conform to the requirements of the section violated, then deduct the cost from money due or to become due to the Contractor or the surety. If the Contractor fails to comply with the requirements specified in Sections 107.12 and 107.16(c), the Secretary will not proceed until 48 hours after written notice to the Contractor and the surety that the Secretary will take such action.

- The Secretary has the right to enter upon the project and repair or replace public or private property which has been damaged in violation of Section 107.12, to estimate the amount of such damage, and to deduct the amount from money due or to become due to the Contractor or the surety. When money is deducted as provided, the Secretary will settle with the property owner and secure a written statement, releasing the State and the Contractor from further responsibility for such damage.

**108.10 STRIKES OR LABOR DISPUTES**—Time extensions will be considered appropriate in the event of a strike or labor dispute which causes, despite all reasonable efforts of the contractor to avoid it, a shutdown of the entire project or of one or more controlling operations, whether the strike or labor dispute involves a union bargaining with the Contractor, a subcontractor, the Department, or third parties. In no event, however, will the Contractor be entitled to any delay costs for labor, material, equipment, or related expenses such as overhead or administrative costs, profit, etc., resulting from the strike or labor dispute, regardless of whether the strike or labor dispute involves a union bargaining with the Contractor, a subcontractor, the Department, or third parties affecting a controlling operation.

# SECTION 109—MEASUREMENT OF QUANTITIES

## 109.01 MEASUREMENT—

**(a) Units of Measure.** Work performed under this contract will be measured in the following units shown in the Measurement and Payment sections of the Specifications and in the Design Items in the proposal, unless otherwise specified:

- **Lump Sum.** Not measured. Indicates complete construction of the item of work, as specified.
- **Each.** Measured by the number of individual items of work completed.
- **Meter (Linear Foot).** Measured parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item.
- (**M. Linear Feet.** 1,000 Linear Feet, to the nearest 0.01 M. feet.)
- **Vertical Meter (Vertical Foot).** Measured vertically to the nearest 0.01 m (0.1 foot), with a minimum vertical measurement of 0.10 m (1 foot), at each unit.
- **Square Meter (Square Foot, Square Yard).** Measured by a two-dimensional area method on the surface of the item.
- **Cubic Meter (Cubic Yard).** Measured by a three-dimensional volume method.
- **Hectare (Acre).** Measured by a two-dimensional area method on the surface to the nearest 0.05 hectare (0.1 acre)**.**
- **Kilogram (Pound).** Measured by actual item net mass (weight) (avoirdupois).
- **Tonne (Ton).** Measured by actual item net mass (weight in short tons) consisting of 1000 kg (2,000 pounds, avoirdupois).
- **Liter (Gallon).** Measured by actual item liquid volume.
- **1000 Liters (M. Gallon).** Measured by actual item liquid volume consisting of 1000 L (1,000 gallons, to the nearest 0.1 M. gallon).
- (**Foot Board Measure.** Measurement by a three-dimensional method of the actual item lumber board foot.)
- (**M. Feet Board Measure.** 1,000 feet board, to the nearest 0.01 M. feet board.)
- **Set.** Measured as an item unit set, consisting of two or more parts together, as specified.
- **Bag.** Measured as an item unit bag.
- (**Bushel.** Measured by actual item dry measure consisting of 32 quarts.)

**(b) General.** Measurement will be according to the current edition of International System of Units (SI) (the Modernized Metric System) (measurement will be according to the system of weights and measures) recognized by the United States Bureau of Standards. Method of measurement and computation of quantities will conform to generally recognized engineering and construction practice. Computer generated or electronic digital measuring and computing devices are acceptable methods.

A station, when used as a definition or term of measurement, will be a kilometer (100 linear feet), horizontal measurement.

When required, weigh material on accurate, acceptable scales, using competent, qualified personnel at locations designated. When material is shipped by rail, the car mass (weight) may be accepted, if only the actual mass (weight) of material is measured. However, car mass (weights) will not be acceptable, for material passed through mixing plants. Weigh empty trucks used to haul material measured by mass (weight) daily, as directed. Mark each truck with a distinct, legible identification. Trucks may be selected at random and weighed, as directed, to verify the mass (weight) of material by weighing the truck empty and loaded on other acceptable scales.

Use acceptable vehicles to haul material to be measured by volume at the delivery point. Use acceptable vehicles of any size or type, provided the actual body contents can be readily and accurately determined. Load vehicles to at least their water level capacity. Level the loads at the delivery point.

If requested, material measured by the cubic meter (cubic yard) may be weighed and converted to tonnes (tons), if approved in writing by the District Executive. Factors to be used for conversion from mass (weight) measurement to volume measurement or mass (weight) measurement to area measurement will be determined by the Representative and agreed to by the Contractor before using this method of measurement.

Measure bituminous material by the liter (gallon) or tonne (ton), as indicated. Measure volumes at 15 °C (60F) or correct to volume at 15 °C (60F), using ASTM D 1250 for asphalts or ASTM D 633 for tars. Net certified scale mass (weights), or mass (weights) based on certified volumes for rail shipments, will be used as a measurement basis. Mass (weights) will be subject to correction when bituminous material has been lost from the car or by the distributor, wasted, or otherwise not incorporated in the work. If bituminous materials are shipped by truck, the net certified mass (weight) or volume, subject to correction for loss or foaming, may be used for computing quantities.

# SECTION 110—PAYMENT

**110.01 GENERAL**—Payment for items of work performed under this contract will be made at the contract price per unit of measure, as specified in Section 109.01 for the item complete in place, or portions thereof. Unless otherwise specified, the contract unit price will cover all costs for materials, labor, and equipment:

- specified, described, or identified in each section of the specifications (including the special provisions and plans);
- identified in each section of the specifications (including the special provisions and plans) as "as required" or "as directed;" or
- allowed under the specifications (including the special provisions and plans) and for which payment is not expressly provided.

In addition to the above, the contract price includes all other costs incurred in performing work on the project (e.g., home office overhead) and all profit. The contract price is accepted as payment in full for all risk, loss, damage, or expense of every kind arising out of the nature of the work or the performance as specified in Section 107.20.

Work specified as "incidental" in the Measurement and Payment section of the specification for a contract item is to be considered as an additional obligation to the other work required for the item(s). This incidental work is not payable directly, but is to be considered included in the contract price for the item(s) of work specified.

Removal and replacement of defective work, as specified in Section 105.12, will not be paid by the Department.

No payment will be made for work in excess of that indicated, shown, or specified, unless otherwise accepted in writing by the Secretary.

Removal of material found in excavation areas and accepted for use, as specified in Section 106.04, will be paid for at the contract unit price for the class of excavation in which it is found. Payment will also be made for the contract bid item in which the excavated material is used.

Work, material, or labor specified for an item will not be measured or paid for again under any other indicated pay items.

**110.02 DIFFERING SITE CONDITIONS, SUSPENSIONS OF WORK, AND SIGNIFICANT CHANGES IN THE CHARACTER OF WORK—**

**(a) General.** If differing site conditions, changes in quantities, or alterations of the construction drawings will significantly increase or decrease the cost of performing the work directly affected, perform such work only when authorized in writing, as specified in Section 110.03(a). Payment for such work will be made as specified in Section 110.03.

**(b) Differing Site Conditions.** During the progress of the work, if subsurface or latent physical conditions, differing materially from those indicated, are encountered at the site, or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work, are encountered at the site, the party discovering such conditions is responsible for promptly notifying the other party, in writing, of the specific differing conditions, before the site is disturbed and before the affected work is performed.

Upon written notification, the Representative will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made as specified in Section 110.02(a). The Representative will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

No contract adjustment will be allowed under this section for any effects caused on unchanged work.

**(c) Suspensions of Work Ordered by the Representative.** If the performance of all or any portion of the work is suspended or delayed by the Representative in writing, as specified in Section 107.16(c), for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or contract time is due as a result of such suspension or delay, submit to the Representative, in writing, a request for adjustment within 7 calendar days of receipt of the notice to resume work. Set forth the reasons, and support for such adjustment, in the request.

Upon receipt, the Representative will evaluate the Contractor's request. If the Representative agrees that the cost and/or time required for the performance of the contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors, and not caused by weather, the Representative will make an adjustment, excluding profit, as specified in Section 110.03 and Section 108.06, as applicable. The Representative will notify the Contractor of the determination whether or not an adjustment of the contract is warranted.

No contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No contract adjustment will be allowed under this clause to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded as specified in Section 107.16(c).

**(d) Required Changes in the Scope of Work.** The Department reserves the right to make, in writing, at any time, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations in the work will neither invalidate the contract or release the surety, and the Contractor agrees to perform the work as changed or altered.

If alterations in the work or changes in quantities do not significantly change the character of the work to be performed under the contract, the work will be paid for at the original contract unit price.

If alterations in the work or changes in quantities significantly change the character of the work under the contract, whether such alterations or changes are in themselves significant changes to the character of the work or by affecting other work cause such other work to become significantly different in character**,** an adjustment, excluding loss of anticipated profits, will be made as specified in Section 110.03. The basis for the adjustment will be agreed upon before the performance of the work. If a basis cannot be agreed upon, the work will be paid for as extra work as specified in Section 110.03.

The term "significant change in character" applies only to the following circumstances:

- If the work as altered differs materially in kind or nature from that involved or included in the original proposed construction, or

- If an item of work is increased to in excess of 125% or decreased to below 75% of the original contract quantity. Any allowance for an increase in quantity applies only to that portion in excess of 125% of the original contract item quantity or, in case of a decrease below 75%**,** to the actual quantity of work performed.

When a contract item experiences a significant change in character as a result of a decrease to below 75% of the original contract quantity, the actual quantity of work performed may be paid at an adjusted price, as agreed upon with the Contractor and as approved; however, total compensation will not exceed the contract item's original value. Item value is defined as the original contract quantity multiplied by the contract unit price.

**(e) Adjustment of Lump Sum Items.** The original contract price for a lump sum item, where quantities and unit prices for component items are designated on a component item schedule submitted as specified in Section 103.01(a), will be adjusted only if differing site conditions, as specified in Section 110.02(b), or changes directed by the Representative will significantly increase or decrease the cost of performing the work. If the Representative determines that conditions materially differ and cause an increase or decrease in the cost or time for performance of the work, or if increases or decreases in quantities are required due to a change directed by the Representative, adjusted payment will be made as specified in Section 110.03.

## 110.03 ADDITIONAL WORK, EXTRA WORK, AND EXTRA WORK ON A FORCE ACCOUNT BASIS—

**(a) General.** Work specified in Sections 104.02 and 104.03 will be paid, if authorized in writing by the District Executive, as additional work, extra work, or extra work on a force account basis. Compensation will be limited to the work authorized in writing and actually performed. Work performed before written authorization will be at the Contractor's risk.

A work order identifying the work to be done and the price to be paid therefore will be processed before or during the performance of the work. To avoid interrupting the project, written authorization to perform work under this section will be in the form of a letter, telegram, mailgram, or other writing from the District Executive, or the Inspector-in-Charge, in writing to the Contractor when confirming an oral authorization of the District Executive, issued within a reasonable length of time.

If the work is to be paid as additional work, the District Executive's writing will refer to the contract price for that work.

If the work is to be paid as extra work and:

- is such that a reasonable price therefore can be negotiated, and
- is such that force account records, if necessary, can be kept by the Department,

the District Executive's writing will authorize commencement of work as extra work. Within 10 calendar days of such authorization, submit a price for the extra work with back-up data to the District Executive for transmittal to the Representative. Pending approval of the price, force account records will be kept as stated below. If the price is accepted, the work will be paid only at the negotiated price, which will not be renegotiated once submitted for acceptance.

If the work is to be paid as extra work and:

- the Contractor and District Executive cannot agree on a tentative price, therefore, and
- the work is such that force account records cannot be kept by the Department,

the District Executive's writing will contain a firm, binding price determined by the District Executive to be fair and equitable for the work to be performed.

If the District Executive and Contractor cannot agree on a tentative price for the extra work and if the work is such that force account records can be kept by the Department, the District Executive's writing will state that such work is to be paid on a force account basis. Force account records will be kept as stated below.

Payment for additional work, extra work, and extra work on a force account basis is accepted as payment in full for all profit and for all equipment, labor, material, field overhead, home office and general administrative expenses, and every other expense incurred as a result of the additional or extra work. No claims for additional compensation of any kind arising out of or relating to such work can be asserted against the Department with the Board of Claims.

**(b) Additional Work.** This includes only the following:

- work of the type already provided by the contract, and
- work for which there is a contract price.

Perform all such work only when authorized in writing by the District Executive, as stated in Section 110.03(a).

All additional work will be paid at the contract price and in the same manner as if it had been included in the original contract.

**(c) Extra Work.** This includes only the following:

- work arising from changes specified in Section 110.02 that result in a significant increase or decrease in the cost of performing that work, or

- work, having no quantity and/or price included in the contract, which is determined by the District Executive to be necessary or desirable to complete the project.

Perform all such work only when authorized in writing by the District Executive, as stated in Section 110.03(a). All extra work will be paid only as stated in Section 110.03(a).

**(d) Force Account Work.** Perform extra work on a force account basis only when directed in writing by the District Executive, as stated in Section 110.03(a).

The Department will keep records of extra work done on a force account basis. Compare force account records with those kept by the Department, at the end of each day or as directed, to ensure accuracy and obtain concurrence. Report any unresolved disagreements with such records to the Representative. Failure to review the Department's records or to report disagreements with such records will create a presumption that the Department's records are complete and accurate.

Payment for extra work performed on a force account basis will be made, as specified herein, upon completion of the work. Progress payments will be made only when an itemized estimated force account of cost is provided, in writing, within 10 working days after receipt of the Department's written authorization to perform the extra work on a force account basis.

**1. Labor.** Wages of forepersons; equipment operators; and skilled, semiskilled, and common laborers directly assigned to the specific operation will be reimbursed, as direct labor costs, at the actual base pay rate and fringe benefit rate paid, for each hour that such employees are engaged in the performance of authorized work and, if directed, overtime as provided for in existing laws and regulations.

Indirect labor costs will be allowed as a percentage of the total base labor cost. However, if certified payroll records indicate that the Contractor's method of making payment is such that fringe benefits are paid directly to the worker, indirect labor costs will be allowed as a percentage of the total direct labor cost. Compute indirect labor costs as follows:

- Social Security Tax at the percentage legally required;

- Medicare Tax at the percentage legally required;

- Unemployment Taxes at the estimated effective rate;

- Workers' Compensation Insurance at the policy percentage rate as adjusted for experience modifiers;

- Contractor's Public Liability Insurance at the policy percentage rate; and

- Contractor's Property Damage Liability Insurance at the policy percentage rate, including coverage for damage due to blasting and explosions, when additional coverage is required on projects involving blasting.

Compute estimated effective rates for the current calendar year by dividing the Contractor's total, company-wide Unemployment Tax payments for the previous calendar year by the total wages and salaries paid to all employees for the same period. Recompute estimated effective rates each year thereafter, for the duration of the project, based on the previous calendar year's total wages and salaries and total tax payments.

**2. Material.** The cost of material used will be reimbursable, including applicable sales tax and transportation costs charged by the material supplier.

**3. Equipment.** Reasonable rental rates for equipment, including trucks and machinery, mutually considered necessary, will be allowed, computed as follows:

**3.a Owned Equipment.** For any Contractor-owned equipment, an hourly rental rate will be determined using the monthly rate listed in the applicable edition of the Rental Rate Blue Book for Construction Equipment (Blue Book), Volume 1. The Blue Book edition in effect as of the first day that work is performed on a specific force account is the edition that will remain applicable throughout the performance of such work. The applicable edition of the Blue Book will be authorized for use statewide on a specified date.

The hourly rental rate for owned equipment will be computed by dividing the monthly rate listed in the Blue Book by 176. Apply to this rate, the area adjustment percentage for the State and the age adjustment percentage for the model year of the piece of equipment, as shown on the Regional Adjustment Maps and in the Rate Adjustment Tables, respectively, located at the beginning of each section of the Blue Book.

An allowance will be made for operating costs by adding, to the above adjusted hourly rate, the estimated operating cost per hour, as listed in the Blue Book, for each hour that the equipment or machinery is actually in operation on the force account work. If equipment or machinery is required at the work site on a standby basis, but is not operating, compensation will be at 50% of the adjusted hourly rate, exclusive of operating costs.

Equipment used for maintenance and protection of traffic on a 24-hour basis will be reimbursed at a daily rental rate, which will be determined by dividing the monthly rate listed in the Blue Book by 22.

Where Contractor-owned equipment or machinery is not listed in the Blue Book, a rental rate will be determined based on the manufacturer's list price for sale (new) of such equipment. In these cases, the monthly rate will be computed as 6% of the sale price (new), and the total hourly rate determined by dividing the monthly rate by 160, when operating, and by 352, when required at the work site on a standby basis, but not operating, with no adjustment percentages applied. For equipment used for maintenance and protection of traffic on a 24-hour basis, with no listing in the Blue Book, the daily rental rate will be computed as 6% of the manufacturer's list price for sale (new) of the equipment divided by 22, with no adjustment percentages applied.

The rates established above include the cost of fuel; oil; lubrication; supplies; necessary attachments; repairs; overhaul and maintenance of any kind; storage; all costs of moving equipment on to and away from the work site, except as specified below; and all incidentals.

The Department will not approve any costs in excess of those outlined above unless such costs were incurred for the convenience of the Department, as directed, and are supported by an acceptable cost breakdown. If a piece of owned equipment, not already on or near the project site, is needed specifically for the force account work, the cost of moving the equipment on to and away from the work site will be reimbursed, provided the equipment will not be used immediately thereafter in the performance of original contract work.

The term "owned equipment," as used above applies to equipment (including trucks and machinery) which the Contractor is required to provide for the proper execution of the contract work, as specified in Section 108.05(c), whether the equipment is actually owned directly by the Contractor, is leased, or has been obtained in some other manner.

**3.b Rented Equipment.** If a piece of equipment needed for the force account work is not of the type required to be provided by the Contractor for the proper execution of the contract work, or if the piece of equipment needed is "owned" but not currently available, and the equipment can be obtained by rental, discuss the need to rent the equipment with the Representative and obtain approval of the rental rate to be paid before renting the equipment for the force account work.

Additionally, if an item is purchased specifically for the force account work, but does not become a permanent part of the work, the item will be considered rented equipment for cost reimbursement purposes. If the item's useful life is completely expended in the performance of the work, as determined by the Representative, the full cost of the item will be reimbursed, including applicable sales tax and transportation costs. Otherwise, that portion of the item's useful life expended in the performance of the force account work will be determined and reimbursement made at a prorated cost.

The Contractor will be reimbursed the actual invoiced cost for rented equipment, plus the cost of transporting the equipment to and from the work site. An allowance will be made for operating costs by adding, to the rental cost, the estimated operating cost per hour, as listed in the Blue Book, for each hour the rented equipment is actually in operation on the force account work. Furnish a copy of the invoice, receipt, or canceled check as support for the rental expense incurred.

Transportation charges for each piece of rented equipment, to and from the site of the force account work, will be paid provided:

- Equipment is obtained from the nearest available source,

- Return charges do not exceed the delivery charges,
- Haul rates do not exceed the established rates of licensed haulers, and
- Charges are restricted to those units of equipment not readily available and not on or near the project.

**4. Services by Others.** For specialized construction analyses, engineering services, or work not considered subcontract work requiring prequalification, the Contractor will be reimbursed the invoice price plus 2% to cover administration and all other costs. Furnish a copy of the invoice, receipt, or cancelled check as support for the expense incurred. The markup on service by others costs will be limited to 2% only, regardless of whether the service was arranged by the Contractor or a subcontractor performing any or all of the force account work. The overhead and profit allowances specified in Section 110.03(d)7 are not applicable to service by others costs.

**5. Permits, Bonds, and Insurance.** When specifically required for the force account work, as directed, the securing of permits, bonds, or specialized insurance coverage, of a type not already required by the contract, will be considered service by others, as specified in Section 110.03(d)4, and reimbursement of the permit fee, bond price, or insurance premium paid will be allowed plus the specified markup.

**6. Subcontracting.** If any or all of the force account work is to be performed by an approved subcontractor, the work must be considered subcontract work requiring prequalification and the Contractor's need to subcontract the work must be approved. Payment for work performed by a subcontractor, will be determined based on a complete statement of applicable material, labor, and equipment costs, computed as specified herein, plus applicable markups for overhead and profit.

**7. Overhead and Profit.** Except for work considered to be service by others, as specified in Section 110.03(d)4, to cover all administration, general and project superintendence, other overhead, bonds, insurance, anticipated profit, and use of small tools and equipment for which no rental is allowed, 25% will be added to the total material cost, 40% will be added to the total labor cost, and 5% will be added to the total equipment cost. If applicable, in addition to the above markups, 8% will be added to the total cost of any force account work performed as approved subcontract work as specified in Section 110.03(d)6.

**8. Statements.** Final payment will not be made for work performed on a force account basis until the Contractor has furnished the Representative with an itemized statement of the cost of the work, in the form of a properly completed force account record, detailed as follows:

- Name, classification, work dates, daily hours, total hours, base pay rate, fringe benefit rate, total pay rate and extension for each foreperson; equipment operator; and skilled, semi-skilled, and common laborer;
- Description (year, make, model, capacity, etc.), use dates, daily hours, total hours, rental rates (operating and standby) and extension for each piece of rented equipment and/or description, rental cost, transportation costs (if separate), and extension for each piece of rented equipment;
- Description, quantity, unit price and extension for all materials, applicable sales tax, and transportation costs charged by the material supplier;
- Name, description, unit price and extension for all services by others; and
- Rates (legally required, estimated effective, or policy percentage) paid for property damage and public liability insurance, workers' compensation insurance, unemployment taxes, medicare tax, and social security tax.

Statements of labor costs are to be supported by certified payroll records.

Statements of material costs (including sales tax and transportation costs) and service by others costs are to be supported and accompanied by invoices.

If materials used in the force account work are not specifically purchased for the work but are taken from the Contractor's stock or provided by entities that are divisions, affiliates, subsidiaries or in any other way related to the Contractor or its parent company, furnish an affidavit certifying that the materials were obtained as described above, that the quantity claimed was actually used, and that the price and transportation costs claimed were actually incurred.

**(e) Disputes.** Notwithstanding the provisions specified in Section 105.01, in the event of a disagreement with the District Executive as to whether work is:

- original contract work or additional work,
- original contract work or extra work, or
- additional work or extra work,

notify the Inspector-in-Charge immediately of such disagreement and confirm the disagreement in writing to the District Executive within 10 calendar days. Upon notification to the Inspector-in-Charge of such disagreement, records will be kept daily of all labor, equipment, and materials used from that day forward in the disputed work. Keep and maintain such daily records in the field. Claim no extra costs of any kind for work performed before notifying the Inspector-in-Charge of disagreements with the District Executive's decision. On each Monday, compare records of the previous week's work with those kept by the Department and review for accuracy. Report to the District Executive within 10 calendar days of each review all disagreements with such records or to report disagreements with such records. Refusal or repeated failure to meet to review the Department's records or to report disagreements with such records will create an irrebuttable presumption in favor of the Department that its records are accurate.

Disputes concerning all such work will be resolved by the District Executive and payment will be made on the basis determined by him.

In the event of a disagreement with the decision of the District Executive, comply with provisions specified in Section 105.01 concerning due notice in writing of an intent to file a claim and send a copy of the written notice to the District Executive within the time frame allowed by that section. If written notice is not submitted to the District Executive within 10 calendar days of receipt of the District Executive's decision, daily records of labor, equipment and materials will no longer be kept by the Department and no claim for additional compensation of any kind arising from or relating to the disputed work or the decision of the District Executive can be filed with the Board of Claims.

If due notice in writing is submitted to the District Executive and Deputy Secretary for Highway Administration within the 10 calendar-day period, continue to keep and review daily records, as provided above, until completion of the disputed work.

With the exception of those specific daily records or portions thereof on which written disagreements were filed with District Executive as provided above, any claim for damages filed with the Board of Claims arising out of or relating to the disputed work or the decision of the Secretary can be measured at the hearing solely by the aforementioned daily records kept by the Department.

**110.04 PRICE ADJUSTMENT OF BITUMINOUS MATERIALS**—These requirements provide for a price adjustment, in the form of a payment to the Contractor or a rebate to the Department, for fluctuations in the cost of asphalt cement used in the bituminous materials placed as part of the construction work specified in the following Sections:

| | | | | | |
|---|---|---|---|---|---|
| 305 | 360 | 424 | 460 | 471 | 653 |
| 309 | 409 | 430 | 461 | 480 | 654 |
| 320 | 420 | 431 | 467 | 481 | 656 |
| 341 | 421 | 439 | 469 | 482 | 657 |
| 342 | 422 | 440 | 470 | 651 | |

Applicable contract items include any modified standard or nonstandard item where the work to be performed involves placement of one or more of the bituminous materials specified in these Sections.

**(a) General.** These price adjustment provisions apply only to projects where more than 90 tonnes (100 tons) of asphalt cement, including asphalt cement residue contained in emulsions or cut backs, will be used in the bituminous materials specified or indicated for placement.

The Department posts monthly index prices for asphalt cement (PG 64-22) using price data obtained, on the last Wednesday of the preceding month, from a survey of producers who do business in Pennsylvania. Data provided by producers serving the eastern portion of the state is averaged to compute the index price for Zone 1 (Districts 3-0, 4-0, 5-0, 6-0, and 8-0). Data provided by producers serving the western portion of the state is averaged to compute the index price for Zone 3 (Districts 1-0, 10-0, 11-0, and 12-0). The index price for Zone 2 (Districts 2-0 and 9-0) is computed as the average of the index prices for Zone 1 and Zone 3.

The price index in the proposal, IB, will be the index price posted by the Department, determined as specified above, for the month in which the project is advertised.

The price index at the time of placement, IP, will be the index price posted by the Department, determined as specified above, for the month during which the applicable material is placed.

**(b) Price Adjustment Criteria and Conditions.** The following criteria and conditions will be considered in determining a price adjustment for bituminous materials:

**1. No Price Adjustment.** When the ratio IP/IB falls within the range of 0.90 to 1.10, no price adjustment will be made for any bituminous material placed during the relevant month.

**2. Price Rebate.** When the ratio IP/IB is calculated to be less than 0.90, the Department will receive an automatic price rebate determined according to the following formula:

$$P.R. = (0.90 - IP/IB)\ (Q)\ (IB)$$

where:

P.R. = Price Rebate
IP = Price Index for the last Wednesday of the month preceding the month in which the material is placed (One-Month Price Adjustment Period)
IB = Price Index in the Proposal
Q = Quantity tonnes (tons) of Bitumen in Mixture placed

**3. Price Increase.** When the ratio IP/IB is calculated to be greater than 1.10, the Contractor will receive a price increase determined according to the following formula:

$$P.I. = (IP/IB - 1.10)\ (Q)\ (IB)$$

where:

P.I. = Price Increase
IP = Price Index for the last Wednesday of the month preceding the month in which the material is placed (One-Month Price Adjustment Period)
IB = Price Index in the Proposal
Q = Quantity tonnes (tons) of Bitumen in Mixture Placed

**4. Equivalent Tonneage (Tonnage).**

**4.a Square Meter (Square Yard) Basis.** For bituminous mixtures placed on a square meter (square yard) basis, the equivalent tonneage (tonnage) is computed as follows:

Metric Only: Bituminous Mixture Tonneage Placed = (0.000 001) (A) (D) (d)

where:

A = Surface Area (square meters)
D = Design Depth (millimeters)
d = Design Density* (kilograms per cubic meter)

$$\begin{pmatrix}\text{Bitumen}\\ \text{Tonneage in}\\ \text{Bituminous Mixture}\end{pmatrix} = \begin{pmatrix}\text{Bituminous Mixture}\\ \text{Tonneage Placed}\end{pmatrix}\begin{pmatrix}\text{Percent}\\ \text{Bitumen by Mass*}\end{pmatrix}$$

English Only: Bituminous Mixture Tonnage Placed = (0.000375) (A) (D) (d)

where:

A = Surface Area (square yards)
D = Design Depth (inches)
d = Design Density* (pounds per cubic feet)

$$\begin{pmatrix}\text{Bitumen}\\ \text{Tonnage in}\\ \text{Bituminous Mixture}\end{pmatrix} = \begin{pmatrix}\text{Bituminous Mixture}\\ \text{Tonnage Placed}\end{pmatrix}\begin{pmatrix}\text{Percent}\\ \text{Bitumen by Weight*}\end{pmatrix}$$

* The design density (i.e., lab density) and percent bitumen by mass (weight) will be obtained from the approved JMF (Form TR-448A) for the bituminous mixture placed. Convert the design density obtained from Form TR-448A to SI (the proper) units by multiplying by the density of water, which is 997.1 kg/m$^3$ (62.4 pounds per cubic foot).

**4.b Liters per Square Meter (Gallons per Square Yard) Basis.** For bituminous material placed on a liters per square meter (gallons per square yard) basis according to specification, and residue content according to Bulletin 25, the equivalent tonneage (tonnage) is computed as follows:

Metric Only: Bitumen Tonneage = (0.001) (A) (a) (g)

where:

A = Surface Area (square meters)
a = Actual Residue Application Rate (liters per square meter)
g = Specific Gravity of Bituminous Material

English Only: Bitumen Tonnage = (0.004164) (A) (a) (g)

where:

A = Surface Area (square yards)
a = Actual Residue Application Rate (gallons per square yard)
g = Specific Gravity of Bituminous Material

**4.c Liter (Gallon) Basis.** For bituminous material placed on a liter (gallon) basis, the equivalent tonneage (tonnage) is computed as follows:

Metric Only: Bitumen Tonneage = (0.001) (g) (p) (No. of liters)

where:

g = Specific Gravity of Bituminous Material
p = % Asphalt in Emulsion

English Only: Bitumen Tonnage = (0.004164) (g) (p) (No. of gallons)

where:

g = Specific Gravity of Bituminous Material
p = % Asphalt in Emulsion

**5. Expiration of Contract Time.** If bituminous materials or mixtures are placed after expiration of contract time and liquidated damages are chargeable, the value for IP used to compute the price adjustment will be either the price index at the time of actual placement or the price index at the time contract time expired, whichever is less.

**6. Approval.** Should the price index at time of placement, IP, indicate an increase of 50% or more over the price index in the proposal, IB, do not furnish bituminous material for the project without prior written approval.

**7. Payment/Rebate.** The price adjustment will be paid, or rebated, upon approval of a work order to be prepared after completion of all work. Cumulative price adjustments amounting to less than $500 will be disregarded. Upon written request by the Contractor, partial payments may be made, before total completion, when the unpaid accrued price increase exceeds $10,000 or once every 12 months.

**8. Inspection of Records.** The Department, through the Office of Inspector General, reserves the right to inspect the records of the prime contractor and its subcontractors and material suppliers to ascertain actual pricing and cost information for the asphalt cement used in the bituminous materials incorporated in the work.

**9. Extra Work.** If applicable items of work, as specified herein, are added to the contract as extra work, as specified in Section 110.03, no price adjustment will be made for fluctuations in the cost of asphalt cement used in any bituminous materials placed in the performance of the extra work, unless otherwise approved. The current price for asphalt cement is to be used when preparing required backup data for extra work to be performed at a negotiated price. For extra work performed on a force account basis, reimbursement for material costs along with the specified overhead and profit markup will be considered to include full compensation for the current cost of asphalt cement.

**110.05 CURRENT ESTIMATE PAYMENTS**—Current estimate payments will be processed based upon assessments made by the Department as work is satisfactorily completed. Processing of estimate payments will begin on the first estimate date established following the Notice to Proceed Date or indicated in the special provisions. No estimate payments will be processed before the Notice to Proceed Date. Current estimate payments exceeding $1,000 will be processed by the Department at semimonthly intervals, or more frequently, as work progresses. Current estimate payments amounting to less than $1,000 may be processed monthly. Final payments amounting to between -$10 and +$10 will be disregarded. Partial payments do not bind the Department to the acceptance of any material furnished or work performed.

Within 7 calendar days of the receipt of current estimate and final payments from the Department, pay all subcontractors their earned share of the payments, including all retainage, provided the terms and conditions of the applicable subcontract or purchase agreement have been reasonably met.

**110.06 MATERIAL STORED OR ON HAND—**

**(a) Stored Material.** The Representative may authorize payment for certain material, before its incorporation into the work. Upon the Contractor's written request and the Representative's written approval, the Contractor may be paid 100% of the cost of the material, less the pro-rata share of the retainage, if any; provided the quantity of stored material does not exceed the total estimated quantity required to complete the project, the cost is at least $1,000 but does not exceed 90% of the contract price of the applicable contract item and/or component item, and the accumulative costs do not exceed 25% of the current contract amount. The cost of the material is that amount to be paid by the Contractor as evidenced by invoices. Fabricated structural steel that is to receive a protective coating may be approved for prepayment at 75% of the contract price of the applicable contract item and/or component item, before application of the coating, provided the structure has been fully fabricated and preassembly of field connections has been made.

Payment for stored material will not be authorized until the material has been delivered to the project site or an approved location in the vicinity of the project, is inspected by the Representative to ensure the material is in a satisfactory condition and of sufficient quantity, is stored in an approved manner, and conforms to the requirements specified in this section and Section 106.03. Identify stored material by project designation and set apart from other materials. Material to be stored less than 45 days is not eligible for prepayment. If the Representative determines that, because of required fabrication at an off-site location, it is not feasible or practicable to store material in the vicinity of the project, the material may be stored at an approved location, which is not in the vicinity of the project.

Only end product manufactured material or fully fabricated products that are awaiting installation and/or incorporation into the finished work are eligible for prepayment. Components, elements, or ingredients of a finished product are not eligible for prepayment. Aggregates, cements, and other bulk material are not eligible for prepayment. Living or perishable plant materials are not eligible for prepayment before planting.

Assume full control and responsibility for the protection of the stored material from the elements and against loss or damage by any cause. In the event any stored material becomes lost, stolen, impaired, or damaged while stored, the monetary value of the lost, stolen, impaired, or damaged material as may have been paid for in a current estimate will be deducted from the next estimate. Retain the title to the prepaid material until issuance of the acceptance certificate.

Payment for acceptable stored material will be made on current estimates against the applicable contract item, the quantity being determined by dividing the accepted material cost by the contract unit price and rounding to the lower whole number. This quantity will be proportionately reduced as the material is incorporated into the work. The cost of surplus stored material, though previously paid on a current estimate but not ultimately incorporated in the final measured work, will not be included in the final payment. Surplus stored material is the property of the Contractor. Remove and dispose of this surplus material from the project in a satisfactory manner.

Pay the material provider the amount owing shown on the invoices within 7 calendar days of receipt of payment from the Department. Provide evidence of payment upon request. Failure to make invoice payments as specified will cause the appropriate monies to be deducted from future estimates and will cause the disapproval of further prepayment requests.

**(b) Erected Steel.** Partial payment for structural steel required for bridge construction will include not over 97% of the total estimated mass (weight) of structural steel in a span erected and completely and permanently bolted, riveted, or welded. The total estimated mass (weight) of structural steel will be included in partial payments after painting has been satisfactorily completed.

**110.07 VALUE ENGINEERING—**Upon approval of a value engineering proposal, as specified in Section 104.04, a two-part, lump sum Value Engineering payment will be made in an amount equal to one-half of the actual net cost savings associated with the proposal. Actual net cost savings is defined as the cost difference between the original contract work and the actual cost of the new work.

Compensation will be made only for proposals pertaining to contracts in effect with the submitting Contractor at the time of submission.

An initial contract work order or contract adjustment will be processed to provide payment for one-half of the lump sum value engineering payment, based on the estimated net cost savings as identified in the approved value engineering proposal. Upon completion of all items of work included as part of the value engineering proposal, a final, lump sum payment will be made by processing a follow-up contract work order or contract adjustment. The final, lump sum payment amount will be determined by computing the actual net cost savings associated with the value engineering proposal, based on actual item quantities, taking one-half of the actual net cost savings, and deducting the amount paid under the initial contract work order or contract adjustment.

## 110.08 FINAL INSPECTION, ACCEPTANCE, AND FINAL PAYMENT—

**(a) Final Inspection.** When the project is substantially complete, make arrangements for a mutual final inspection. Substantial completion is the date when at least 90% of the contract work has been completed and the project can be used, occupied, or operated for its intended use.

At the time of final inspection, the Representative, along with the Contractor, will establish the following:

- The date of final inspection;
- The list of all physical work items, by stations and in detail, requiring completion and/or correction; and
- A list of all certificates or documents requiring submission, completion, and/or correction.

As established during the final inspection, perform work as necessary for required correction or completion of all physical work items, and complete, correct, and submit all outstanding certificates and documents.

The Contractor will be relieved of responsibility for further physical work, maintenance, and third-party liability only for work items which are satisfactorily completed at the time of, or subsequent to, the final inspection. The Contractor's responsibility for further physical work, maintenance, and third-party liability remains for work items, which are not satisfactorily completed at the time of, or subsequent to, the final inspection. When all physical work has been satisfactorily completed according to the requirements of the contract, the Representative will establish the Date of Physical Work Completion.

Upon receipt and verification, the Representative will establish the date that all required certificates and/or documents are satisfactorily furnished.

When all physical work has been satisfactorily completed and all contractually required certificates and documents have been properly furnished, the date of project acceptance will be established.

If any substantial project section has been completed in advance of the whole, a final inspection will be made of that section and the Contractor will be relieved of responsibility for further physical work, maintenance, and third-party liability on the section of the project as specified in Section 108.04(b). The final inspection will be conducted as specified for the entire project; except, the date of project acceptance will not be established nor will an acceptance certificate be issued.

**(b) Acceptance Certificate.** Upon completion of the requirements specified in Section 110.08(a), an acceptance certificate will be issued, establishing the date on which the project has been satisfactorily completed and certifying that the project is accepted as of that date.

**(c) Final Settlement Certificate Computations.** The Representative will compute the entire amount of each contract work item performed and its contract value. The Representative will notify the Contractor of the amount for each item, including additions to and deductions from the contract quantity for each item of work, all other legal and equitable additions and deductions to be made, amounts previously paid, and the net amount of the final settlement certificate computations. The Representative will request written acceptance of, or exception to, these final settlement certificate computations within 10 days of the notification. Failure to follow the following procedures will waive the right to file a claim.

**1.** Within 10 days from the date the final settlement certificate computations or revised computations are submitted, notify the Representative, in writing, of acceptance or exceptions.

**1.a** If accepted, or upon failure to accept or take exception within the specified time, the Chief Engineer, Highway Administration will certify to the Secretary, in the final settlement certificate, the entire amount of each work item performed, its contract value, all legal and equitable additions and deductions, and the amounts previously paid. The Secretary will certify to the State Treasurer the amount due in final payment and contract settlement. Under these circumstances, all claims are considered waived by the Contractor.

The Department will forward a copy of the final settlement certificate, setting forth the final settlement date. Copies will also be forwarded to the surety and other appropriate interested agencies. The date the Secretary notifies the Contractor of the final settlement certificate computations, or revised computations, will be the date of contract completion.

**1.b** If not acceptable, notify the District Executive, in writing, of all exceptions. The District Executive will give notification of the acceptance or rejection of the exceptions. The Contractor or surety has the right to appeal, within 10 days of the rejection, to the Director, BOCM. Notification will then be sent, in writing, from the Director, BOCM stating that the claim has been approved or rejected. Where the claim does not involve any disputes specified in Section 105.01, the "date that the claim accrued," for purposes of filing claims before the Board of Claims, will be the date notification in writing is sent from the District Executive, of the rejection of the claim. In the event of an appeal within 10 days, as provided, the date will be the first notification following the claim rejection by the Director, BOCM.

**2.** During final settlement certificate computations, if the Department determines that the net total amount to be received is actually a negative amount, then prompt reimbursement to the Department for the total amount overpaid is required. In the event of failure to reimburse the Department, the Secretary will take legal measures to secure the amount due. The Department may, in addition, remove the Contractor from its list of approved pre-qualified contractors, according to regulations.

**(d) Final Settlement of Contract.** Final contract settlement will occur when the Secretary certifies to the State Treasurer the amount due in final payment and contract settlement, after making all legal and equitable additions and deductions, including amounts previously paid, according to the contract terms, the terms of written or approved work orders, and the terms of an award, if any, of the Board of Claims. The Department will forward a copy of the final settlement certificate, setting forth the final settlement date. Copies will also be forwarded to the surety and other appropriate interested agencies.

**(e) Final Settlement Certificate on Related Contracts.** Where work has been done for a political subdivision of the State or other agency, by means of approved related contract or contracts under the specifications and Department supervision, the Secretary will forward a copy of the acceptance certificate to the proper authorities. The final settlement certificate in such cases will be certified to the proper authorities for payment, after approval by the Secretary or authorized representative, instead of to the State Treasurer, as provided for work done for the State.

**110.09 RELEASE OF FINAL PAYMENTS**—The Secretary will authorize interest payments on the final payment due, at the rate of 6% per annum, beginning 30 calendar days after the date of physical work completion and running until the date when payment is made. If payment for an item or items is withheld due to a lack of required information from the Contractor, interest charges for the item or items will not begin to accrue until 30 days after the date the Representative receives the information required for payment. For projects financed with bonds, interest will be payable at the rate of interest of the bond issue or at the rate of 10% per annum, whichever is less.

Foreign corporations and their sureties will not be discharged from liability on the bond, nor the bond surrendered, until the corporation files the following with the Department:

- a certificate, from the Department of Revenue, proving the payment in full of all bonus taxes, penalties, and interest; and

- a certificate, from the Bureau of Employment and Unemployment Compensation of the Department of Labor and Industry, as required by the Act of June 10, 1947, P.L. 493 (8 P.S. 23).

**110.10 EVALUATION, DISPOSITION, AND ADJUSTED PAYMENT OF LOW STRENGTH CEMENT CONCRETE**—The following outlines procedures for the evaluation, disposition, and adjusted payment of low strength cement concrete. Use the Concrete Specification Flowchart, Section 110.10(e), as a visual guide to these procedures.

**(a) General.** Low strength, cast-in-place cement concrete will be evaluated using the compressive strength of concrete cylinder or concrete core test specimens. The requirements of this specification do not apply to concrete construction performed as specified in Section 506.

**(b) Definitions.**

- **F'(28-day).** 28-day minimum mix design concrete compressive strength (MPa (pounds per square inch)), as specified in Section 704, Table A.
- **$C_{28}$.** Correction factor for 28-day minimum mix design concrete compressive strength (MPa (pounds per square inch)), as specified in Section 110.10, Table B.
- **F'(c).** 28-day structural design concrete compressive strength (MPa (pounds per square inch)), as specified in Section 704, Table A.
- **$C_c$.** Correction factor for 28-day structural design concrete compressive strength (MPa (pounds per square inch)), as specified in Section 110.10, Table B.
- **F'(cyl).** 28-day concrete compressive strength (MPa (pounds per square inch)) of acceptance cylinders representing a specific concrete lot. Determined as the average of the compressive strength testing of two cylinders molded from the same sample.
- **F'(cs).** Minimum allowable concrete compressive strength (MPa (pounds per square inch)), as specified in Section 110.10, Table A.
- **$C_{cs}$.** Correction factor for minimum allowable concrete compressive strength (MPa (pounds per square inch)), as specified in Section 110.10, Table B.
- **CUP.** Contract unit price of in-place concrete as shown in the Bid Items or, for lump sum structure items, the Component Item Schedule. This value represents the cost of the in-place concrete only and does not include the cost of reinforcing steel. The cost of stay-in-place formwork and other incidental items is to be included in the contract unit price.
- **LOT.** Lot size ($m^3$ (cubic yards)).
- Standard Deviation of the lot measurements, as specified in Section 106.03(a).

**TABLE A**
**Minimum Concrete Compressive Strength Requirements**

| Class of Concrete | Use | Minimum F'(cs) (MPa) | Minimum F'(cs) (psi) |
|---|---|---|---|
| AAA | Bridge Deck | 24 | 3,500 |
| AA | Paving | 21 | 3,000 |
| H.E.S. | Paving | 21 | 3,000 |
| AA | Structures and Misc. | 21 | 3,000 |
| A | | 17 | 2,500 |
| C | | 14 | 2,000 |
| H.E.S. | | 21 | 3,000 |

**(c) Evaluation, Disposition, and Payment of Low Strength Cement Concrete Using Acceptance Cylinders.** If F'(cyl), representing a specific concrete lot, fails to meet the F'(28-day) for the specified class of concrete, the concrete will be considered deficient. Disposition of the low strength concrete will be determined as follows:

**1. F'(cyl) ≥ F'(c).** If F'(cyl) is greater than or equal to F'(c), and the 28-day QC test result is greater than or equal to F'(c), the concrete lot may be accepted at an adjusted payment. The adjusted payment will be calculated as follows:

Adjusted Payment = {(A/B x 0.20) + 0.80} x CUP x LOT

where:

A = F'(cyl) – F'(c)
B = F'(28-day) – F'(c)

As an alternative, within 2 working days of notification of deficient F'(cyl), request permission of the Representative, in writing, to extract concrete cores from the deficient lot of concrete. If this alternative is permitted, the procedures specified in Section 110.10(d) for extracting and evaluating the core specimens will be followed. When coring is approved, final disposition of the low strength concrete will be determined based solely on the compressive strength of core specimens. The acceptance cylinder strength will no longer be used.

**2. F'(cyl) < F'(c).** If F'(cyl) is less than F'(c), extract core specimens from the deficient lot of concrete. Notification to core will be given by the Representative within 2 working days after receiving acceptance cylinder test results.

Use the procedures specified in Section 110.10(d) for extracting and evaluating the core specimens.

**(d) Evaluation, Disposition, and Payment of Low Strength Cement Concrete Using Concrete Core Specimens.** Core locations will be randomly selected within the deficient lot of concrete according to PTM No. 1. Obtain cores, under the direction and supervision of the Representative, within 1 week of notification, at no additional cost to the Department.

Obtain three cores if the size of the deficient lot of concrete is less than 20 $m^3$ (25 cubic yards). If the deficient lot size is greater than or equal to 20 $m^3$ (25 cubic yards,) obtain five cores.

Obtain cores according to AASHTO T 24, except as follows:

Obtain 100 mm (4-inch) diameter cores, which are free of reinforcing steel. A pachometer will be used to locate the reinforcing steel. If 100 mm (4-inch) diameter cores free of reinforcing steel cannot be obtained, smaller diameter cores will be allowed provided the core diameter is at least three times the nominal maximum size of the coarse aggregate used in the concrete mix, but not less than 75 mm (3 inches). Obtain approval from the BOCM, MTD, for any deviation from these requirements.

Deliver cores immediately to the Representative. Cores will be delivered to the MTD within 3 working days. Cores will be prepared for testing according to AASHTO T 24 and compressive strength testing will be conducted according to PTM No. 604.

The compressive strength test results of the core specimens will be evaluated to determine material acceptance and adjusted payment. Disposition of the low strength concrete will be determined as follows:

**1. Acceptance.** Material acceptance for the lot of low strength cement concrete will be determined as follows:

**TABLE B**
**Metric Correction Factor for Quality Index ($Q_L$)**
**Section 106.03(a)3.a.6**

| Class of Concrete | Correction Factors (Cx) | | |
|---|---|---|---|
| | $C_{28}$ | $C_C$ | $C_{CS}$ |
| AAA | -0.03/s | 0.42/s | -0.13/s |
| AA;H.E.S. | 0.14/s | -0.13/s | 0.32/s |
| A | 0.25/s | 0.32/s | -0.24/s |
| C | 0.21/s | 0.21/s | 0.21/s |

For metric calculation only, add correction factors to quality index ($Q_L$) (which is calculated as specified in Section 106.03(a)3.a.6) to determine the corrected Quality Index $Q'_L$:

$$Q_L + C_X = Q'_L$$

Estimate the percentage of material that will fall within the lower tolerance limit (L) by entering $Q'_L$ in Table A of Section 106.03(a) using the column corresponding to total number of measurements (n).

**1.a PWL F'(cs).** The percent within tolerance relative to F'(cs), PWL F'(cs), will be calculated as specified in Section 106.03(a)3 (except the corrected Quality Index $Q'_L$, as specified in Table B, will be used in place of $Q_L$), using F'(cs) value for specified class of concrete, as specified in Section 110.10, Table A, as the lower limit and the core strengths as lot measurements.

- If PWL F'(cs) is greater than or equal to 99%, calculate payment as specified in Section 110.10(d)2.

- If PWL F'(cs) is less than 99%, concrete will be considered deficient. Remove and replace deficient lot of concrete, at no additional cost to the Department, unless otherwise directed, in writing, by the Chief Engineer. Remove and replace reinforcement steel damaged as a result of the concrete removal process, and not conforming to requirements specified in Sections 709 and 1002, at no additional cost to the Department.

Under certain specific circumstances, the Chief Engineer may approve allowing deficient concrete to remain in place. This approval may be granted only if all of the following conditions are met:

- The Contractor must request, in writing, that the lot of deficient concrete remain in place.

- An engineering analysis of the deficient concrete is performed at no expense to the Department.

- Adjusted Payment for the lot of deficient concrete left in place will be exactly 5% of the contract unit price (CUP) of the contract item.

- The Contractor provides a signed document waiving the right to pursue a claim as a result of the reduced payment for the lot of concrete.

For deficient incidental concrete meeting the above conditions, this approval may be granted by the District Executive provided all of the conditions detailed above are met.

**2. Payment.** Adjusted payment for lot of low strength cement concrete will be calculated as follows:

**2.a PWL F'(c).** The percent within tolerance relative to F'(c), PWL F'(c), will be calculated as specified in Section 106.03(a)3 (except the corrected quality index $Q'_L$, as specified in Table B, will be used in place of $Q_L$), using the F'(c) value for the specified class of concrete, as specified in Section 704, Table A, as the lower limit and the core strengths as the lot measurements.

**2.b PWL F'(28-day).** The percent within tolerance relative to F'(28-day), PWL F'(28-day), will be calculated as specified in Section 106.03(a)3 (except the corrected quality index $Q'_L$, as specified in Table B, will be used in place of $Q_L$), using the 28-day minimum mix design compressive strength requirement for the specified class of concrete, as specified in Section 704, Table A, as the lower limit and the core strengths as the lot measurements.

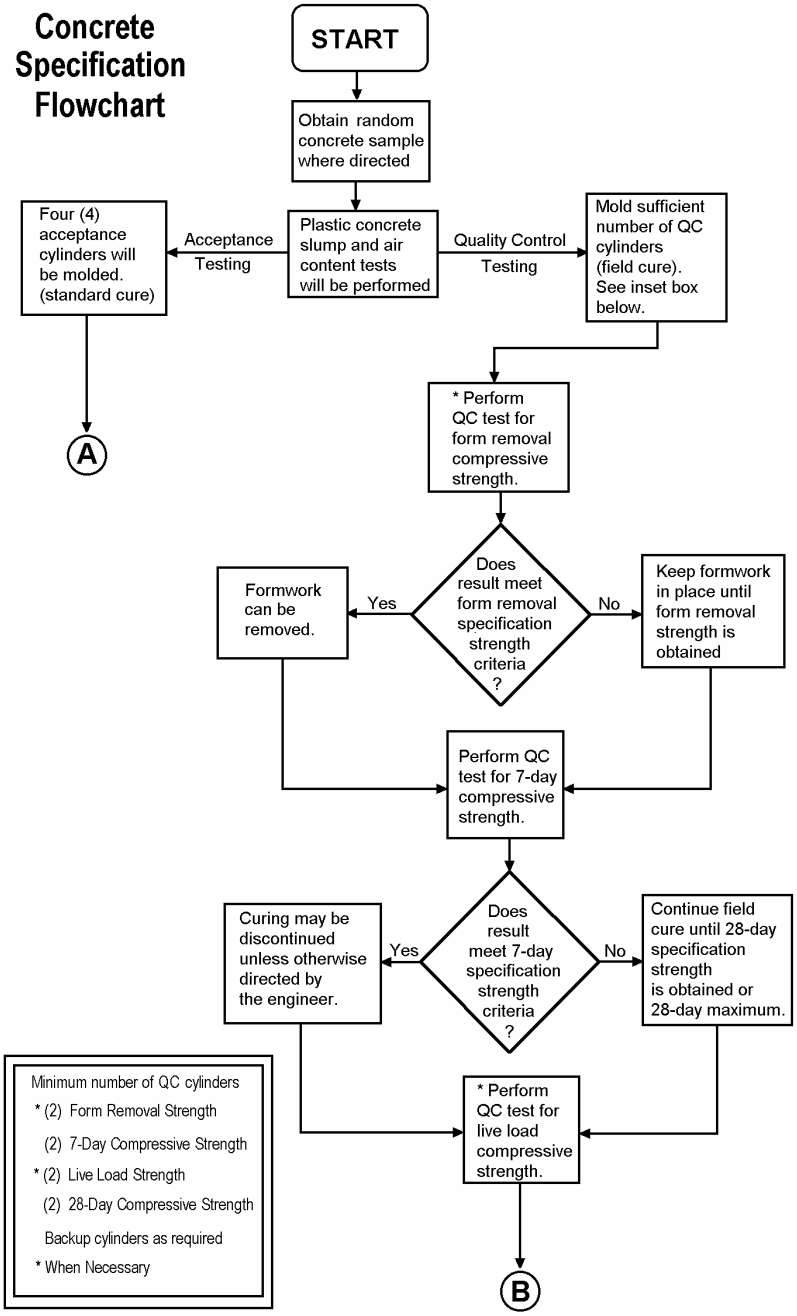
**2.c Payment Equation.** Adjusted payment for the lot will be calculated as follows:

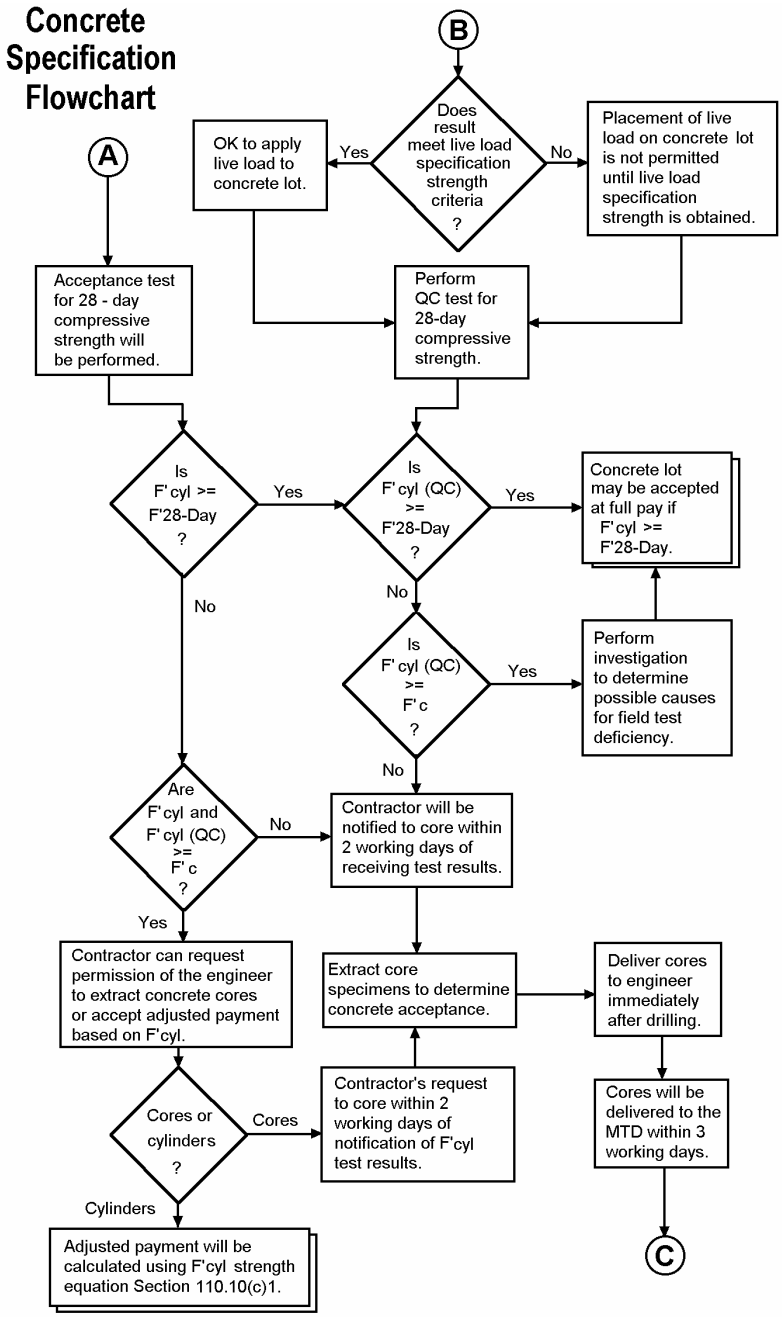
Adjusted Payment = (A + 0.85B + 0.50C) x CUP x LOT

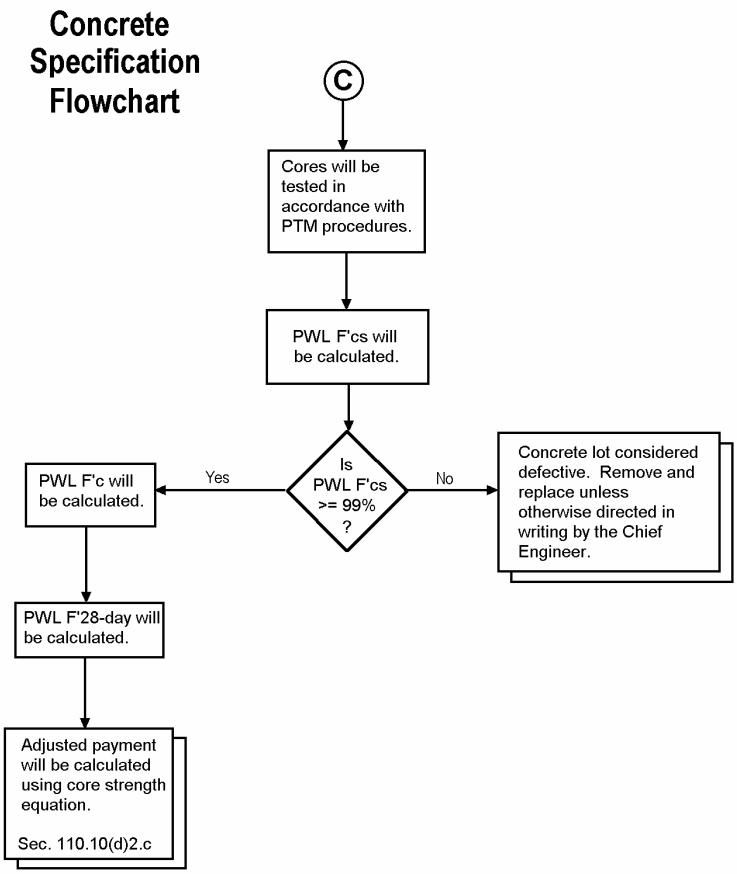
where:

A = PWL F'(28-day)
B = PWL F'(c) - PWL F'(28-day)
C = PWL F'(cs) - PWL F'(c)

**(e) Concrete Specification Flowchart.**




Concrete Specification Flowchart
A
B
C
Acceptance test for 28 - day compressive strength will be performed.
Is F'cyl >= F'28-Day ?
Yes
No
Perform QC test for 28-day compressive strength.
Is F'cyl (QC) >= F'28-Day ?
Yes
No
Concrete lot may be accepted at full pay if F'cyl >= F'28-Day.
Is F'cyl (QC) >= F'c ?
Yes
No
Perform investigation to determine possible causes for field test deficiency.
Does result meet live load specification strength criteria ?
Yes
No
OK to apply live load to concrete lot.
Placement of live load on concrete lot is not permitted until live load specification strength is obtained.
Are F'cyl and F'cyl (QC) >= F'c ?
No
Yes
Contractor will be notified to core within 2 working days of receiving test results.
Contractor can request permission of the engineer to extract concrete cores or accept adjusted payment based on F'cyl.
Extract core specimens to determine concrete acceptance.
Deliver cores to engineer immediately after drilling.
Cores or cylinders ?
Cores
Cylinders
Contractor's request to core within 2 working days of notification of F'cyl test results.
Cores will be delivered to the MTD within 3 working days.
Adjusted payment will be calculated using F'cyl strength equation Section 110.10(c)1.


Concrete Specification Flowchart
C
Cores will be tested in accordance with PTM procedures.
PWL F'cs will be calculated.
Is PWL F'cs >= 99% ?
Yes
No
PWL F'c will be calculated.
Concrete lot considered defective. Remove and replace unless otherwise directed in writing by the Chief Engineer.
PWL F'28-day will be calculated.
Adjusted payment will be calculated using core strength equation.
Sec. 110.10(d)2.c

## 110.11 EVALUATION, DISPOSITION, AND ADJUSTED PAYMENT OF PRESTRESSED CONCRETE BEAMS—

**(a) General.** Low strength concrete prestress beams will be evaluated using the compressive strength of concrete cylinder or concrete core test specimens.

**(b) Definitions.**

- **F'(28-day).** 28-day minimum concrete compressive strength (MPa (pounds per square inch)), as specified on the approved shop drawings.
- **F'(cyl).** 28-day concrete compressive strength (MPa (pounds per square inch)), of acceptance cylinders representing a beam. Determined as the average of the compressive strength of two or more cylinders.
- **F'(r).** Minimum concrete compressive strength (MPa (pounds per square inch)), for transfer of prestress as indicated.
- **F'(core).** Concrete compressive strength (MPa (pounds per square inch)) of acceptance cores extracted from a beam. Determined as the average of the compressive strength of three cores.
- **FBP.** Fabricated beam price.

**(c) Evaluation, Disposition, and Payment of Low Strength Prestressed Concrete Beams Using Acceptance Cylinders.** If F'(cyl), representing a specific beam, fails to meet the F'(28-day) for the specified design, the beam will be considered deficient. If F'(cyl) < F'(r), the beam will be rejected. If F'(cyl) ≥ F'(r), perform structural calculation based on F'(cyl) for the prestressed beam. Calculations must include all the original design considerations and be performed by a Professional Engineer registered in the State. Submit calculations to the Structural Materials Section, MTD for review by the appropriate Engineering District. These calculations must be submitted within 2 weeks of notification that F'(cyl) was deficient. If the structural calculations show that the beam is not acceptable to the Department, the beam will be rejected. If the calculations show that the beam is structurally acceptable, the adjusted payment will be determined as follows:

$$\text{Adjusted Payment} = [\,(A/B \times 0.50) + 0.50\,] \times FBP$$

where:

$A = F'(cyl) - F'(r)$
$B = F'(28\text{-day}) - F'(r)$

As an alternative, within 2 working days of notification of deficient F'(cyl), request permission of the Structural Materials Engineer, in writing, to extract concrete cores from the deficient beam. If this alternate is permitted, the procedures specified in Section 110.11(d) for extracting and evaluating the core specimens will be followed. When coring is approved, final disposition of the low strength beam will be determined based solely on the compressive strength of core specimens. The acceptance cylinder strength will no longer be used.

**(d) Evaluation, Disposition, and Payment of Low Strength Prestressed Concrete Beams Using Cores.** When coring is approved by the Structural Materials Engineer, obtain cores, under the direction and supervision of the Representative or his or her designate, within 1 week of notification, at no additional cost to the Department.

Obtain three cores, one from each third of the deficient strength beam, according to AASHTO T 24. Obtain cores from the portion of the beam that does not contain prestressing strands. Use a pachometer if necessary to avoid damage to the stirrups or strands. Patch holes left after coring using an approved patching material from a manufacturer listed in Bulletin No. 15 or the approved concrete mix design.

Deliver the cores to the Representative immediately upon drilling. Cores will be delivered to the MTD within 3 working days of obtaining them. No cores will be tested at an age of greater than 50 days. Cores will be prepared for testing according to AASHTO T 24 and compressive strength testing will be conducted according to PTM No. 604.

The [F'(core)] and standard deviation(s) of three cores will be determined and the results sent to the supplier of the prestress beam. If F'(core) ≥ F'(28-day), the beam will be accepted at full payment; no structural analysis is required. If F'(core) falls below F'(r), the beam will be rejected. If s ≥ 7.0 MPa (1,000 pounds per square inch) and [F'(core) – s] < F'(r), the beam will also be rejected. If s < 7.0 MPa (1,000 pounds per square inch) or [F'(core) – s] ≥ F'(r), perform structural calculations based on F'(core) and submit these to the Structural Materials Section as specified in Section 110.11(c). If the calculations show that the beam is not structurally acceptable, the beam will be rejected. If the calculations show that the beam is structurally acceptable, the beam will be accepted at an adjusted payment. The adjusted payment will be calculated using the equation specified in Section 110.11(c), except that F'(core) will be used in place of F'(cyl).

# SECTION 111—DELAY CLAIMS

**111.01 COMPENSABLE DELAYS**—The Department is responsible for delay damages arising only from delays created by its negligent acts or omissions and from Utility Infrastructure and Utility Adjustment delays as specified in Section 105.06. Unless otherwise specified, assume the risk of damages from all other causes of delay.

**111.02 GENERAL CONDITIONS CONCERNING DELAY CLAIMS**—Because of the nature and extent of damages arising out of work that has been delayed; of the need for the Department to be made aware of potential delay claims promptly after the cause or causes of delay have arisen so that record-keeping can begin; and of the parties' intent to have all such claims as fully documented as possible, strict adherence to the provisions of this section is an essential condition precedent to filing a delay claim with the Board of Claims. The following items of damage cannot be included in any delay claim against the Department:

- profit;
- loss of profit;
- labor inefficiencies;
- home office overhead, including but not limited to costs of any kind for home office personnel; and
- consequential damages, including but not limited to loss of bonding capacity, loss of bidding opportunities, and insolvency.

**111.03 NOTIFICATION OF DELAY CLAIM**—Notwithstanding the provisions specified in Section 105.01, within 10 calendar days of any negligent act or omission of the Department or of any Utility Infrastructure or Utility Adjustment delay as specified in Section 105.06, notify the Inspector-in-Charge that operations have been or will be delayed and that a claim for delay damages either is going to or might be filed with the Board of Claims. Confirm such notification in writing to the District Executive within 10 calendar days of such notification to the Inspector-in-Charge.

**111.04 PROCEDURES**—Upon notifying the Inspector-in-Charge as provided above, keep records, on a daily basis, of all labor, material, equipment, and site overhead expenses for all operations that are affected by the delay. Identify in such daily records each operation and the station or stations thereof affected by the delay. The Department's forces will also keep daily records of all labor, equipment, material, and site overhead expenses for all operations affected by the delay. On each Monday, compare the previous week's daily records with those kept by the Department and review for accuracy. Report to the District Executive, within 10 calendar days of each such review, all disagreements with such records. Refusal or failure to meet to review the Department's records or to report disagreements with such records will create an irrebuttable presumption in favor of the Department that its records are accurate. Make no claim for delay costs of any kind allegedly incurred, before notifying the Inspector-in-Charge that operations have been delayed.

On a weekly basis, prepare and submit to the Inspector-in-Charge written reports containing the following information:

**(a)** The number of days behind schedule.

**(b)** An identification of all operations that have been, or are to be delayed.

**(c)** An explanation of how the Department's negligent act or omission or the Utility Infrastructure or Utility Adjustment as specified in Section 105.06 delayed each operation, and an estimation of how much time is required to complete the project.

**(d)** An itemization of all extra costs being incurred, including:

- An explanation as to how those extra costs, including site overhead costs, relate to the delay and how they are being calculated and measured;
- An identification of all project employees for whom costs are being compiled; and
- An identification of the manufacturer's numbers for all items of equipment for which costs are being compiled.

Upon completion of the project, submit to the Inspector-in-Charge and the District Executive copies of a report containing the following information:

- An itemization and explanation of the measurement and basis of all extra costs being sought, including all reports certified by an accountant;
- A description of the operations that were delayed, including all reports by scheduling experts or other consultants, if any;
- All actions taken by the Contractor to minimize the delay and to minimize the delay costs incurred;
- An as-built chart, CPM scheme, or other diagram, depicting in graphic form how the operations were adversely affected; and,
- For delays related to Utility Infrastructure and Utility Adjustments, an explanation of why the delay was unforeseen based on the contract documents and a careful pre-bid examination of the project site, or of any waste or borrow sites designated in the proposal.

The District Executive will review the submission and any reports prepared by the Inspector-in-Charge. If, in the opinion of the District Executive, the Department is not liable for any delay, a written decision will be issued. Comply with the provisions of Section 105.01 if the District Executive's decision is disputed.

If the District Executive determines that the Department delayed operations, a review of the damages claimed will be made and a written decision will be issued. Comply with the provisions of Section 105.01 if the District Executive's decision is disputed. For operation delayed by a Utility Infrastructure or Utility Adjustment as specified in Section 105.06, concurrence of the district Executive's decision by the Chief Engineer is also required.

Only expenses for extra labor, material, equipment, and site overhead will be considered by the Department. Ten percent will be added to these costs to cover allocable home office overhead. Likewise, in the event a delay claim is filed with the Board of Claims, only the foregoing expenses may be claimed.

If computing additional equipment expenses (i.e., ownership expenses), do not use, in any way, the Rental Rate Blue Book for construction equipment or any other rental rate book. Use actual records kept in the usual course of business, and compute increased ownership expenses pursuant to generally accepted accounting principles.

# SECTION 112—PROJECT RECORDS

**112.01 SCOPE**—This section pertains to all project records that were used to prepare and compute the bid; to prepare all schedules used on the project; to record the progress of work on the project; and to record, compute and/or analyze all costs incurred on the project, including those used in the preparation or presentation of claims to the Department or the Board of Claims.

**112.02 DEFINITION**—Charts, graphs, cross-sections, plans, photographs, schedules, reports, accounting statements, accounting ledgers, balance sheets, bid sheets, take-off sheets, cost estimates, cost records, payroll records, financial documents, notes, memoranda, correspondence, and all other records, whether typewritten, handwritten, computerized, microfilmed, photographed, or recorded, that were prepared by or received by the Contractor.

**112.03 RETENTION PERIOD**—Retain the aforementioned project records for a period of 3 years from the date of receipt of final payment with the following exception:

- If any litigation, claim, or audit is started before the expiration of the 3-year period, retain the records until all litigations, claims, or audit findings involving the records have been resolved.

**112.04 INSPECTION**—Upon written notice by the Representative or an authorized agent acting on behalf of the Department, make available all requested project records for inspection and copying by Department personnel or those authorized to act on its behalf. Make such records available at a reasonable time and place.

Refusal or repeated failure to present requested project records for inspection or copying may be considered grounds for declaring the Contractor in default and may be considered against prequalification for work on future projects.

Exempt from this section are all project records, which under the Pennsylvania Rules of Civil Procedure, are deemed confidential and, therefore, exempt from discovery.

# SECTION 200
# EARTHWORK

## SECTION 201—CLEARING AND GRUBBING

**201.1 DESCRIPTION**—This work is:

- Removal of the first 200 mm (8 inches) of topsoil and organic material.
- Removal of topsoil and organic matter such as trees, stumps, brush, roots, and other vegetation within the limits of grading, including ditches and channels. Remove trees individually selected for removal as specified in Section 810.
- Removal of objectionable material, rubbish, and junk within the project limits.
- Removal of buildings and structures, fences, walls, guide rail posts, guide rails, signs, direction markers, and other obstructions interfering with the work.
- Disposal of removed material.
- Salvaging, temporarily storing, and delivering of material.
- Obtaining of waste areas for disposal of material as specified in Section 105.14.
- Stockpiling of topsoil mixture as specified in Section 801.
- Chipping and stockpiling wood waste material, if specified in the Special Provisions.

**201.3 CONSTRUCTION**—Clear and grub before the start of grading operations in an area. The Contractor may remove stumps within excavation areas during grading. Replace suitable material and topsoil that is required on the project and was wasted during clearing and grubbing operations, at no expense to the Department.

Do not damage trees or other vegetation beyond the grading limits. Install protective fencing as indicated, as specified in Section 811, before clearing and grubbing operations.

Clear the ground of organic matter within excavation areas. Remove stumps and roots to a depth of at least 600 mm (2 feet) below subgrade or slope surfaces.

Remove organic matter and topsoil within embankment areas to a depth of 200 mm (8 inches) below the existing ground to 6 m (20 feet) beyond the pavement edges. Beyond 6 m (20 feet) of the pavement edges and within the embankment area, cut trees and stumps flush with the ground surface. Remove remaining topsoil over 200 mm (8 inches) in depth, when directed, as specified in Section 203. Stockpile removed topsoil as specified in Section 801.

Trees and shrubs along a highway previously opened to traffic belong to the property owner. Surrender all material from the removal of trees and shrubs to the owner of the abutting property. Dispose of the trees and shrubs if the owner refuses to accept the wood.

Trim tree branches that extend over the pavement and shoulders.

Transport wood chips to approved stockpile areas that will not interfere with construction operations, obstruct drainage, or cause water pollution.

Dispose of material in an approved waste area, unless otherwise specified in the Special Provisions, or burn, if permitted. Comply with the requirements of the Air Pollution Control Act (Act 245-1972, or as amended), the Solid Waste Management Act (Act 97-1980, or as amended), and the permits specified in Section 107.27(a), whichever are applicable. Do not burn within 12 m (40 feet) of remaining vegetation. Recondition the sites of fires as specified in Section 105.14.

When an enclosure fence is partly or wholly within the right of way, notify the property owner 30 days in advance of clearing and grubbing operations to allow the owner to make necessary arrangements to restore the enclosure. Upon failure of the property owner to proceed with work required to enclose the property, carefully remove the fence within the right of way and neatly pile material on the owner's property adjacent to the right of way.

**201.4 MEASUREMENT AND PAYMENT**—Hectare (Acre) or Lump Sum

If no item of work is provided in the contract, this work is incidental to the other contract items.

# SECTION 202—TOTAL DEMOLITION OR PARTIAL DEMOLITION OF BUILDINGS AND OTHER STRUCTURES

**202.1 DESCRIPTION—**This work is total or partial demolition of buildings and other structures, as indicated. The following definitions apply:

**(a) Total Demolition.** Total demolition and removal of indicated buildings and other structures located wholly within the right of way.

**(b) Partial Demolition.** Partial demolition and removal of indicated buildings and other structures located partly within the right of way. Demolish and remove only the portion within the right of way, unless the owner of the remaining portion requests and authorizes total demolition in writing.

**(c) Refinishing Party Walls.** Demolition of indicated buildings or other structures to the party wall that separates them from another building or structure outside the right of way. Refinishing of the exposed portion of the party wall, including the party wall foundation.

**202.2 MATERIAL—**

**(a) Cement, Type IS, IP, or II.** Section 701

**(b) Fine Aggregate, Type A.** Section 703.1

**(c) Lime.** Section 723

**(d) Water.** Section 720.1

**(e) Emulsified Asphalt, Class E-1 or E-2.** Section 702

**(f) Caulking Compound.** Section 705.8

**(g) Other Material.** Certify as specified in Section 106.03(b)3.

- Metal Mesh Lath, 1.8 kg/m$^2$ (3.4 pounds per square yard)—FSS QQ-L-101a
- Roofing Material, 29.5 kg (65 pounds) per roll—ASTM D 224
- Insulating Board—ASTM C 578, Types I and II, Grades 2 and 3
- Asphalt Mastic—FSS SS-C-153

**202.3 CONSTRUCTION—**

**(a) General.** Confine movements and operations to the existing right-of-way limits. Do not deposit construction material, junk, debris, or rubbish on private property. Do not enter private property without first obtaining the written consent of the property owner or owners, and filing a copy of the consent with the Department.

The Department will obtain the vacation of all buildings or structures to be demolished as expeditiously as possible. The Department does not guarantee that all facilities will be vacated and available in sufficient time to allow systematic operations.

The Department does not assume responsibility for the condition of the various buildings or loss of fixtures, equipment, material, or other objects between submittal of the proposal and actual possession of the buildings.

Remove and dispose of material taken from within the project limits as well as debris and rubbish, except items of personal property belonging to owners or tenants and material required for backfilling. Remove material from the project limits as it accumulates, or as directed. Conduct no sale of material while within the project limits.

Comply with the requirements, outlined in Pennsylvania's Asbestos Occupations Accreditation and Certification Act of 1990 (Acts 194 and 161) as well as Federal National Emission Standard for Hazardous Air Pollutants (NESHAP) regulations, for providing notification to all State and County agencies having regulatory enforcement responsibility for demolition and asbestos abatement projects prior to the start of any such work. Such notification should be made using the "Asbestos Abatement and Demolition/Renovation Notification Form," which may be obtained by contacting the DEP Asbestos Office at (717) 787-9257, or the nearest DEP regional office. The form may also be obtained here.

**(b) Safety Regulations.** Furnish, erect, and maintain barricades, steady burn lights, flashing warning lights, and warning and "Keep Out" signs where the placing of such protective devices is warranted, or as directed.

Provide, erect, light, and maintain suitable footway shelter platforms, as required by law or as directed.

Control dust resulting from demolition.

Comply with the National Emission Standard for Asbestos, as contained in the Federal Register, Vol. 55, No. 224.

**(c) Utility Disconnections.** Before starting work, make arrangements with the proper authorities for turning off and disconnecting utilities in connection with demolition operations. Perform the work according to local requirements.

When only a portion of an occupied building is to be demolished, conduct demolition and related operations without interrupting utility service to the remaining portion of the building.

Make permanent reconnections where it is necessary to reconnect facilities to the un-demolished portion of the building.

**(d) Demolition.** Submit a demolition plan to the Representative at least 2 weeks before beginning demolition. Provide a rodent control plan if directed. Before beginning demolition, pump out and clean wells, cesspools, and outbuildings, within the areas to be cleared, in a sanitary manner. Disinfect all such structures as required by the appropriate health authorities, then backfill to the adjacent ground level.

Do not interfere with functioning wells, cisterns, cesspools, or other ground openings outside the condemned area. Securely and permanently cap well casings. Cut off and cap pipes leading into or out of abandoned wells or wells to be demolished.

Where the uncondemned portion of a property has been abandoned, cover, backfill, or treat wells and other openings that constitute a hazard or dangerous condition. Before proceeding with this work, obtain the consent of the owner or owners in writing.

Leave contiguous buildings in a safe condition. Do not deface, mar, or jeopardize them. Repair damage and restore them as directed.

Remove existing fences and guide rail posts, unless otherwise directed. Do not disturb existing curbs, sidewalks, and street paving unless directed.

Do not use a swinging ball immediately adjacent to any public thoroughfare or in any area where its use may create a public hazard.

Do not set fire to any structure. Burn debris only with written permission of local police or fire authorities and if the burning conforms to State Air Pollution Control Commission regulations. Do not begin burning debris until the Department receives a copy of the written permission.

Ensure that the demolition work is strictly confined within the limits of the indicated temporary construction area without hazard to adjacent properties or to the public.

Do not demolish chimneys common to adjacent properties. Do not disturb these chimneys other than to give them support as necessary for continued stability. Repoint and cap as directed.

Restrict partial demolition to horizontal operations, one floor of each structure at a time. Progressively demolish a structure(s), except for the stripping of fixtures, from top to bottom, one floor at a time. The Contractor may perform bay or sectional-type demolition provided a detailed plan, including the building's structural framework, is submitted and accepted before beginning the work. Progressively demolish bay or sectional-type structures from top to bottom as well. Completely demolish each bay or section before starting operations on any adjacent bay or section. Remove each bay or section in a manner that maintains the integrity and proper support of adjacent bays or sections.

If only a portion of a building is to be demolished, adequately shore, brace, and support the remaining part to maintain the integrity of remaining walls, floors, and roofs and their supporting members. Construct shoring, bracing, and supports to be outside the right of way. Tightly board up and seal the remaining portion of a partially demolished building along the right-of-way line. Construct the new closure and connections to the remaining portion of the building in a satisfactory manner and make them weatherproof. Provide a closure of adequately braced lumber studding placed not more than 400 mm (16 inches) apart, with plywood or equal facing, without holes, tightly and securely nailed to the studding. Cover the plywood facing with two layers of smooth finished roofing material. Overlap the roofing material by not less than 100 mm (4 inches).

Where demolition involves severance through a cellar or other subsurface opening, immediately erect a 450 mm (18-inch) thick cement masonry wall adjacent to and wholly outside the right of way. Provide a wall extending from 450 mm (18 inches) below the existing cellar floor to the elevation of the top of adjacent cellar walls. Integrally connect the new wall to the existing adjacent walls.

Demolish wall portions above the first floor that are located immediately adjacent to and parallel to any street. Remove walls and foundations, except required party walls as indicated, to an elevation 1.2 m (4 feet) below the adjacent sidewalk elevation. Clear partition walls and columns of any nature, in cellars or in other subsurface openings, to their floor elevations.

Fill in and repair holes, breaks, or depressions in remaining walls with brick and cement mortar.

Rough cast repaired areas with cement mortar so that they are left in a safe and weatherproof condition.

Remove floor construction above cellars. Remove basement partitions, furnaces, heating apparatus, piping, fuel tanks, miscellaneous fixtures, and stairways from the demolition area.

Store material suitable for backfill that may be encountered in the demolition, until the walls are down.

**(e) Refinishing Party Walls.** Where indicated or directed, cap party walls and restore by insulating and plastering to an acceptable finish. Before work, thoroughly clean the party wall of old plaster, sand, and dirt. Rake pit joints in the brickwork to a minimum depth of 6 mm (1/4 inch), as directed. Water joints, and repoint while damp.

**1. Insulating Coating.** If the wall has an average thickness of less than 150 mm (6 inches), apply an insulating coating as follows:

- Evenly spread a heavy coating of cold asphalt mastic over the entire wall surface.
- Fit, press in place, and securely bond insulating boards (25 mm x 610 mm x 2438 mm stock (1-inch by 2-foot by 8-foot stock)) to the asphalt mastic.
- Caulk joints between the insulating boards with emulsified asphalt or caulking compound to obtain a uniform and finished appearance.

**2. Cement Plaster Coating.**

**2.a Metal Mesh Lath.** Place metal mesh lath against the insulating coating, and securely attach with acceptable devices.

If an insulating coating is not required, securely attach the metal mesh lath directly to the wall, using acceptable devices penetrating the mortar and not the brick. Repair damage to the mortar bond or interior of the wall to the satisfaction of the Representative.

**2.b Cement Plaster.** Do not plaster until the preceding operations have been inspected and accepted. Do not plaster when the outside air temperature is below 7 °C (45F). Extend the plaster from the roofline or wall top to the established ground line, or as directed. Provide a total thickness of finished plaster not less than 22 mm (7/8 inch).

Mix plaster in a suitable mixer with water to obtain a plastic composition. Proportion the mix as follows:

| **Cement Plaster Scratch and Brown Coats** | **Cement Plaster Finish Coat** |
|---|---|
| Cement—1 bag (42.6 kg (94 pounds)) | Cement—1 bag (42.6 kg (94 pounds)) |
| Lime—1 bag (22.7 kg (50 pounds)) | Lime—1 bag (22.7 kg (50 pounds)) |
| Natural Sand—0.14 $m^3$ (5 cubic feet) | Natural Sand—0.17 $m^3$ (6 cubic feet) |

Immediately before scratch coat application, evenly wet the wall surface but do not saturate. Apply a 10 mm (3/8-inch) scratch coat, heavily cross-hatched to integrate with the metal mesh lath.

After the scratch coat dries thoroughly, again, evenly wet the wall surface but do not saturate. Apply a 10 mm (3/8-inch) brown coat.

After the brown coat dries thoroughly, again, evenly wet the wall surface but do not saturate. Apply a 3 mm (1/8-inch) finish coat. Provide color and finish type as directed.

Protect each coat of plaster from sun and wind to prevent rapid drying. Keep each coat moist by sprinkling for at least 3 days after application or as directed. Allow each coat to dry thoroughly before placing the succeeding coat.

Upon completion of the plastering, install suitable matching wood trim along the border of the roof. Paint new wood trim to conform to the trim color of the remainder of the structure or as directed.

**(f) Backfilling.** Backfill subsurface areas as specified in Section 206.3 and as follows:

Before starting backfilling operations, submit the method of backfill and compaction for review and acceptance.

Furnish additional embankment material for backfilling subsurface areas. Have the quality, nature, and source of any additional embankment material accepted before use. Do not use unsuitable or unstable material in the backfill.

Break-up existing cellar floors and other surface areas to ensure adequate subsurface drainage. Backfill cellars and other subsurface spaces, and grade to the adjacent ground level or as directed.

Clean party wall foundations against which backfill material is to be placed, point brick or block walls with mortar, and waterproof with two coats of emulsified asphalt.

**(g) Treatment of Disturbed Areas.** Treat disturbed areas resulting from demolition with seeding and soil supplements as specified in Section 804. Use a seeding type as indicated or directed. When directed, mulch as specified in Section 805.

## 202.4 MEASUREMENT AND PAYMENT—

**(a) Demolition.** Lump Sum

If a structure is set afire, the amount bid for this item will be deducted from the total amount due.

**(b) Refinishing Party Walls.** Lump Sum

**(c) Utility Disconnections/Reconnections.** Utility disconnections/reconnections are incidental to demolition. The Contractor shall pay all expenses resulting from utility disconnections/reconnections, including fees to utility companies or other agencies.

**(d) Treatment of Disturbed Areas.** Treatment of disturbed areas is incidental to this work.

# SECTION 203—CLASS 1, CLASS 1A, AND CLASS 1B EXCAVATION

**203.1 DESCRIPTION**—This work is excavation for roadways, roadway appurtenances, and structures. The three classes of excavation include the following:

**(a) Class 1 Excavation.**

- Excavation as shown on the Standard Drawings, for roadways, shoulders, ditches, drainage structures, stream channels, grade separation structures, retaining walls, and wingwalls.
- Excavation, as indicated or directed, for benches and for the removal of existing pavements not being rehabilitated.
- Excavation, as indicated or directed, for the removal of unsuitable material having a bottom width of 2.5 m (8 feet) or more.
- Excavation, as indicated or directed, to allow for the placement of topsoil.
- Excavation and stockpiling, as indicated or directed, for the removal of topsoil other than the first 200 mm (8 inches), which are incidental to the clearing and grubbing operations specified in Section 201.
- Removal of unforeseen slides and rock ledges.
- Removal of stone fences, piles of dirt or stones, individual boulders, and any portions of structures above the natural ground, when in excess of 0.5 $m^3$ (1/2 cubic yard) volume.

**(b) Class 1A Excavation.** Excavation for the removal of unsuitable material below subgrade having a bottom width of less than 2.5 m (8 feet), as indicated or directed. Saw cut as necessary. Includes backfilling as specified in Section 206.

**(c) Class 1B Excavation.** For roadway rehabilitation, sawcutting and removal of existing pavement to neat lines, as indicated or directed.

**203.3 CONSTRUCTION—**

**(a) General.** During construction, keep the excavation graded to drain seal with smooth-wheeled compaction equipment to prevent subgrade from becoming saturated. Seal the surface at the end of the workday in order to prevent conditions from deteriorating before work can proceed. Temporary drainage structures or channels may be required.

**(b) Blasting.** Drill and blast rock, not removable by other excavating methods, in a manner that completes the excavation to the lines indicated, with the least disturbance to adjacent material to provide a safe and stable slope face. Remove loose, unstable material during excavation. Limit drilling and blasting to a maximum of 1 m (3 feet) below the subgrade elevation to limit the disturbance of the subgrade. Perform deeper drilling and blasting only with the written approval of the Geotechnical Engineer. Compact loose, residual material below the subgrade after the blasting operations. Replace material removed below subgrade with suitable material.

Provide information describing pertinent blasting procedures, dimensions, and notes before starting any phase of the operation.

**1. Presplit Blasting Method.** Excavate material overlying rock or hard shale to the elevation directed before start of presplit blasting. Excavate those areas not designated for presplit blasting at ends of the excavation section.

Presplit according to the following criteria:

- Drilling depth increments—not to exceed 9 m (30 feet).
- Maximum diameter of holes—90 mm (3 1/2 inches).
- Spacing of holes—450 mm (18 inches) minimum, 900 mm (36 inches) maximum.
- Explosives—manufactured for presplit blasting: cartridge-type less than or equal to one-half the diameter of presplit hole up to a maximum of 40 mm (1 1/2 inches).

Arrange a meeting with the Representative to discuss presplit blasting operation at least 2 weeks before anticipated start of operation. Submit a presplit blasting plan to the Representative 1 week before the meeting, with a copy for the Project Geotechnical Engineer, for review. Arrange a meeting with the Representative when a change in drilling or presplit blasting method is proposed.

The presplit test blasting plan will contain complete details on drilling, blasting patterns, and include the following information as a minimum:

- Approved DEP blasting activity permit.
- Manufacturer data sheets for all explosives, primers, and initiators to be employed.
- Station limits of test area and presplit blast section.

Construct test sections approximately 7.5 m (25 feet) in length to determine optimum spacing, size, and loading of holes for presplitting at the beginning of the operation, and when material of different characteristics is encountered. Test sections may have varied loading and hole spacing, depths, and sizes. Use an overall test area up to 30 m (100 feet) in length.

Presplit blast the first test area using 9 m (30-foot) maximum lifts and four 7.5 m (25-foot) sections with holes spaced at 450 mm (18 inches), 600 mm (24 inches), 750 mm (30 inches), and 900 mm (36 inches).

Expose test area for the Representative and Project Geotechnical Engineer to examine and evaluate upon completion of the presplit blasting test. Prepare presplit blasting plan for full-scale operations based on evaluation of loads and hole spacing in presplit blasting test. Adjust presplit blasting lift based on presplit blasting test evaluation.

Drill presplit holes within one bit diameter of the staked collar location. A hole outside the tolerance of one bit diameter of the size drill bit used to drill the hole is not acceptable.

Control drilling operations by the use of proper equipment and technique. Ensure that no drill hole deviates from the indicated slope by more than 300 mm (12 inches) either parallel or normal to slope after blasting.

Holes out of 300 mm (12-inch) alignment tolerance or one drill bit diameter of the staked collar location will be deducted from the payment. If parallel deviation results in an acceptable presplit face, those holes may be accepted for payment.

Submit a plan for correction when more than 5% of presplit holes in any lift are misaligned.

An offset bench 600 mm (2 feet) in width will be allowed when excavation is deeper than drilling depth increment, to accommodate drill head to slope for each lift. Stake offset benches for toe of completed slope to coincide with indicated toe of slope.

Complete presplit slopes before blasting interior portions of excavation by separate operations or use time delay initiators, which will fracture slope before charges detonate in interior portion. Always extend presplitting holes to end of excavation, or not less than 15 m (50 feet) beyond limits of interior portion.

Submit copies of seismic data showing generated frequencies and particle velocities to the Representative after each blast. Submit shot reports and seismic records to the Representative within 14 days of blasting.

**(c) Removal of Existing Pavements.**

**1. Under Embankments.** Remove existing pavements within 1 m (3 feet) of the finished grade, scarify the underlying base to a depth of 150 mm (6 inches) and recompact.

**2. Outside Embankment Limits.** Remove existing pavements outside the limit of embankments, as indicated, to neat lines, and backfill with suitable material compacted as specified in Section 206.3(b).

**3. Roadway Rehabilitation.** Outline area, cut, and remove existing pavement structure as indicated or directed.

**(d) Slopes.** Vary the slopes, if directed, depending on the type of material encountered, in order to obtain satisfactory stability. Remove the material by a method that allows the revised slope lines to be neatly and acceptably trimmed to meet existing conditions.

If a slide occurs, notify the Inspector-in-Charge immediately and cease operations in the slide area until directed to resume.

Remove slide material and bench or flatten slopes, as directed, to obtain the planned width of roadway.

**(e) Excavation Beyond Established Slope Lines.** Do not remove or excavate any material beyond the slope lines indicated, without written authorization.

**(f) Stream Channels.** Do not excavate stream channels until directed.

**(g) Topsoil.** Stockpile topsoil removed from within the excavation or under embankment areas as specified in Section 801, unless otherwise directed. Replace topsoil that is required on the project and wasted during clearing and grubbing operations at no expense to the Department.

**(h) Bracing and Shoring.** Brace and shore sides of the excavation, as necessary. Remove bracing and shoring when no longer required, unless otherwise indicated or directed.

**(i) Cofferdams.** Drive timber or metal sheeting to form a cofferdam. Brace the sheeting in all directions. Pump or bail to remove water as necessary. Remove sheeting or bracing when no longer required, unless otherwise indicated or directed.

**(j) Suitable Material Required for Embankment and Backfill.** Haul suitable excavated material for placement in embankment and for backfill. Replace suitable material (Section 206.2(a)2) that is required on the project and wasted during clearing and grubbing operations at no expense to the Department.

**(k) Unsuitable and Surplus Material.** Dispose of unsuitable and surplus material in suitable waste areas obtained as specified in Section 105.14.

**203.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

For the class of excavation indicated and as follows:

**(a) Excavation Within Established Slope Lines.** Excavation quantities will be determined for payment as follows:

**1. Plan Quantities.** Indicated quantities may be used if the Representative agrees, in writing, that the project has been constructed as indicated and that the indicated quantities may only be used if the borrow section can be isolated.

**2. Measured Quantities.** If the plans have been altered by construction changes, or if the project involves Borrow Excavation that cannot be isolated, excavation will be measured. Measurement may also be requested, or the Representative may require measurement, if there is disagreement as to the accuracy of the indicated quantities. Cross-sectional measurements will be obtained by field survey or by photogrammetric methods. The original cross-sections will be used as the base cross-sections and the final cross-sections plotted thereon. Additional cross-sections may be interpolated at intermediate points, where necessary to more accurately determine the quantities. The average end-area method, based on horizontal measurement, will be used to compute quantities. If this method produces considerable error, the Representative will use any other three-dimensional method that will keep the error to a minimum.

Stone fences, piles of stone, and individual surface boulders, in excess of 0.5 $m^3$ (1/2 cubic yard) and not shown on the cross-sections, will be measured by a three-dimensional volume method.

Measure the excavation by acceptable methods involving three-dimensional measurements where it is otherwise impractical to measure material by the cross-sectional method due to the erratic type or location of work.

**(b) Excavation Beyond Established Slope Lines.** The Department will make payment as specified in Section 205.4(a) when widened excavation is used in place of borrow excavation, as shown on the Standard Drawings and accepted in writing. Excavating offsets for the convenience of drilling is incidental to the Class 1 Excavation.

**(c) Stream Channels.** Request an inspection of the excavation when excavation of a channel is completed as indicated. Cross-sections will be obtained, and the quantities computed, using the method specified in Section 203.4(a)2 when the excavation is satisfactory. These quantities will be used as the basis for current and final payments.

Clearing and grubbing required to make such measurements is incidental to stream channel excavation.

**(d) Presplit Blasting.** Lineal Meter (Lineal Foot)

Measured on lineal meter (lineal foot) of acceptable presplit blast hole depth with appropriate deductions for holes not drilled within tolerance as specified in Section 203.3(b).

**(e) Slope Changes.** The Department will pay for work required to change slopes from the indicated template, when directed, as specified in Section 110.03.

**(f) Saw Cutting.** Saw cutting is incidental to Class 1A excavation.

# SECTION 204—CLASS 2, CLASS 3, AND CLASS 4 EXCAVATION

**204.1 DESCRIPTION—**This work is excavation for ditches, stream channels, culverts, drains, and structures. The three classes of excavation include the following, as shown on the drawings or the Standard Drawings.

**(a) Class 2 Excavation.** Excavation for inlet, outlet, and parallel ditches; stream channels; structures removed below the ground surface and not replaced with new structures; spillways; and half-circle pipe.

**(b) Class 3 Excavation.** Excavation for new grade separation and drainage structures, new retaining walls, abutments, piers, and wingwalls.

**(c) Class 4 Excavation.** Excavation for pipe culverts; pipe-arches; metal plate pipe; metal plate pipe-arches; standard endwalls for pipe culverts and pipe-arches; and excavation in excess of the standard depth for pavement base drains, pipe underdrains, subsurface drain outlets, and subgrade drains.

**204.3 CONSTRUCTION—**

**(a) Foundations.** Notify the Representative 2 weeks in advance of excavation for structures so that cross-sections may be obtained. Excavate to a depth that provides a satisfactory foundation, as directed. Do not disturb the foundation area to the extent that it requires removal of additional material to provide a satisfactory bearing. Compact direct load bearing foundation to the original bearing capacity as specified in Section 206.3(b). Do not place concrete or masonry until the foundation area has been accepted.

**(b) Drilling and Blasting.** Drill and blast to complete the excavation to the required lines, with the least disturbance to remaining material. Do not blast within 1.5 meters (5 feet) of the foundation bearing elevation. Remove remaining rock to bearing elevation using mechanical means.

**(c) Bracing and Shoring.** Section 203.3(h)

**(d) Cofferdams.** Drive timber or metal sheeting to a depth below the bottom of foundation, substantially braced in all directions to form a cofferdam, when required, allowing the foundation area to be pumped reasonably free of water while concrete or masonry is being placed. The Representative may require the cofferdam to be sealed below the foundation with sufficient concrete so that it may be pumped reasonably dry where the foundation area is of sandy or other porous materials. Remove sheeting and bracing when no longer required, unless otherwise indicated or directed.

**(e) Backfilling.** Backfill spaces excavated for, but not occupied by, structures with acceptable material as specified in Section 206.3(b).

**(f) Ditch and Stream Channel Slopes.** Trim slopes neatly to the lines indicated. Do not remove or excavate any material beyond lines indicated, without written authorization from the Representative.

**(g) Topsoil.** Dispose of or utilize topsoil removed in Class 2 Excavation as specified in Section 203.3(g)

**(h) Suitable Material Required for Embankment and Backfill.** Section 203.3(j)

**(i) Unsuitable and Surplus Material.** Section 203.3(k)

**204.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

Measured, using the methods specified in Section 203.4(a)2, for the class of excavation indicated.

When directed to perform excavation below the indicated structure foundation elevation, the Department will pay for excavation as additional work, as specified in Section 110.03(b), to a maximum depth of 610 mm (2 feet), and as extra work, as specified in Section 110.03(c), beyond a depth of 610 mm (2 feet).

The Department will not pay for material removed or excavated in advance of obtaining cross-sections, unless written authorization by the Representative is first obtained.

# SECTION 205—BORROW EXCAVATION

**205.1 DESCRIPTION—**This work is excavation of or obtaining embankment material from borrow areas acquired as specified in Section 105.14 or from other sources for construction of embankments or backfills.

Borrow excavation includes Common Borrow Excavation, Foreign Borrow Excavation, and Selected Borrow Excavation, described as follows:

**(a) Common Borrow Excavation.** Excavation of suitable material as specified in Section 206.2 from borrow areas that can be measured before and after excavation. Common Borrow Excavation also includes the removal of topsoil from borrow areas and stockpiling as specified in Section 801.

**(b) Foreign Borrow Excavation.** Excavation of or obtaining satisfactory material from sources outside the limits of the project that cannot be measured before and after excavation.

**(c) Selected Borrow Excavation.** Excavation of or obtaining material used in specific items of work and designated by quality, size, and/or gradation, from sources outside the limits of the project that cannot be measured before and after excavation.

**205.3 CONSTRUCTION—**

**(a) General.** If project excavation is insufficient to complete the embankments or backfills, or does not meet the physical requirements, obtain material to complete the work.

Do not use material from borrow excavation until all suitable and available project excavation is used, unless otherwise directed.

If suitable material is available on the project, the Representative may, upon request, authorize in writing the widening of areas adjacent to slopes to obtain a portion or all of the excavation in place of borrow excavation, as shown on the Standard Drawings.

The Contractor may waste suitable material and replace it with common borrow after obtaining written authorization from the District Executive and making satisfactory arrangements for obtaining cross-sections of borrow and waste areas and the satisfactory disposal of the waste material.

Haul material from borrow excavation of other sources for placement in embankment or for backfill.

Restore borrow areas as specified in Section 105.14.

**(b) Common Borrow Areas.** When common borrow areas are required, obtain from areas as specified in Section 105.14. Clear and grub the borrow site as specified in Section 201, and remove topsoil. Notify the Representative at least 2 weeks before removing any suitable material, to sample, test, and take cross-sections.

**(c) Foreign and/or Selected Borrow Excavation.** When foreign or selected borrow excavation is required, do not begin operations until the material and placement sequence is accepted in writing and an Erosion and Sediment Pollution Control Plan is accepted by the County Conservation District and/or the DEP and by the Representative, as applicable.

**205.4 MEASUREMENT AND PAYMENT—**

**(a) Common Borrow Excavation.** Cubic Meter (Cubic Yard)

Measured as specified in Section 203.4(a)2 based on cross-sections of the borrow area. The Department will not pay for material removed before measurements are taken.

Additional material obtained within project limits as specified in Section 205.3(a), used in place of borrow excavation will be measured and paid for as specified in the preceding paragraph. However, the Department will make payment at the lower contract unit price for either Class 1 Excavation or Borrow Excavation of the type indicated.

The Department will not pay for common borrow required to replace suitable excavated material wasted for contractor convenience, error, or oversight.

**(b) Foreign Borrow Excavation.** Cubic Meter (Cubic Yard)
Measured as compacted material in completed embankments.

**(c) Selected Borrow Excavation.** For the type indicated, and as follows:

**1. Volume Basis.** Cubic Meter (Cubic Yard)
Measured in place as compacted material, using the average end-area method.

**2. Mass (Weight) Basis.** Tonne (Ton)

# SECTION 206—EMBANKMENT

**206.1 DESCRIPTION**—This work is the construction of embankments and backfills.

**206.2 MATERIAL—**

**(a) Embankment Material.** Obtain material for embankment construction from the various classes of excavation on the project, including Common Borrow Excavation, Foreign Borrow Excavation, and Selected Borrow Excavation, all conforming to the following requirements:

**1. General.** Material of maximum size that can be readily placed in loose 200 mm (8-inch) layers, except as specified and classified as follows:

**1.a Soil.** Includes earth material with the following physical characteristics:

- Gradation—More than 35% passing 75 µm (No. 200) sieve.
- Minimum dry mass density—1522 kg/m$^3$ (95 pounds per cubic foot) determined according to PTM No. 106, Method B.
- Maximum liquid limit—65, determined according to AASHTO T 89.
- Plasticity index—Not less than liquid limit minus 30, determined according to AASHTO T 90 for soils with liquid limits of 41 to 65.

**1.b Granular Material.** Includes natural or synthetic mineral aggregates having 35% or less passing the 75 µm (No. 200) sieve.

**1.c Shale.** Includes rock-like material formed by natural consolidation of mud, clay, silt, and fine sand; usually thinly laminated, comparatively soft, and easily split.

**1.d Rock.** Includes natural material that cannot be excavated without blasting or using rippers; also boulders and detached stones of a size that cannot be readily placed and compacted in loose 200 mm (8-inch) layers and having insufficient soil to fill the voids in each layer.

**1.e Random Material.** Includes any accepted combination of the above classifications and may include concrete, brick, stone, or masonry units from demolition.

**2. Suitable Material.** Reasonably free of organic matter, coal or coal blossom, or other objectionable matter. Wet, dry, or frozen material may be suitable when dried, wetted, or thawed, respectively.

The Contractor may waste suitable material, including wet or frozen material, after obtaining written authorization. This suitable material is subject to replacement in equivalent volume.

**(b) Select Granular Material (2RC).** Section 703.3

**206.3 CONSTRUCTION—**

**(a) General.** Prepare the embankment foundation area as specified in Section 201.

Backfill existing depressions in embankment areas, such as gullies, old stream channels, stump holes, and areas of undercutting and topsoil or pavement removal, to the adjacent ground elevation.

Where undercutting is not directed, loosen embankment foundation areas to a depth of at least 200 mm (8 inches) and compact to the required dry mass (dry weight) density as determined in AASHTO T 99, Method C. In wet areas or unstable areas, the Representative may waive this requirement.

Break existing pavements, more than 1 m (3 feet) below the finished grade, as follows:

- break bituminous pavements to a maximum size of 0.1 $m^2$ (1 square foot) and recompact;
- break concrete pavements to a maximum size of 0.8 $m^2$ (1 square yard); and
- scarify bituminous, surface-treated roadways to a depth of 150 mm (6 inches) and recompact.

When constructing embankment on an existing slope, bench the slope to the width and depth indicated, or as directed.

Where required for installation of transverse drainage, construct embankment as shown on the Standard Drawings.

**(b) Placement and Compaction.**

**1. General.** Except as specified in Section 206.3(b)2 or except for rock, place embankment material for the full width in uniform horizontal layers of not more than a loose 200 mm (8-inch) depth, unless otherwise directed. The Contractor may end-dump material in water to the elevation necessary to establish a satisfactory working platform if rock is used, as approved by the Representative.

Other than rock, compact each embankment layer to the following requirements:

- Compact embankment for its full width to not less than 97% of the required dry mass (dry weight) density as determined according to PTM No. 106, Method B.
- Compact top 1 m (3 feet) of embankment for full width to 100% of the required dry mass (dry weight) density.
- In-place density will be determined according to AASHTO T 191 or AASHTO T 310.
- Maintain material to within minus 3% of optimum and the optimum moisture content at the time of compaction.
- When material is too coarse (more than 20% retained on the 19 mm (3/4-inch) sieve and less than 35% passing the 75 µm (No. 200) sieve, or more than 30% retained on the 19 mm (3/4-inch) sieve) to satisfactorily use these methods, compaction will be determined based on nonmovement of the material under compaction equipment as specified in Section 108.05(c)3.a, 3.b, 3.e, 3.h, or 4. Compact until embankment does not rut under a loaded triaxle (GVW 34 tonnes (75,000 pounds)).

Place rock, shale, and random material with coarser material in the outside and place finer material in the center of the embankment to produce a gradual transition in size. Using equipment, break the large pieces until most voids are filled.

Shape the top layer of the compacted embankment to drain during construction.

**2. Wet and/or Unstable Foundation Areas.** Where the embankment foundation is in water or swamp areas or is saturated or unstable, construct embankment with rock to the indicated elevation or as directed.

**3. Existing Embankment.** Existing embankment is defined as material placed and compacted during prior construction not associated with the current project, or material placed and compacted as part of the current project during a prior construction season and has wintered over. When an existing embankment requires additional material to bring it to the required elevation, proof roll the entire existing surface. Proof rolling shall be conducted with a minimum 9 tonne (10-ton) smooth drum roller (static or in static mode) in a systematic manner ensuring complete coverage of the existing embankment surface. Operate the roller at a speed between 5 km/h and 8 km/h (3 miles per hour and 5 miles per hour). Remove and recompact any unstable material before placing additional material. Material unstable due to excessive moisture should be thoroughly scarified to a minimum depth of 150 mm (6 inches), dried to the required moisture content, and recompacted.

**4. Inaccessible Areas.** Place embankment material in uniform loose layers not exceeding 100 mm (4 inches) in depth in areas inaccessible to compaction equipment; compact to required density by means of mechanical tampers.

**5. Structure Areas.** Construct structure backfill behind bridge abutments and adjacent to structures under structure backfill with Selected Borrow Excavation, as shown on the Standard Drawings and as specified in Sections 1001.3(q)2.b. Material requirements for structure backfill are indicated in the Standard Drawings. Do not place rock where piles are to be driven.

**6. Rock.** Do not place rock in embankment without acceptance of the planned excavation and embankment operations.

When used to form the base of embankment, place rock the full cross-section width. Place rock on embankment side slopes, where indicated. With the Representative's verification, the Contractor does not need to compact excess rock disposed of on side slopes.

Before placing rock on other compacted embankment material, slope the top of the embankment from centerline to the sides, at a rate of approximately 85 mm per meter (1 inch per foot), and compact the embankment top.

Place rock in uniform loose layers not exceeding in depth the approximate average size of the larger rock, but limited to a maximum depth of 900 mm (36 inches). Remove oversize rock or reduce in size until it can be readily incorporated in a 900 mm (36-inch)layer. Do not dump rock in final position, unless specified, but distribute by blading or dozing; keep voids, pockets, and bridging to a minimum. Place rock embankment so larger pieces are evenly distributed and voids are filled as completely as possible.

When rock and other embankment material are placed at the same time, place the other material sufficiently above rock layers to allow for compaction when rock and other embankment material are placed at the same time.

When rock embankment is to be constructed to subgrade elevation, place a scratch lift of select granular material of sufficient thickness to completely fill all voids in the rock, and permit fine grading as specified by the requirements in Section 210.

When transitioning from rock to other embankment materials, place a scratch lift of select granular material of sufficient thickness to completely fill all voids in the rock. Place a second lift of select granular material to a compacted thickness of 150 mm (6 inches). Only one transition from rock to other embankment material is permitted in an embankment section.

When lifts of rock and other finer embankment material are placed at the same time, place the finer material sufficiently above the rock layer to allow for proper compaction.

**7. Frozen Material.** Do not place frozen material on embankment. Do not place embankment material on any material frozen to a depth of 75 mm (3 inches) or more. Remove frozen material, if the embankment top freezes to a depth of 75 mm (3 inches) or more, before placing additional material.

**8. Wet Material.** Dry material to at least the optimum moisture content before compacting in embankment. Do not place material on embankment made unstable by excessive moisture.

**9. Dry Material.** Moisten material to within minus 3% of optimum and the optimum moisture content before compacting in embankment.

**(c) Stability.** Assume responsibility for the stability of embankment. Replace embankment that, in the Representative's judgment, has been damaged or displaced due to the following: carelessness or negligence, natural causes such as storms and floods, shrinkage of embankment material, and all other reasons not attributable to other than movement of the natural ground upon which embankment is placed.

Dry, reshape, and recompact material if construction equipment on embankments causes movement, rutting, or displacement of the material, and test for density and moisture requirements.

## 206.4 MEASUREMENT AND PAYMENT—

**(a) Embankment.** When measurement is required, embankment will be measured in its final position as specified in Section 203.4(a)2 by the cubic meter (cubic yard).

Embankment construction is incidental to excavation or borrow excavation.

**(b) Select Granular Material (2RC).** Tonne (Ton)

# SECTION 210—SUBGRADE

**210.1 DESCRIPTION—**This work is preparation of the roadbed to establish the subgrade.

**210.3 CONSTRUCTION—**

**(a) General.** Form roadbed to the established subgrade elevation and compact to specified density requirements, using equipment specified in Section 108.05(c)3.a, 3.b, 3.e, or 4.

**(b) Density Requirements.** Compact subgrade to 100% of the determined dry-mass (dry-weight) density. Dry-mass (Dry-weight) density for material in place in the field will be determined, according to PTM No. 106, Method B. In-place density or compaction will be determined, according to AASHTO T 191 or T 310 where directed, for each 2500 $m^2$ (3,000 square yards), or less, of completed subgrade. When material is too coarse (more than 20% retained on the 19 mm (3/4-inch) sieve and less than 35% passing the 75-µm (No. 200) sieve, or more than 30% retained on the 19 mm (3/4-inch) sieve) to use these methods, compaction will be determined based on nonmovement of material under compaction equipment specified in Section 210.3(a). Compact until embankment does not rut under a loaded triaxle (GVW 34 tonne (75,000 pounds)).

Maintain material to within minus 3% of optimum and the optimum moisture content at the time of compaction. For subgrades displaying pronounced elasticity or deformation under rolling, maintain a moisture content not greater than optimum at the time of compaction or at the time of placing the overlaying construction. When unable to obtain the specified stability, excavate material in the area to a depth that, when replaced and recompacted with a moisture content not exceeding optimum, the subgrade will have required stability.

**(c) Subgrade Requirements.** Complete, maintain, and protect subgrade in continuous lane construction. Promptly reshape and recompact, or remove and replace, damaged or unsatisfactory areas before placement of pavement structure.

Install reference grade lines with ample supports, or grade stakes, offset along each side of the subgrade, to control the elevation. Maintain reference grade lines until after completing the surface and correcting deficiencies.

Check subgrade for grade and slope. Test the finished surface for irregularities by using a string line stretched tautly, transversely across the subgrade area, between the reference grade lines. Measure the vertical distance from the string line to the finished grade, at various points along the string line, from one side of the surface to the other. Test for surface irregularities at longitudinal intervals of not more than 7.5 m (25 feet).

As an alternative or whenever the Representative suspects an area is deficient or irregular, check the finished surface with a template and 3 m (10-foot) straightedge. Test the finished surface for irregularities by using a template cut to the required cross-section of the surface. Equip the template with metal or other vertical extensions attached to the top of each end to support a leveling device for checking the cross slope. The bottom of the template is to be at the elevation of the top of the subgrade. Use a 3 m (10-foot) straightedge to test for longitudinal irregularities in the surface. Hold the straightedge parallel to the road centerline in contact with the surface. Move the straightedge from one side of the surface to the other. Advance along the surface in 1.5 m (5-foot) increments.

Where subgrade is constructed using an automatic grading machine that cuts the subgrade and is controlled by a reference line or lines, the longitudinal interval for checking the surface cross-section may be increased to not more than 15 m (50 feet).

Correct surface irregularities exceeding 12 mm (1/2 inch) by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling. Recheck the corrected subgrade area for grade and slope.

**210.4 MEASUREMENT AND PAYMENT—**

**(a) Subgrade.** Subgrade is incidental to the immediate overlying pavement structure. If required for shaping and finishing unpaved classes of work, subgrade is incidental to those items of work.

# SECTION 212—GEOTEXTILES

**212.1 DESCRIPTION**—This work is furnishing and installing geotextiles for the class specified.

**212.2 MATERIAL—**Use geotextiles as specified in Section 735 for the specified class and type.

For bedding use open-graded stone conforming to the requirements of Type C or better aggregate, as specified in Section 703.2, except do not use No. 2-A or No. 10 coarse aggregate.

Use steel securing pins 460 mm long x 4.75 mm (18 inches long by 3/16 inch) in diameter, pointed at one end, and with a 40 mm (1 1/2-inch) washer head at the other end. If permitted, alternate securing devices may be used. Certify as specified in Section 106.03(b)3.

Use cover material as specified or indicated.

**212.3 CONSTRUCTION—**As shown on the Standard Drawings, and as follows:

**(a) General.** Remove and replace fabric areas damaged during construction. Lap or sew replaced fabric as specified for the class of fabric used. Do not allow traffic or construction equipment on the fabric.

**(b) Class 1—Subsurface Drainage.** Provide smooth side and bottom trench surfaces so the fabric does not bridge depressions in the soil and is not damaged by rock projections. Use fabric of a width to permit a minimum trench-width overlap across the backfill at the trench top. Lay the fabric flat in the prepared trench without stretching. Lay the top of the fabric back on the sides to allow for the placement of the aggregate backfill and pipe. Overlap ends of rolls an amount equal to the trench width before placing fabric. Fill pockets or cavities in the trench bottom or sides with acceptable granular material to prevent distortion or damage to the fabric.

Backfill aggregate and install pipe in a manner to prevent damage to the fabric. Compact aggregate and overlap the fabric across the trench top. Do not allow the fabric to be exposed for more than 2 weeks without covering with aggregate.

**(c) Class 2—Erosion Control.** Use Type A or Type B fabric as indicated or specified. Remove vegetation, large stones, and other debris from the area to be protected and grade the surface to a relatively smooth condition. Undercut areas of soft material and replace with acceptable compacted material, as directed.

Lay the fabric on the prepared area in a loose and unstretched condition to minimize shifting, puncturing, or tearing the fabric. Join adjacent edges and ends with a folded seam and sew using a single lock-type stitch seam or a double chain type stitch seam equivalent in strength to the fabric tensile strength. Sewing may be done on-site or by the manufacturer. Overlap only when directed. Provide a minimum overlap of 300 mm (1 foot). For underwater placement, overlap a minimum of 1 m (3 feet). Offset adjacent roll ends a minimum of 1.5 m (5 feet) when lapped.

Lay and overlap the fabric in the direction shown in Table A for the indicated use.

Anchor the fabric in place by securing pins or other acceptable methods, along sewn seams or overlaps, at the spacing shown in Table B. Place securing pins on a maximum 1.8 m (6 foot) grid on the unsewn or unlapped portions of the fabric.

Eliminate securing pins for slopes flatter than 1:6 (6:1), provided that aggregate, rock, or other acceptable means are used to secure the fabric.

**TABLE A**
**Fabric Placement**

| Operation | Slope Stabilization Runoff Protection and Internal Seepage Piping | Stream Slope Protection | Wave Protection |
|---|---|---|---|
| Direction of fabric laying | Up and down (parallel with slope direction) | Parallel to stream flows from upstream to downstream | Up and down (parallel with slope direction) |
| Overlap direction | Upslope over downslope | Upstream over downstream and upslope over downslope | Upslope over downslope |

**TABLE B**
**Securing Pin Spacing ***

| Slope | Steeper Than 1:3 (3:1) | 1:4 (4:1) | Flatter Than 1:4 (4:1) |
|---|---|---|---|
| Pin Spacing along sewn seams or overlaps | 0.6 m (2 feet) | 1 m (3 feet) | 1.5 m (5 feet) |

* Place additional pins to secure unlapped portions as specified.

Cover the fabric with the covering material as soon as possible. Do not expose the fabric for more than 4 weeks for Type A and 2 weeks for Type B. Prevent slippage of the cover material on the fabric.

Do not drop rocks, 600 mm (2 feet) or larger in dimension, directly on the fabric from a height greater than 300 mm (1 foot). Do not allow the rock placement procedure to puncture or damage the fabric. Use a minimum 150 mm (6-inch) layer of bedding stone and a greater drop-height combination if the combination produces the placement, thickness, gradation and fabric integrity requirements, and if permitted.

**(d) Class 3—Sedimentation Control.** Use Type A or B fabric as indicated or specified. Install as specified in Section 865.3.

**(e) Class 4—Layer Separation (Type A).** Use to separate the subgrade and other layers. Place the fabric on a prepared subgrade area covering the full width of the subbase layer being protected. Place fabric in a loose and unstretched condition to minimize shifting, puncture, and/or tearing of the fabric. Overlap fabric roll-ends and edges a minimum of 300 mm (12 inches) with adjacent material. Place subbase material within 2 weeks after placement of fabric to minimize exposure. Place subbase material in a manner to minimize slippage of the fabric. Use steel securing pins, as specified in Section 212.2, at a maximum spacing of 1.8 m (6 feet) if excessive slippage occurs.

**(f) Class 4—Stabilization (Type B).** Fine grade the subgrade as specified in Section 210.3(c), as indicated, and in compliance with the cross sections. Remove any object that may puncture the geotextile. Roll out the geotextile over the prepared subgrade as indicated. Place the geotextile free of wrinkles. Do not drag the geotextile on the ground during placement or handling. Overlap parallel rolls or intersecting rolls a minimum of 610 mm (2 feet) in the direction of fill. For curves fold and overlap the geotextile in the direction of the turn. Do not allow any equipment directly on the geotextile until it is covered to full plan depth of subbase. Do not back dump the subbase material directly onto the geotextile. Place subbase material by back dumping then spread the subbase ahead of all equipment at full plan depth. Compact the subbase material with a roller in static mode, if directed. Fill any wheel ruts that form during construction with additional subbase to maintain plan profile. Do not remove the wheel ruts by blading the wheel ruts level.

**(g) Class 4—Reinforcement (Type C).** Section 212.3(f) except as follows: For a subgrade with a CBR value of 0.5 or lower, overlaps must be stitched. Use a 401 lock chain stitch seam with a 100 mm (4-inch) lap.

## 212.4 MEASUREMENT AND PAYMENT—

**(a) Geotextiles, Class 1.** Meter (Linear Foot)
Measured by the length of trench.

**(b) Geotextiles, Class 2.** Square Meter (Square Yard)
For the type indicated or specified.

**(c) Geotextiles, Class 3.** Meter (Linear Foot)
For the type indicated or specified. Measured by the length of sedimentation device.

**(d) Geotextiles, Class 4.** Square Meter (Square Yard)
For the type indicated or specified.

# SECTION 213—TEMPORARY PROJECT AIR POLLUTION CONTROL

**213.1 DESCRIPTION—**This work is disposal of burnable spoils by the use of an open-pit incinerator, by removal, or by other acceptable disposal methods.

**213.3 CONSTRUCTION**—Do not perform this work without before obtaining written authorization from the Deputy Secretary for Highway Administration or authorized designee and, if applicable, FHWA.

**(a) General.** Use temporary air pollution control measures whenever burning is prohibited because it violates the Air Pollution Control Act (Act 245), as approved October 26, 1972, or as amended.

**(b) Open Pit Incinerators.** The DEP will allow the operation of an air curtain destructor (open pit incinerator), as defined in Title 25, Section 129.14, of the Rules and Regulations of the DEP. Use the destructor for destroying wood waste generated by clearing and grubbing operations. If operating this unit creates an air pollution problem, the DEP will take enforcement action.

**213.4 MEASUREMENT AND PAYMENT—**Dollar

The proposal will include an item and a predetermined amount of money for Temporary Project Air Pollution Control. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Temporary Project Air Pollution Control item as follows:

**(a) Negotiated Price.** At a price agreed upon with the Department, before performing the work. If applicable, agreement is also required with FHWA.

**(b) Force Account Basis.** Section 110.03(d)

# SECTION 220—FLOWABLE BACKFILL

**220.1 DESCRIPTION**—This work is furnishing, transporting, and placing flowable backfill. Flowable backfill is a mixture of coarse aggregate, fine aggregate, water and air entraining agents, either cement or pozzolans, or a combination of both, and may or may not include bottom ash, or other admixtures. The four types of flowable backfill are as follows:

**(a) Flowable Backfill, Type A and Type B.** Future excavation of the backfill may be necessary such as at utility trenches, pipe trenches, bridge abutments, and around box or arch culverts.

**(b) Flowable Backfill, Type C.** Excavation of backfills not anticipated, including replacing unsuitable soils below structure foundations, filling abandoned conduits, tunnels and mines, and backfilling around pipe culverts where extra strength is required.

**(c) Flowable Backfill, Type D.** Construction in areas requiring low-density backfill material as in abutments over highly deformable soils, backfilling retaining walls, filling vaults, and backfilling on top of buried structures.

**220.2 MATERIAL—**

**(a) Cement.** Type I, IP, or II, Section 701. If using Type IP cement, adjust the quantity of flyash in the design as necessary. From a source listed in Bulletin 15.

**(b) Flyash.** Type F or C flyash, Section 724 except as follows:

- Flyash—conforming to AASHTO M 295 (or ASTM C 618) Table 1 requirements except maximum loss on ignition is 16%, and excluding the requirements of Table 1A, 2, or 2A.

From a source listed in Bulletin 15 or tested and approved before incorporating into the flowable backfill mix.

**(c) Ground Granulated Blast Furnace Slag.** Section 724.3. From a source listed in Bulletin 15.

**(d) Fine Aggregate.** Type A, B, or C; Section 703.1; except, having a maximum loss of 20% in the Soundness Test, PTM No. 510. The fine aggregate may be natural sand, manufactured sand, or foundry sand meeting Section 703.1. From a source listed in Bulletin 14.

**(e) Coarse Aggregate.** Type A, B, or C, AASHTO 10, Section 703.2. Except 10% maximum for material finer than the 75 µm (No. 200) sieve. From a source listed in Bulletin 14.

**(f) Bottom Ash.** From a source listed in Bulletin 14. Coal ash having a maximum loss of 20% in the Soundness Test, PTM No. 510, and conforming to the following dry sieve gradation requirements:

| Sieve Size | % Passing |
|---|---|
| 12.5 mm (1/2-inch) | 100 |
| 75 µm (No. 200) | 0-10 |

**(g) Water.** Section 720.1

**(h) Admixtures.** Section 711.3. Including air-generating admixtures.

**(i) Geotextile, Class 4, Type A.** Section 735

**(j) Mix Design.** Submit a mix design and test results (density and strength) to the Representative, at least 3 weeks before construction. Use Table A as a guideline for the mix design or submit an alternate design based on density guidelines and conforming to the strength requirements of Table A. Base the submitted mix design on an absolute volume of 1 $m^3$ (1 cubic yard).

**TABLE A**
**Mix Design**

| Properties & Criteria | Type A | Type B | Type C | Type D |
|---|---|---|---|---|
| Mix Design ( /m$^3$ ( /CY))<br>Cement (kg (lbs))*<br>Pozzolans (kg (lbs))*<br>Bottom ash (kg (lbs))*<br>or Coarse Aggregate<br>or Fine Aggregate<br>Air Generating Admixture* | <br>45 (100)<br>910 (2000)<br>0 | <br>23 (50)<br>136 (300)<br>1180 (2600) | <br>68-90 (150-200)<br>136 (300)<br>1180 (2600) | <br>136-320 (300-700)<br>45-180 (100-400)<br>** |
| Slump (mm (inches))<br>AASHTO T 121, C 136 | 178 (7) min<br>**** | 178 (7) min<br>**** | 178 (7) min<br>**** | 178 (7) min<br>**** |
| Density (kg/m$^3$ (pcf))<br>AASHTO T 121, C 136 | N/A | N/A | N/A | 480-1120 (30-70) or as specified *** |
| Water Absorption of Aggregate AASHTO T 85 | -- | -- | -- | 20% max |
| Compressive Strength (MPa (psi))<br>PTM No. 604 28 Days | 0.86 (125) max | 0.86 (125) max | 5.51 (800) min | 0.62-2.75 (90-400) |

*Quantities may be varied or alternate designs submitted to adapt mix to conform to density and strength requirements or to adapt to specific site conditions.
**Requires using a suitable lightweight aggregate or air entraining admixture. Provide a mix design that achieves the specified strength and density requirements.
***Approximate Value. Use of air entraining agent may reduce these values.
****Some applications may require containing flowable backfill by constructing dikes from the mix by using less water to produce a 75 mm (3-inch) minimum slump, if approved by the Representative. Thickening of the mix in other areas is allowed if approved by the Representative.

Provide mix designs that conform to specific density requirements, if specified. If source of material is changed, submit a revised mix design before using material. Conduct design mix testing at the highest flowability or slump being used for the project.

If applications involve exposed metal or metal coated with a layer of thin concrete (< 13 mm (< 1/2 inch)), test the design mixes for corrosion resistance as follows:

| | |
|---|---|
| Resistivity, AASHTO T 288, 60 day cure | > 2000 ohm-centimeters |
| pH of pulverized flowable backfill | 5.0 to 9.5 |
| Chlorides of pulverized backfill after cure | < 200 ppm |
| Sulfates of pulverized backfill after cure | < 1000 ppm |
| Sulfides of pulverized backfill after cure | < 200 ppm |

**(k) Certification.** Certify the properties of flowable backfill as specified in Section 106.03(b)3.

**(l) Forms.** Section 1001.2(h)1

## 220.3 CONSTRUCTION—

**(a) General.** Furnish indicated type of flowable backfill conforming to Table A. Do not allow the flowable backfill to contact aluminized materials or compounds.

Produce and transport according to Section 704, excluding maximum temperature range of 32° C (90F), or by other approved methods from a facility accepted by the Department. The Contractor may adjust the mix in the field provided it achieves the criteria specified in Table A.

**(b) Placement.** Submit the sequence of operations at least 4 weeks before starting the work. If required, design the forms to sustain lateral fluid pressure equal to total weight of unhardened flowable backfill with a minimum 1.3 factor of safety. Construct formwork according to Section 1001.3(a).

Do not place flowable backfill through flowing water. Remove and replace flowable backfill damaged by rain or flowing water. If excavation cannot be dewatered, place flowable backfill by a tremie procedure approved by the Representative.

Break up lumps by remixing or other approved methods.

Ensure that base drain outlets do not intersect areas where placing flowable backfill. Furnish solid base drain outlet pipes in areas intersecting the flowable backfill.

Do not place flowable backfill at a material temperature below 10° C (50F) or if the temperature of either the air or the surface that the flowable backfill is placed on is 5° C (40F) or lower. Maintain the temperature of the in-place flowable backfill at no less than 10° C (50F) for a minimum of 24 hours or until the next lift is placed.

Do not place additional lifts until surface bleed water dissipates or the preceding lift hardens sufficiently to support foot traffic or both.

Protect finished surface from frost, erosion, and damage with suitable covers of soil, aggregate, concrete, pavement, or other material approved by the Representative.

If required, contain flowable backfill by constructing dikes from the mix. For the mix for dikes use less water to produce a 75 mm (3-inch) minimum slump, as directed by the Representative. Dikes will remain an integral part of completed flowable backfill. The Contractor may thicken the mix in other areas if allowed by the Representative.

**1. Structure Backfill**. When backfilling, place flowable backfill in lifts to prevent lateral pressures from exceeding resisting capacity of structure. Do not place lifts that exceed 1.2 m (4-foot), unless approved by the Representative. Protect structure foundation drains from intrusion and contamination of flowable backfill by using a separation membrane of Class 4, Type A geotextile. During placement of flowable backfill, protect existing structures, drainage facilities, utilities, etc., that are to remain within the fill area from movement or floating, damage, or misalignment. Repair or replace any damaged items, as directed by the Representative, at no additional cost to the Department. Provide preformed drain, no more than 50 mm (2 inches) thick, between the wall and the flowable fill and provide outlets at not more than 4.5 m (15 feet) through the wall, or as directed by the Representative.

**2. Pipe Bedding and Backfill**. Backfill the trench as shown on the Flowable Backfill Detail in the Standard Drawings. Place adequate support to provide the minimum required bedding from trench bottom to bottom of pipe, and protect pipe from damage, movement, floating and improper alignment. Protect pipe from intrusion of flowable backfill. If shown, place Class 4, Type A geotextile membrane around pipe.

Prevent floating of pipe by placing flowable backfill in lifts or use sandbags or other weights to ballast pipe until lift is set. Place the backfill evenly on both sides of the trench to avoid overstressing the pipe. Monitor pipe alignment according to Section 601.3(c).

**3. Utility Trench Backfill.** Provide adequate tie-downs or weights, if required, for utility conduits to prevent floating. Protect utilities from damage and movement. Maintain proper alignment of conduits during placement of flowable backfill. Perform all utility work according to the permit requirements.

**(c) Testing and Acceptance.** Section 704.1(d)1, Section 704.1(d)2, Section 704.1(d)4, and as follows:

Test flowable backfill slump, according to AASHTO T 119, and for yield, according to AASHTO T 121, C 136, as part of the QC Plan.

Test flowable backfill for proper flowability using the slump cone. Conduct slump tests as often as necessary (at least once daily or every 150 $m^3$ (200 cubic yard)) to maintain the correct flowability at placement and if requested by the Representative. The Contractor may add water on-site to maintain flowability as needed. Test flowable backfill for yield at least once daily, or one test for every 150 $m^3$ (200 cubic yard) of material. Record all test results and submit to the Representative.

Mold 76 mm x 152 mm (3-inch by 6-inch) or 152 mm x 305 mm (6-inch by 12-inch) cylinders according to PTM No. 611, except specimens will remain in the mold until just before testing. Mold cylinders from the sample obtained for testing material flowability. Test for compressive strength according to PTM No. 604, except use neoprene caps.

Ensure the Inspector witnesses compressive strength tests. Remove material that does not conform to Table A strength requirements. The Representative may allow the material to remain in place with liquidated damages assessed at $32.70/m$^3$ ($25/cubic yard) per lot of deficient flowable fill.

**(d) Opening to Traffic.** For flowable backfill Type A, Type B, and Type C material, do not open to traffic until 1 hour after the surface bleed water has dissipated and as allowed by the Representative. Open flowable backfill Type D to traffic when directed by the Representative.

## 220.4 MEASUREMENT AND PAYMENT—

**(a) Flowable Backfill.** Cubic Meter (Cubic Yard). For the type indicated.

**(b) Class 4 Geotextile, Type A.** Section 212.4(d)

If using flowable backfill in place of a material incidental to another item of work, then the flowable backfill is also incidental.

# SECTION 300
# BASE COURSES

## SECTION 303—CEMENT TREATED PERMEABLE BASE COURSE

**303.1 DESCRIPTION**—This work is the construction of a cement treated permeable base course (CTPBC) on a prepared surface. If placed on subgrade, this work includes the preparation of subgrade as specified in Section 210.

**303.2 MATERIAL—**

**(a) Aggregate.** Coarse Aggregate, Type A or Type B- Section 703.2 for AASHTO No. 67 or No. 57, except restrict the material passing the 75 µm (No. 200) sieve to a maximum of 2%. Determine the loss by washing according to PTM No. 100. Do not use fine aggregate in the mixture. The use of blast furnace slag or crushed gravel is allowed. When using crushed gravel, provide a minimum of 75% crushed particles with at least two faces resulting from fracture.

**(b) Cement.** Type I or Type II cement, Section 701.

**(c) Water.** Section 720.1

**(d) Pozzolan**. Section 724.2(b)

**(e) Mixture Design.** Provide a mix design as follows:

- Submit, for review by the Representative, a mix design using 90.72 kg (200 pounds) of cement per cubic meter (cubic yard) based on the saturated surface-dry rodded unit weight of aggregate. Fly ash may be substituted for up to 10% of the required cement, with a substitution ratio of 1.5 kg (3.3 pound) of fly ash for each 1.0 kg (2.2 pound) of cement. Design and proportion the cement and water based on the saturated surface-dry weight of the aggregate. Do not exceed a water-cement ratio of 0.40. Provide a mix with 100% coverage of aggregate without runoff. Mix and proportion as specified in applicable sections of Section 704.

- Certify as specified in Section 106.03(b)

**(f) Concrete Curing Material.** Section 711.1(a), 711.1(e), and 711.2(a) Type 2

**(g) Admixtures.** Section 711.3

**303.3 CONSTRUCTION—**

**(a) General.** The Contractor may perform half-pavement or full-pavement width construction.

**(b) Weather Restrictions.** Section 501.3(b).1

**(c) Concrete Mixtures.** Section 501.3(c)

**(d) Conditioning of Rubblized Pavement/Subbase.** Thoroughly sprinkle water on the rubblized pavement/subbase before placing CTPBC, if necessary to ensure a moist condition. Sprinkle with as much water as it readily absorbs, well in advance of CTPBC placement.

**(e) Placement and Compaction.** Use an approved asphalt paver or mechanical spreader, equipped with screed, plate vibrator, and fully automated sensors to control profile and transverse grade. Use mechanical equipment for the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth.

Compact the CTPBC using steel-wheel power rollers having a manufacturer's certified metal mass (weight) from 7.26 tonnes to 9.07 tonnes (8 tons to 10 tons). Use of vibratory paver screed as sole means of attaining compaction is not allowed. Perform a minimum of one pass with the roller to achieve compaction and do not compact material to the point that the CTPBC is not free draining or the aggregate is crushed. One roller pass is defined as one trip of the roller in one direction over any one spot. Perform handwork as directed. Do not disturb the freshly placed CTPBC. Do not allow more than 1 hour from the time water is added to the aggregate and cement to the time compaction is complete. The Contractor may use a retarding admixture to increase the time to 1 1/2 hours.

**(f) Surface Tolerance.** Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 3 m (10-foot) straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 1.5 m (5 feet).

Correct irregularities of more than 13 mm (1/2 inch) by loosening surface mixture and removing or adding CTPBC. For irregularities that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the CTPBC. The area is defective if irregularities or defects remain after final compaction.

**(g) Curing.** Begin curing immediately after compaction. Cure with white membrane forming curing compound as specified in Section 501.3(l)1.c. except apply at a rate of 1 L/2 m² (1 gallon per 75 square feet) ± 10% of the surface area, or as directed. As an alternative curing method, the Contractor may select to cover the CTPBC with white polyethylene sheeting material as specified in Section 501.3(l)1.a. Maintain curing materials for 24 hours. If the CTPBC temperature falls below 4°C (40F) during the 24 hour curing period, extend the cure period by an additional 24 hours. At no cost to the Department, remove and replace CTPBC if the CTPBC temperature drops to 0°C (32F) within 72 hours of the placement..

**(h) Protection of Courses.** Section 105.13 and as follows: Construction traffic is not allowed on the CTPBC for at least 3 days after the CTPBC has been placed. Do not place overlying pavement on the CTPBC during this time period. After the 3 day period, restrict construction traffic to only allow trucks and equipment required to place the next layer or any adjacent CTPBC lift or pavement course. Remove and replace areas damaged or contaminated at no cost to the Department.

**(i) Protection Against Rain.** Section 501.3(t)

**(j) Tests for Depth.** After curing the CTPBC, and at locations determined by the Representative, carefully dig or drill one full-depth, test hole for each 2 500 m² (3,000 square yards) of completed CTPBC. The Representative will measure the depth of the CTPBC. Where the depth is defective, define the defective limits by digging or drilling additional test holes longitudinally and transversely until the depth meets requirements. Backfill test holes with CTPBC mixture.

**(k) Defective Work.** CTPBC is defective when the depth is deficient by 13 mm (1/2 inch) or more from the indicated depth, deficient in surface tolerance, or when the surface contains defects caused by rain or improper finish that in the Representative's opinion cannot be repaired. Unless otherwise directed in writing by the District Executive, remove and replace defective CTPBC full depth at no additional cost to the Department. Submit a plan to the Representative with proposed methods to remove and replace the CTPBC. Remove and replace the CTPBC after review of the plan.

**303.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 305—BITUMINOUS CONCRETE BASE COURSE

**305.1 DESCRIPTION**—This work is standard construction of plant-mixed bituminous concrete base courses using a conventional mixture design (Modified Marshall Procedure). If placed on subgrade, this work includes the preparation of subgrade as specified in Section 210.

**305.2 MATERIAL—**

**(a) Bituminous Material.** One of the following:

**1. Virgin or Recycled Mix Containing 5% to 15% RAP.** Asphalt cement, Class PG 64-22, Section 702. The Contractor may use asphalt cement, Class PG 58-28, Section 702 instead of PG 64-22 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0 and the Monroe, Carbon, and Schuylkill Counties of District 5-0. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b) 1. Provide the Representative a copy of a signed Certificate of Compliance (CS-4171), a Bill of Lading, and a Certificate of Analysis for bituminous material on the first day of paving and when the batch number changes.

**2. Mix Containing More than 15% RAP.** The MTD will evaluate the asphalt cement in the RAP source material. The MTD will determine the class (grade) of asphalt cement and recycling agent the Contractor shall use in the mixture. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b) 1. Provide the Representative a copy of a signed Certificate of Compliance (CS-4171), a Bill of Lading, and a Certificate of Analysis for bituminous material on the first day of paving and when the batch number changes.

**(b) Aggregates and RAM.** Provide aggregates from sources listed in Bulletin 14.

**1. Fine Aggregate.** Section 703.1, except Table A gradation does not apply.

**2. Coarse Aggregate.** Section 703.2, Type A or Type B, except Table C does not apply.

**3. RAM.** RAM shall conform to the applicable quality requirements of Section 703.1, Table A or Section 703.2, Table B.

**(c) RAP.** If RAP material is proposed for use in the mixture, use at least 5% RAP consisting of cold-milled or crushed hot-mix bituminous mixtures. Include a plan to control RAP and the procedures to handle RAP of significantly different composition in the producer's QC Plan. Maintain all processed material free of foreign materials and minimize segregation. The processed RAP shall conform to Table A and have at least 95% pass the 50.0 mm (2 inch) sieve.

**(d) Mixture Composition.**

**1. Virgin Material Mixtures.** Use Bulletin 27 to design and control production of bituminous mixtures. Establish a JMF that conforms to Bulletin 27 and the requirements of this specification. Submit a copy of the JMF to the District Materials Engineer/District Materials Manager (DME/DMM) at least 3 weeks before the planned start of mixture production for the project. Do not produce the mixture until after the DME/DMM reviews the JMF. The JMF shall conform to Table A, unfilled voids from 4.0% to 7.0%, and the following Marshall values determined according to PTM No. 705:

- Stability at 60 °C (140F)
  - at least 5 300 N (1,200 pounds), when the maximum aggregate size is not over 37.5 mm (1 1/2 inches), with a 102 mm (4-inch) test specimen, or
  - at least 13 300 N (3,000 pounds), when the maximum aggregate size is over 37.5 mm (1 1/2 inches), with a 152 mm (6-inch) test specimen.
- Flow
  - from 6 to 16 with a 102 mm (4-inch) test specimen; or
  - from 9 to 24 with a 152 mm (6-inch) test specimen.

**TABLE A**
**Composition of Mixture**
**(Mass (Weight) Percent Passing Square Openings, Based on Laboratory Sieve Tests)**

| Sieve Size | Required Percent Passing |
|---|---|
| 50 mm (2 inches) | 100 |
| 37.5 mm (1 1/2 inches) | 95 - 100 |
| 19 mm (3/4-inch) | 52 - 100 |
| 9.5 mm (3/8-inch) | 36 - 70 |
| 2.36 mm (No. 8) | 16 - 38 |
| 600 µm (No. 30) | 8 - 24 |
| 300 µm (No. 50) | 6 - 18 |
| 150 µm (No. 100) | 4 - 10 |
| **Asphalt Content % by Mass (Weight)** | |
| Stone or Gravel | 3.5 - 6.0 |
| Slag | 4.5 - 8.5 |

**2. Producer QC Plan** Each producer must prepare a QC Plan as specified in Section 106 and conforming to the additional QC requirements of this specification. Submit the QC Plan to the DMM/DME annually, but at least 3 weeks before the planned start of mixture production and do not start mixture production until the DMM/DME reviews the QC Plan. Until project completion, annually resubmit the QC Plan for this work to the DMM/DME.

**3. Mixture Production**

**3.a JMF Verification.** During initial production of each JMF for a project, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the production limits for asphalt content, gradation, stability, flow, and voids within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the above requirements. During JMF verification, mixture acceptance is as specified in Section 305.2(f).

**3.b Mixture Production.** After JMF verification, test materials, proportions, and the mixture according to the QC Plan, Bulletin 27, and the requirements below. For daily production of each JMF greater than 45 tonnes (50 tons), test for asphalt content, gradation, stability, flow, and voids to ensure the mixture conforms to the following production limits:

**3.b.1 Asphalt Content.** Use automated and recordated plants. Use printed tickets for controlling asphalt content of the mixture. If the producer is not currently approved to use printed tickets, request Department approval according to Bulletin 27. Include in the producer's QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests. Perform asphalt content tests to verify the automated plant is recording the actual asphalt content and to verify the mixture asphalt content is within 0.8

percentage points of the JMF for individual samples (n=1) and within 0.5 percentage points for multiple samples ($n \geq 3$).

After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances. After obtaining five or more test results, determine compliance with the multiple sample tolerances using the running average of the last five consecutive test results. During mixture production, maintain 90% of the printed ticket results for each day of production within 0.2 percentage points of the JMF.

**3.b.2 Gradation.** Sample the completed mixture, or sample the combined aggregate from the hot bins of a batch plant or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer's QC Plan.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.
- Produce a mixture within the aggregate composition of Table A.

**3.b.3 Stability and Flow.** Sample the completed mixture according to PTM No. 1 and at the frequency in the producer's QC Plan. Test the mixture according to PTM No. 705 and produce a mixture meeting the minimum stability and flow ranges specified in Section 305.2(d).

**3.b.4 Unfilled Air Voids.** Sample the completed mixture according to PTM No. 1 and at the frequency in the producer's QC Plan. Test the mixture according to PTM No. 705 and produce a mixture with air voids from 3.5% to 7.5%.

**3.b.5 Maximum Theoretical Specific Gravity.** Sample the completed mixture according to PTM No. 1 at the frequency required in Bulletin 27. Test the mixture according to AASHTO T 209. Maintain the running average of the last five consecutive test values. Inform the Representative of the running average within 24 hours after completing each test. Calculate the percentage of unfilled air voids and the theoretical maximum density of the mixture using the running average.

**3.c Corrective Actions.** Immediately take corrective actions if less than 90% of the daily printed tickets are within 0.2 percentage points of the JMF, QC tests for asphalt content are not within the production limits, or if the percent passing the 2.36 mm (No. 8) sieve does not conform to the production limits. After taking corrective actions, sample the completed mixture within 140 tonnes (150 tons) of production. After sampling, test the mixture and provide test results to the Representative before shipping additional mixture to the project. If the mixture does not conform to the production limits for asphalt content and percent passing the 2.36 mm (No. 8) sieve, suspend production and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan.

**(e) Mixtures with RAP or RAM.** As specified in Section 305.2(d) and as follows:

For recycled courses, determine the average asphalt content and gradation of the RAP stockpile and determine the average gradation of stockpiles of virgin aggregate and RAM. Obtain a minimum of ten samples from different locations in each stockpile. Determine the proportions of RAP, RAM, and virgin materials necessary to conform to the JMF requirements. Maintain and provide the Representative access to records of all sampling, testing, and calculations.

**(f) Mixture Acceptance.** The Department will accept the mixture by certification. Obtain certification from the mixture producer. Certify mixtures using Form CS-4171 or another acceptable form. Provide the form to the Inspector-in-Charge within 1 working day after mixture production. Certify mixtures as specified in Section 106.03(b)3 and the requirements below.

**1. Certification.** Certify each mixture daily if QC test results conform to the production limits of Section 305.2(d) 3.b and at least 90% of the printed tickets for asphalt content are within 0.2 percentage points of the JMF. If the mixture does not conform to the above requirement, do not certify the mixture. Instead, provide all QC tests results to the Inspector-in-Charge. Payment will be determined according to Section 401.4(a), Table G, based on the QC test results.

**2. Maintaining Approval to Certify Mixtures.** The Department may suspend certification if the Contractor is not performing QC according to the producer's QC Plan or not producing mixtures according to Bulletin 27, and as described below.

The Department may take independent assurance (IA) samples of the completed mixture at the plant. In the presence of the Department, test the IA samples for asphalt content and gradation according to the test methods indicated in the producer's QC Plan. Take corrective actions if the mixture does not conform to Table A.

The Department may take QA samples of the completed mixture at the plant or from directly behind the paver. The Department will test QA samples according to PTM No. 757 conformance to Table A. If the results of the QA samples do not comply with Table A, review the producer's QC Plan and the QC test results that followed the QA samples for conformance to Table A.

After completing corrective actions or the sample review, the Department will perform an on-site evaluation of the producer's plant operation and QC, and then take a sample of the completed mixture at the plant. In the presence of the Representative, test the sample. If the sample does not comply with Table A, the Department will suspend certification. Immediately suspend shipping mixtures accepted by certification to the project.

After testing verifies that the produced mixture conforms to Tables A and B and with the Department present, conduct JMF verification according to the QC Plan. After successfully completing JMF verification, resume both certification and shipping mixtures accepted by certification to the project.

**305.3 CONSTRUCTION**—Section 401.3 with additions and modifications as follows:

**(b) Weather Limitations.** Replace with the following:

Do not place the base course on surfaces that are wet or when the air or the surface temperature is 2 °C (35F) or lower. If work is stopped for adverse weather, the Representative may allow the Contractor to place limited quantities of base course that are en route to the project

**(h) Spreading and Finishing.** Add the following:

If the base course is more than 130 mm (5 inches) in compacted depth, construct it in two or more layers of approximately equal compacted depth, with no layer less than 65 mm (2 1/2 inches) or more than 130 mm (5 inches). If the air temperature is below 5 °C (40F), only construct base courses that are greater than 200 mm (8 inches) in compacted depth and using layers at least 100 mm (4 inches) in depth.

**(j) Mat Density Acceptance.** As specified in Section 401.3(j), revised as follows:

**4.b Lot/Sublot Size.** A lot is the area of base course completed each day. The Inspector will divide the lot into three sublots of approximately the same area. The Inspector will select one random test location in each sublot according to PTM No. 1. The Inspector will select another random test location if the test location is:

- within 600 mm (2 feet) of an unsupported edge.
- within 300 mm (1 foot) of a longitudinal paving joint.
- within an area of pattern segregation evaluated according to Section 401.3(h).
- within 300 mm (1 foot) of the edge of obstructions such as manhole covers and inlets.

**(l) Surface Tolerances.** Replace the requirement for defective pavement with the following:

The pavement is defective if irregularities are more than 6 mm (1/4-inch).

**(m) Tests for Depth.** Replace with the following:

Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerance.

On the top lift and in the presence of the Inspector, drill full-depth cores at one random location selected by the Inspector according to PTM No. 1 in each 2500 $m^2$ (3,000 square yards) of completed base course and at other locations the Inspector suspects are deficient

The Representative will measure the depth of the full-depth cores according to PTM No. 737. Pavement deficient in depth by 13 mm (1/2 inch) or more and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 13 mm (1/2 inch) of the design depth.

**305.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard) or Tonne (Ton)

**(a) Mixture Composition.** As specified in Section 401.4(a), Table G, for asphalt content only.

**(b) Density.** As specified in Section 401.4(a) 2.b, except that the pay factor percentages for asphalt content and percent passing the 75 µm (No. 200) sieve are both 100.

# SECTION 309—SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, HMA BASE COURSE

**309.1 DESCRIPTION—**This work is the Standard construction of a plant-mixed HMA base course on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor (SGC).

**309.2 MATERIAL—**Section 409.2

**309.3 CONSTRUCTION—**Section 409.3 as specified for Standard construction and with additions and modifications as follows:

**(b) Weather Limitations.** Section 409.3(b). Replace with the following:

Do not place base course on prepared surfaces that are wet or when the temperature of the air or the prepared surface is 2°C (35F) or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of base course that are en route to the project.

**(h) Spreading and Finishing.** Revise as follows:

**1.b Spreading and Finishing.** Add the following:

If the indicated compacted depth of a Superpave 25.0 mm HMA base course is more than 150 mm (6 inches), place the HMA base course in two or more layers of approximately equal compacted depth, with no layer less than 80 mm (3 inches) or more than 150 mm (6 inches). If the indicated compacted depth of a Superpave 37.5 mm HMA base course is more than 200 mm (8 inches), place the HMA base course in two or more layers of approximately equal compacted depth, with no layer less than 100 mm (4 inches) or more than 200 mm (8 inches).

**(l) Surface Tolerance.** Replace the requirement for defective pavement with the following:

The pavement is defective if irregularities are more than 6 mm (1/4-inch).

**(m) Tests for Depth.** Replace with the following:

Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerance. On the top lift and in the presence of the Inspector, drill full-depth cores at one random location selected by the Inspector according to PTM No. 1 in each 2500 $m^2$ (3,000 square yards) of completed base course and at other locations the Inspector suspects are deficient.

The Inspector will measure the depth of the full-depth cores according to PTM No. 737. Pavement deficient in depth by 13 mm (1/2 inch) or more and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 13 mm (1/2 inch) of the design depth.

**309.4 MEASUREMENT AND PAYMENT—**Section 409.4(a), with modifications as follows:

**(a) Bituminous Mixtures (Standard).** Revise as follows:

**1. HMA Courses.** Add the following:

**1.f Superpave Asphalt Mixture Design, HMA Base Course.** Square Meter (Square Yard) or Tonne (Ton)

# SECTION 320—AGGREGATE-BITUMINOUS BASE COURSE

**320.1 DESCRIPTION—**This work is construction of a bituminous-treated, aggregate base course. When placed on subgrade, this work includes the preparation of subgrade as specified in Section 210.

**320.2 MATERIAL—**

**(a) Aggregate.** Type C or better, No. 2A, Section 703.2.

**(b) Bituminous Material.** One of the following, as specified in Section 702:

- Class PG 64-22 or Class PG 58-28
- Emulsified Asphalt—Class MS-2(E-4) or CMS-2(E-5)

**(c) Composition of Mixture.** Combine the aggregates and bituminous material in proportions required to produce an accepted composition. Produce a mixture with at least 3.5% bituminous material, computed as a percentage by mass (weight) of the total mixture.

**1. JMF.** When Asphalt Cement is used in the mixture, prepare and submit a JMF to the District Materials Engineer/District Materials Manager for acceptance. The JMF shall conform to the accepted composition and the following Marshall values. Test the mixture according to PTM No. 705:

- Stability at 60 °C (140F) at least 2200 N (500 pounds).
- Flow from 6 to 16.

These values are not required for daily plant control.

Determine the design density from the accepted Marshall design criteria.

Produce a mixture conforming to the JMF. The Representative may require a new JMF if unsatisfactory results or other conditions make it necessary. If using emulsified asphalt, do not prepare a JMF. Determine the design density and the optimum liquid content according to PTM No. 106, Method B. The liquid content of the mixture is the sum of the percentage of free water and the percentage of bituminous material.

**2. Mixture Production and Acceptance.** Section 305.2

**320.3 CONSTRUCTION—**

**(a) Equipment.**

**1. Plant.** Mix materials, using continuous-flow or batch-type central mix plants, mechanical mixers, or travel plants. When liquids are automatically metered, use equipment that will control the liquids within a variation of not more than ± 0.5% from the specified percentage.

For central plant mixing, use a mixer equipped with batching or metering devices designed to measure the specified quantity of material.

**2. Hauling.** To transport the base course from a central mix plant to the project, use clean, tight vehicles, with protective covers that do not have rips or holes.

**3. Spreaders.** Use adjustable, self-propelled mechanical spreaders capable of placing and screeding base material without segregation.

**4. Bituminous Distributor.** Section 460.3(b)

**5. Compaction Equipment.** Section 108.05(c)3

**(b) Mixing and Spreading.**

**1. General.** Spray water uniformly through the aggregate before or at the time of addition or application of the emulsified asphalts to ensure a moisture content from 2% to 8% when tested according to PTM No. 106, Method B. For asphalt cements use heat-dried aggregate with a maximum moisture content of 1/2%.

Determine moisture content at the time of compaction according to PTM No. 106, Method B. If necessary, aerate the mixture to reduce the water content in emulsions so the total liquid content (liquid bituminous material and water) of the mixture does not exceed the optimum moisture content of the aggregate.

Maintain the temperature range of the bituminous material when added to the mixture or applied to aggregate according to Bulletin 25. Do not add or apply bituminous material to the aggregate when the air temperature in the shade is 10 °C (50F) or less or when weather conditions are unfavorable. Do not place the base course on a wet surface or on a surface with a temperature less than the air temperature specified above.

If using bituminous material other than Asphalt Cement, do not place base course from September 15 to May 1, unless otherwise permitted.

Construct base courses 150 mm (6 inches) or less in compacted depth in one layer. Construct base courses more than 150 mm (6 inches) in compacted depth in two or more layers of approximately equal compacted depth, with no layer less than 75 mm (3 inches) nor more than 150 mm (6 inches) in depth.

Allow only necessary shaping and processing equipment to travel over the spread mixture. Remove and replace mixture that is displaced or contaminated.

**2. Central Plant Mixing and Spreading.** Thoroughly mix materials to produce a uniform mixture. Spread the mixture on the surface in a loose layer that will compact to the full layer depth.

**3. In-Place Mixing and Spreading.** Spread the aggregate on the surface in a uniform, loose layer that will compact to the specified layer depth.

For travel plants equipped to meter the liquid bituminous material, apply bituminous material to the aggregate during the first mixing pass of the travel plant. Adjust the travel speed and the number of passes to obtain a uniform mixture.

For travel plants not equipped to meter the liquid bituminous material, apply the bituminous material to the aggregate in successive applications using a distributor. After each application, immediately cut in or blend the bituminous material with the aggregate. After applying all the bituminous material, mix the aggregate and bituminous material while also adjusting the travel speed and number of plant passes to obtain a uniform mixture.

**(c) Compaction.** Compact the base course to at least 100% of the design density. If using Asphalt Cement, compact to at least 90% of the design density.

After placing the first layer of a multiple-layer base course, apply a tack coat of bituminous material using a pressure distributor as specified in Section 460.3(b). Apply the tack coat at a rate from 0.25 L/m$^2$ to 0.30 L/m$^2$ (0.05 gallon per square yard to 0.07 gallon per square yard). If asphalt cement is used in the mixture, use Class RS-1 (E-1A), or CRS-1 (E-1C) emulsified asphalt in the tack coat.

**(d) Finishing.** Mix, compact, and finish the base course in a continuous operation and complete finishing during daylight hours.

**(e) Construction Joints.** At the end of each day's work, install a temporary wood bulkhead with a true vertical face, the full depth and width of the base course to form a straight transverse construction joint. Instead of a bulkhead, the Contractor may install a construction joint by scarifying and blending a portion of the previous day's work with the new mixture, and re-compacting to obtain uniformity.

Where necessary or indicated, construct longitudinal joints by sawing the completed work to a vertical face that is free of loose material.

**(f) Density.** Take one field density test, according to AASHTO T 191 or T 310, for each 2500 m$^2$ (3,000 square yards) of each layer.

When the base course fails to comply with the specified density requirements, apply additional compaction to obtain the required density. If additional compaction does not obtain satisfactory density, remove and replace the defective lot. The Representative may require additional density tests to determine if the defective area is less than the entire lot.

**(g) Surface Tolerance.** Section 210.3(c)

**(h) Tests for Depth.** At locations determined by the Representative, carefully dig or drill one test hole to the full depth of the completed base course in each 2500 $m^2$ (3,000 square yards) of completed base course.

The Representative will measure the depth of the base course. After the Representative completes depth measurements, backfill and compact base course mixture in the test holes.

Immediately remove and replace sections in which the depth is deficient by 13 mm (1/2 inch) or more. Start correction at the point of determined deficiency and proceed longitudinally and transversely until the depth meets the 13 mm (1/2-inch) requirement.

**(j) Maintenance and Traffic.** Until placing the surface course, maintain the completed base course as specified in Sections 105.13 and 901.

Maintain and protect base course the Representative opens to traffic as specified in Sections 107.15 and 901.

Allow only necessary local traffic and essential construction equipment on the base course. Repair or replace marred, distorted, or otherwise damaged pavement.

**320.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 321—AGGREGATE-CEMENT BASE COURSE

**321.1 DESCRIPTION**—This work is construction of a cement treated, aggregate base course. If placed on subgrade, it includes preparing the subgrade as specified in Section 210.

**321.2 MATERIAL—**

**(a) Coarse Aggregate.** Type C or better, Section 703.2, except conforming to the following gradation determined according to PTM No. 619:

| Sieve Size | Percent Passing |
|---|---|
| 50.0 mm (2-inch) | 100 |
| 19.0 mm (3/4-inch) | 70 - 100 |
| 9.5 mm (3/8-inch) | 55 - 100 |
| 4.75 mm (No. 4) | 45 - 80 |
| 1.18 mm (No. 16) | 25 - 50 |
| 150 µm (No. 100) | 10 - 25 |

**(b) Cement.** Type I, II, III, IS, or IP, Section 701.

**(c) Water.** Section 720.1

**(d) Bituminous Material.** Emulsified Asphalt, Class RS-1(E-1A) or CRS-1(E-1C), as specified in Section 702.

**(e) Fine Aggregate (for Protection and Curing).** Section 703.1

**(f) Mixture (Design).** Mix the aggregate-cement to comply with the following requirements:

If tested according to AASHTO T 134, mold specimens of the proposed mixture to maximum density. Cure the molded specimens in constant 100% humidity for 7 days. After curing, soak the specimens in water for 4 hours and then test in compression. The required minimum compressive strength is 4.5 MPa (650 pounds per square inch).

If required, test specimens of the mixture according to PTM No. 111. The maximum allowable determined mass loss is 14%.

**(g) Testing.** Section 305.2(d) through 305.2(f)

**321.3 CONSTRUCTION—**

**(a) Equipment.** Section 320.3(a)

**(b) Mixing and Spreading.**

**1. General.** Mix the aggregate and cement to prevent the formation of cement balls when the water is added. Add cement if the percentage of moisture in the aggregate does not exceed either the quantity that allows uniform and thorough mixture of aggregate and cement during the mixing operation or the optimum moisture content determination for the mixture.

Use the quantity of moisture in the mix that allows uniform blending and provides a stable base course during compacting or finishing. However, at final mixing do not vary the moisture content by more than 2% from the optimum moisture determined in the field.

The Contractor may use bulk cement with acceptable equipment and handling methods.

Do not spread cement or place mixture if the aggregate or the base course area is excessively wet or frozen. Do not perform any work if the air temperature is 5 °C (40F) or below.

If base course is more than 200 mm (8 inches) in compacted depth, construct in two or more layers of approximately equal depth, with no layer less than 100 mm (4 inches) or more than 200 mm (8 inches) in depth. A maximum compacted depth of 200 mm (8 inches) will be allowed if the required compaction density can be attained for the full depth of each layer.

Allow only the necessary shaping and processing equipment to travel over the spread cement or mixture; remove and replace cement or mixture that becomes displaced or contaminated, as directed.

**2. Central Plant Mixing.** Mix as specified in Section 320.3(b)1. Place mixture in adjacent lanes within 30 minutes unless using formed longitudinal joints. Start compaction operations within 60 minutes after adding water to the mix.

**3. In-Place Mixing.** Spread the required quantity of aggregate on the prepared area in a uniform loose layer. Apply cement if the moisture content of the aggregate allows uniform blending of the materials. Spread the specified quantity of cement on the aggregate and blend until the cement is uniformly distributed through the aggregate.

After thoroughly blending the aggregate and cement, apply and incorporate water into the mixture. Control the water application so no excessive concentration exists on or near the surface. Provide an adequate water supply and sufficient pressure distributing equipment to ensure a continuous mixing operation. After applying the required water, continue mixing until obtaining a thorough and uniform mixture.

**(c) Compaction.** Compact the loose base course mixture to at least 100% of the maximum dry mass (weight) density. The Representative will determine optimum moisture content and maximum dry mass (weight) density in the field according to AASHTO T 134. Do not vary the mixture percentage of moisture at the start of compaction by more than 2% from the optimum.

To eliminate cleavage planes in multilayer construction, lightly scarify the surface of the existing layer to no more than 25 mm (1-inch) deep before placing the next layer. Place and compact multiple layers to complete the total depth the same day. Keep the surface of the first layer moist until the next layer is placed.

**(d) Finishing.** Mix, compact, and finish the base course in a continuous operation and complete finishing during daylight hours.

During the shaping operation, if directed, scarify and recompact the surface to eliminate imprints left by equipment.

Complete the surface compaction and finishing within 3 hours after adding the water, and produce a smooth, dense surface free of compaction planes, cracks, ridges, or loose material.

**(e) Construction Joints.** Section 320.3(e)

**(f) Protection and Curing.** After completing the base course, sweep it free of foreign material. Moisten and roll to integrate loose and dry surface material, as directed. Apply bituminous material at a rate from 0.45 L/m$^2$ to 0.68 L/m$^2$ (0.10 gallon per square yard to 0.15 gallon per square yard).

Sufficient moisture is required in the surface of the base course to prevent penetration of the bituminous material. If necessary, apply water immediately to fill surface voids before applying the bituminous material.

Apply bituminous material only if the air temperature is 5 °C (40F) or above. Apply as soon as possible and no later than 24 hours after completing the finishing. Keep the surface of the base course moist until applying the bituminous material.

Maintain and protect the bituminous material so the entire surface is uniformly covered, to prevent rapid drying, for a curing period of 7 days. If traffic is to be maintained before receiving the surface course, spread fine aggregate immediately after applying the bituminous material, at a rate of 2.7 kg/m$^2$ to 5.4 kg/m$^2$ (5 pounds per square yard to 10 pounds per square yard).

If required, use an acceptable method to protect the completed base course from freezing until applying the surface course.

**(g) Density.** Density determinations will be made as specified in Section 320.3(f). As directed, remove and replace sections where the density is 80 kg/m$^3$ (5 pounds per cubic foot) or more below that specified.

**(h) Surface Tolerance.** Section 210.3(c)

**(i) Tests for Depth.** Section 320.3(h), and as follows:

The Contractor may correct sections deficient in depth by scarifying the surface and placing additional material, as specified for multilayer construction.

**(j) Maintenance and Traffic.** Section 320.3(j)

**321.4 MEASUREMENT AND PAYMENT—**Square Meter (Square Yard)

# SECTION 341—COLD RECYCLED BITUMINOUS BASE COURSE, COLD-IN-PLACE

**341.1 DESCRIPTION**—This work is the on-grade construction and material processing of a cold recycled bituminous base course (base course) that uses bituminous material combined with RAP, RAM, or virgin aggregates. Construction typically includes milling to an indicated depth, adding and mixing emulsified asphalt, placing, compacting, and testing.

**341.2 MATERIAL—**

**(a) Reclaimed Material.** Reduce oversized materials until 95% of the material passes the 50.0 mm (2-inch) sieve. Incorporate all reclaimed material into the recycled bituminous base course.

**1. RAM.** As specified in Section 703.1, Table A or 703.2, Table B. The Contractor may use RAM from the project or from stockpiles off the project.

**2. RAP.** Processed paving material containing bitumen and aggregates.

**(b) Bituminous Material.** Add bituminous material to the reclaimed material according to the approved mix design. Use one of the following bituminous materials, conforming to the applicable requirements of Bulletin 25:

- Emulsified Asphalt—MS-2(E-4), CMS-2(E-5), SS-1(E-6A), CSS-1(E-6C), SS-1h(E-8A), CSS-1h(E-8C), HFMS-2h(E-11-60), HFMS-2(E-11-90), HFMS-2S(E-11-150), or polymer modified grades of the above materials may be used when approved by the Engineer.

**(c) Aggregate.** Section 703.2 (Type A), No. 8, No. 57, and No. 67.

**(d) Mixture Design.** Take samples of reclaimed materials, and perform testing to establish the mix design. If RAM is included in the depth indicated for removal, take separate samples of RAP and RAM. Establish the mix design according to Bulletin 27, and submit the mix design to the District Materials Engineer/District Materials Manager for review at least 3 weeks before the planned start of mixture production.

**(e) Mixture.** Combine the reclaimed material, aggregates, and bitumen according to the mix design and at the mix design recommended optimum moisture and emulsion content. If RAP gradations and composition vary sufficiently, make field adjustments as recommended in the mix design to obtain satisfactory coating and the specified compaction.

**1. Review of QC Plan.** Prepare a QC Plan, as specified in Section 106, and submit for review at the start of the project. Do not start actual work until the QC Plan has been reviewed and approved by the Engineer.

**341.3 CONSTRUCTION—**

**(a) Equipment.** Provide equipment to produce recycled bituminous base course mixture as follows:

**1.** Provide a self-propelled milling machine having a down cutting drum, screening/crushing plant, and pugmill mixer. Use single-unit or multiple-unit machine with plant and/or mixer as trailer(s). Use pugmill mixer with liquid additive system and spray bar capable of volumetrically controlling liquid additive based on milling depth, milling width, and machine speed.

**2.** Use equipment capable of automatically metering liquids with a variation of not more than ± 2.0% by mass (weight) of liquids.

**3.** Maintain all equipment as specified in Section 108.05(c).

**(b) Mixing.** Do not place base course from September 1 to April 30 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, and 10-0; and from October 1 to April 30 in all other districts. With written approval of the Representative, the Contractor may place base course when no freezing temperatures occur for 24 hours before paving and when the project ambient air temperature is 7°C (45F) and rising.

Maintain adequate total liquids in the mixture to ensure thorough mixing of the reclaimed material and aggregates with the bituminous material. If necessary, add water at the mill head using a calibrated meter.

**(c) Compaction.** After processing, uniformly spread, shape, grade, and compact the base course to the lines, grades, and depth indicated. Before compaction, cure the base course as necessary.

Provide compacted layers between 80 mm and 130 mm (3 inches to 5 inches) in depth. Use rollers as specified in Section 108.05(c).

Begin rolling at the low side of each layer; except, initially leave 80 mm to 150 mm (3 inches to 6 inches) from unsupported edges unrolled to prevent distortion.

Determine the maximum density by constructing at least one control strip of approximately 500 $m^2$ (600 square yards) under the guidance of a nuclear gauge operator. After each pass of the compaction equipment, take a nuclear density reading according to AASHTO T 310. Continue compaction until the Representative determines additional passes do not appreciably increase the density. After compaction, take a minimum of ten density tests at random locations and determine the average control strip density.

Compact the base course to a minimum density of 96% of the average control strip density. Determine the in-place density of each 2500 $m^2$ (3,000-square yard) area according to AASHTO T 310. If the density of an area is less than the minimum density and if additional compaction does not achieve the minimum density, rescarify, adjust the moisture content, and recompact. If the density is still below the minimum, and the base course is uniform in texture, stable, and acceptable, define the area as a new control strip. Take a minimum of ten density tests at random locations and determine the average in-place density. The new minimum density is 96% of the average in-place density.

If the Representative determines that the Contractor achieved the minimum density with minimal compaction, the Representative may require the Contractor to construct a new control strip to verify or establish a new minimum density.

If the completed base course is unacceptable, stop base course construction. Resume construction only after correcting the cause of unacceptable construction.

**(d) Finishing.** Unless otherwise allowed, complete base course construction during daylight hours.

**(e) Protection.** Protect completed portions of base course that are opened to construction equipment from marring, distortion, and other damage. Immediately correct damage to the base course caused by construction equipment to the Representative's satisfaction.

**(f) Surface Tolerance.** If directed, test the completed base course for smoothness and accuracy of grade, both transversely and longitudinally, using a 3 m (10-foot) straight edge or template. Test a 2500 $m^2$ (3,000-square yard) area at three locations. At each location determine the maximum space under the straight edge or template. Correct each 2500 $m^2$ (3,000-square yard) area where the average of the maximum space at the three locations exceeds 13 mm (1/2 inch).

**(g) Maintenance and Traffic.** Maintain the completed base course and control traffic as specified in Section 401.3(n). Use a pilot car for speed control if damage, such as raveling, is likely to occur.

**(h) Curing.** Cure the base course for at least 1 week before placing the wearing course or binder course. In addition, if requested by the Representative and before placing a wearing or binder course, determine the moisture content of the completed base course according to PTM No. 749. Do not place the overlying course if the average moisture content exceeds 2%.

**(i)** Not used.

**(j) Tests for Depth.** Measure milling depth at time of pulverization. Make at least one measurement for each 2500 $m^2$ (3,000 square yards) or less of work done and record measurements to ensure that specified milling depth is

met. Correct or replace any section deficient by 13 mm (1/2-inch) or more from specified depth at no expense to the Department.

**341.4 MEASUREMENT AND PAYMENT—**

**(a) Cold In-Place Recycled Bituminous Base Course.** Square Meter (Square Yard)

**(b) Coarse Aggregate for Cold Recycled Bituminous Base Course.** Tonne (Ton)

**(c) Bituminous Material.** Liter (Gallon)

# SECTION 342—COLD RECYCLED BITUMINOUS BASE COURSE, CENTRAL PLANT MIX

**342.1 DESCRIPTION**—This work is the construction of a cold recycled bituminous base course (base course), central plant mix, using a combination of RAP, RAM, or virgin aggregates, mixed with bituminous material in a continuous or batch type mixer.

**342.2 MATERIAL**—Section 341.2 and as follows:

**(a) Stockpiling.** Store reclaimed material in a manner that preserves its quality and suitability. Separate different types of RAP to prevent contamination. Build stockpiles in horizontal layers to minimize segregation. Keep stockpile height to a maximum of 3 m (10 ft).

**342.3 CONSTRUCTION—**

**(a) Equipment.** Provide equipment to produce recycled bituminous base course mixture as follows:

**1.** Provide a central plant consisting of a RAP feed hopper, conveyor belts, twin shaft pugmill, metered liquid additive and water systems, pumps and spray bars. Other equipment may include additive storage tanks, beltscales, a stacker belt conveyor, and a storage bin. Provide a screening/crushing unit if the maximum size of RAP cannot be controlled otherwise.

Provide equipment capable of mixing reclaimed material and bituminous material into a homogeneous mixture without stripping the bituminous material. Provide a continuous-flow or batch-type mixer accepted by the Engineer and equipped with batching or metering devices to measure the specified quantities of the materials.

Use a positive displacement pump capable of accurately metering the flow rate of additive into the reclaimed material down to 15 L/min (4 gallons per minute). Provide a positive interlock system that automatically shuts off the pump when material is not in the mixing chamber. Provide a meter capable of registering the flow rate and quantity of additive introduced into the reclaimed material.

**2.** Use equipment capable of automatically metering liquids with a variation of not more than $\pm$ 2.0% by mass (weight) of liquids.

**3.** Maintain all equipment as specified in Section 108.05(c).

**(b) Mixing.** Maintain adequate total liquids in the mixture to ensure thorough mixing of the reclaimed material and aggregates with the bituminous material. Add water to the RAP by a calibrated meter, as necessary, to aid in mixing compaction.

**(c) Transporting and Placing.** Transport the mixture in clean, tightly sealed vehicles. The Representative may require vehicle protective covers. Use mechanical spreaders to place the loose mixture on the prepared surface to a uniform depth. Unless allowed, do not use motor graders.

Do not place base course from September 1 to April 30 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, and 10-0; and from October 1 to April 30 in all other districts. With written approval of the Representative, the Contractor may place base course when no freezing temperatures occur for 24 hours before paving and when the project ambient air temperature is 7°C (45F) and rising.

**(d) Compaction.** Section 341.3(c)

**(e) Finishing.** Section 341.3(d)

**(f) Protection.** Section 341.3(e)

**(g) Surface Tolerance.** Section 341.3(f)

**(h) Tests for Depth.** Control the loose depth of each layer to construct the base course to the compacted depth indicated and within the specified tolerances. The Representative will designate one test location in each 2500 m² (3,000 square yards) of completed base course and at locations the Representative suspects the depth is deficient. At each test location, record one depth measurement. If the depth is deficient 13 mm (1/2 inch) or more from the indicated depth, the pavement is defective. Immediately start removal of the defective pavement, beginning at the core location and continuing longitudinally and transversely until the depth is within 13 mm (1/2 inch) of the indicated depth.

**(i) Maintenance and Traffic.** Section 341.3(g)

**(j) Curing.** Section 341.3(h)

**342.4 MEASUREMENT AND PAYMENT—**

**(a) Cold Recycled Bituminous Base Course, Central Plant Mix.** Square Meter (Square Yard) or Tonne (Ton)

**(b) Bituminous Material.** Section 341.4(b)

**(c) Coarse Aggregate for Cold Recycled Bituminous Base Course**. Section 341.4(c)

# SECTION 350—SUBBASE

**350.1 DESCRIPTION—**This work is preparation of subgrade, as specified in Section 210, and construction of a compacted aggregate subbase.

**350.2 MATERIAL—**

**(a) Aggregates.** Type C or better, No. 2A and No. OGS, as specified in Section 703.2 and 703.5.

**350.3 CONSTRUCTION—**

**(a) Equipment.**

**1. Spreaders.** Section 320.3(a)3

**2. Compaction Equipment.** Sections 108.05(c)3.a, 3.b, 3.e

**(b) General.** Prepare the subgrade as specified in Section 210 before placing subbase. Do not place subbase material on soft, muddy, or frozen areas. See images of defective subgrade areas.

If directed, correct unsatisfactory subbase conditions developing ahead of the base and paving operations by scarifying, reshaping, and recompacting, or by replacing the subbase.

**(c) Mixing.** Use acceptable methods to mix materials and water before delivery to the project. Use a blend of materials from different sources only if allowed. Use material containing enough moisture to prevent segregation during stockpiling, hauling, and placing, and to minimize water added during compaction. Maintain No. OGS aggregate in a well-moistened condition from before placement to compaction.

**(d) Placement.** Before placing open-graded subbase, construct berms to confine the subbase material. Place the subbase before paving and as shown on the Standard Drawings. Control the subbase elevation and depth as specified in Section 210.3(c); except do not use templates if the subbase is trimmed using an automatic grading machine. Place the material on the subgrade using spreaders and without causing segregation. In areas where using mechanical spreaders is impractical, use an acceptable method to spread the material.

For rigid pavement and shoulders, place a course of No. 2A aggregate to a minimum compacted depth of 75 mm (3 inches) directly on the subgrade and place a course of No. OGS aggregate to a minimum compacted depth of 100 mm (4 inches) on top of the No. 2A aggregate.

For flexible pavement and shoulders, place the indicated type of aggregate courses at the position and depth indicated the pavement structure. Place each layer of No. 2A aggregate to a minimum compacted depth of 75 mm (3 inches) and place each layer of No. OGS aggregate to a minimum compacted depth of 100 mm (4 inches). Construct subbase in layers not more than 200 mm (8 inches) in compacted depth; however, when granulated slag is used, limit each layer to not more than 100 mm (4 inches) in compacted depth. If permitted and when using granulated slag, the Contractor may place a maximum compacted layer of 150 mm (6 inches) when the full layer depth is compacted as specified in this Section.

If the subbase is constructed in widths less than the full pavement width, neatly trim the edge of completed subbase before placing the abutting subbase.

For simultaneous construction of more than one pavement course, complete and maintain the subbase at least 460 m (1,500 linear feet) in advance of placing the succeeding pavement course.

In areas inaccessible to spreaders or in special areas, and if permitted, deposit the subbase material on the prepared area. Spread, in a manner not causing segregation, to a uniform full depth of the layer being placed.

**(e) Compaction and Density.** Compact No. 2A aggregate to at least 100% of the maximum dry-mass (dry-weight) density, determined according to PTM No. 106, Method B. At locations directed by the Representative, determine the in-place density for each 2500 $m^2$ (3,000 square yards), of each layer according to AASHTO T 191 or T 310.

If the retained is 20% or more for the 19.0 mm (3/4-inch) sieve or if the subbase material is No. OGS, the Representative will accept compaction when the material does not move under the compaction equipment.

Compact from the sides to the center, with each pass uniformly overlapping the previous pass.

If necessary, to obtain the minimum density of No. 2A aggregate or adequate compaction of No. OGS aggregate, remix, add water, reconstruct, or replace the subbase.

**(f) Surface Tolerance.** Section 210.3(c)

**(g) Test for Depth.** At each density test location and after completing the density test, carefully dig one test hole to the full depth of the completed subbase.

The Representative will measure the depth of the finished subbase.

If the subbase depth is deficient by 13 mm (1/2 inch) or more from the depth indicated, the subbase is defective. The Representative may require additional test holes to determine the limits of the defective area. Scarify the subbase to a depth of 75 mm (3 inches), blend in additional material, and recompact. After recompacting, the Representative may require test holes to verify the subbase depth is within 13 mm (1/2 inch) of the indicated depth.

Backfill the test holes with subbase material and compact.

**(h) Maintenance and Traffic.** Section 320.3(j) and as follows:

Do not allow traffic, including construction traffic, on a subbase constructed of No. OGS aggregate. If a subbase constructed of No. 2A aggregate is used as a haul road or if a subbase is exposed to weather in excess of 60 calendar days, retest for surface irregularities and depth and correct deficiencies as specified in Section 210.3(c) and 350.3(g).

## 350.4 MEASUREMENT AND PAYMENT—

**(a) Subbase.** For the type indicated, and as follows:

**1. Area Basis.** Square Meter (Square Yard)

The Department will not pay the entire quantity of subbase complete in place until the base course or pavement is constructed over the subbase. However, the Department will pay for up to 75% of the estimated quantity of subbase placed in advance of the succeeding operations, if the Contractor satisfactorily completed and is properly maintaining the subbase.

**2. Volume Basis.** Cubic Meter (Cubic Yard)

**3. Mass (Weight) Basis.** Tonne (Ton)

# SECTION 360—ASPHALT TREATED PERMEABLE BASE COURSE

**360.1 DESCRIPTION**—This work is the construction of an asphalt treated permeable base course (ATPBC) on a prepared surface. When placed on subgrade, it includes the preparation of subgrade as specified in Section 210.

**360.2 MATERIAL—**

**(a) Bituminous Material.** Asphalt Cement, Class PG 64-22, as specified in Section 702.

**(b) Coarse Aggregate.** Type A or Type B, Section 703.2. When using crushed gravel, provide a minimum of 75% crushed particles with at least three faces resulting from fracture.

**(c) Fine Aggregate.** Type A or Type B, Section 703.1.

**(d) Additives.**

**1. Hydrated Lime.** Before adding the asphalt cement, add hydrated lime to the aggregate to reduce stripping potential.

Furnish hydrated lime conforming to ASTM C 1097 and add the lime as follows:

- Add at least 1% hydrated lime by mass (weight) of the total dry aggregate.
- Provide a separate bin or tank and feeder system to store and accurately proportion the lime, in dry form, into the aggregate.
- Provide a convenient and accurate means of calibrating the proportioning device.
- Interlock the proportioning device with the aggregate feed or weight system.
- Mix the lime and aggregate to uniformly coat the aggregate with lime.
- Furnish aggregate containing at least 3% free moisture.
- Do not stockpile lime treated aggregate.
- Control the feeder system by a proportioning device accurate to within 10% of the specified amount.
- Provide a flow indicator or sensor and interlock with the plant controls such that production is interrupted if there is a stoppage of the lime feed.
- Before production, obtain approval of the method to introduce and mix the lime and aggregate.

**2. Heat-Stable, Anti-Stripping Additive.** The Contractor may use an anti-stripping additive other than hydrated lime. Blend the additive with the asphalt cement before adding the additive and asphalt cement to the mixture. Use the manufacturer's recommended dosage of the additive, but not less than 0.25% by mass (weight) of the asphalt. Select an additive that does not harm the completed bituminous concrete mixture and that is compatible with the aggregate and asphalt supplied for the project.

**(e) Mixture Design and Production.**

**1. Design.** Size, uniformly grade, and combine aggregate fractions according to Table A below. Marshall test requirements do not apply. Design a JMF with an initial target bitumen content of 2.5% by mass

(weight). If necessary, adjust the bitumen content within the range specified in Table A below to uniformly coat the aggregate and ensure the aggregate has no observable runoff of excess bitumen.

Test materials, proportions, and the mixture at the bituminous concrete plant laboratory. Verify conformance with the uniformity requirements specified in this Section. When required, the Department will perform the tests at the MTD. Provide a JMF that conforms to all Department requirements. Submit a copy of the JMF to the District Materials Engineer/District Materials Manager at least 3 weeks before the scheduled start of producing the mixture for the project. If the Department has not used the JMF on previous projects, provide test results from previous mixture production that show the mixture conformed to all JMF production tolerances.

**2. QC Plan.** Prepare and submit a QC Plan, as specified in Section 106, at the start of the project and at least annually thereafter. Do not start ATPBC production until after the Representative reviews the QC Plan.

**3. Production.** During the first day of production, take at least three bitumen content and gradation tests to verify the mixture conforms to the JMF. After the first day, perform tests for bitumen content and aggregate gradation according to the QC Plan and PTM No. 1. Produce ATPBC conforming to the gradation requirements in Table A and with a bitumen content within 0.8% of the JMF (n=1). Ensure the aggregate is uniformly coated with bitumen and no runoff of excess bitumen is observed.

**4. Acceptance of the Mixture.** Obtain material certification from the material producer using the results of QC tests for bitumen content and gradation. Provide the certification to the Inspector-in-Charge within 1 working day after taking QC tests.

**TABLE A**
**Composition of Mixture**
**(Total Percent by Mass (Weight) Passing Square Openings Based on Laboratory Sieve Tests)**

| Sieve Size | Percent Passing |
|---|---|
| 37.5 mm (1 1/2-inch) | 100 |
| 25.0 mm (1-inch) | 95 – 100 |
| 12.5 mm (1/2-inch) | 35 - 65 |
| 4.75 mm (No. 4) | 12 – 24 |
| 1.18 mm (No. 16) | 6 - 16 |
| 75 µm (No. 200) | 0 – 5 |
| | |
| Bitumen Content | 2.0% - 3.0%* |

* For approved gravel and slag mixtures, the Representative may allow the Contractor to exceed the upper limit.

**360.3 CONSTRUCTION**—Section 401.3, with modifications as follows:

**(b) Weather Limitations.** Replace with the following:

Do not place ATPBC on surfaces that are unstable, frozen, or below a temperature of 2 °C (35F) and when the air temperature is below is 2 °C (35F). If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of ATPBC that are en-route to the project.

**(c) Bituminous Mixing Plant.** Add the following:

**3. Plant Requirements.** The Contractor is not required to provide equipment for developing the design and control test according to the Department's modified Marshall Method.

**4. Preparation of Mixture.** Before mixing, dry the aggregate as necessary. Heat the bituminous material so that combining with aggregate produces a completed mixture. Coat the aggregate with the bituminous material to form a film of adequate thickness to provide the required binding properties. Produce ATPBC at a temperature below 163 ºC (325F) that also provides suitable viscosity for adequate coating of aggregate particles, and that does not cause segregation of asphalt and aggregate during transportation.

Do not stockpile ATPBC. The ATPBC must be placed within 8 hours from when it is made.

**(f) Rollers.** Replace with the following:

Use steel-wheel power rollers with a manufacturer's certified metal mass (weight) of 7 tonnes to 9 tonnes (8 tons to 10 tons).

**(h) Spreading and Finishing.** Replace with the following:

Use a slip form paver, as specified in Section 401.3(e), or a mechanical spreader. Spread and strike off the mixture for the entire lane width or as much lane as practical. Place the mixture in maximum 100 mm (4-inch) compacted lifts. Adjust screed assemblies to provide the cross section and depth indicated. Construct the profile to the design grade line. Use fully automated sensors to control profile and transverse grade. Allow the mixture to cool to 38 °C (100F) before placing subsequent layers or pavement courses. Perform handwork at locations directed by the Representative.

**(i) Compaction.** Replace with the following:

Seat ATPBC using a 7 tonne (8 ton) to 9 tonne (10 ton), steel-wheeled roller, or vibratory roller operated in the static mode only. Compact ATPBC by applying four roller passes. One roller pass is defined as one trip of the roller in one direction over any one spot. Additional passes are allowed only to eliminate any surface irregularities, or creases. Perform rolling only when the mat has cooled sufficiently to avoid shoving or lateral movement of the ATPBC. Do not compact the material to the point that it is not free draining or the aggregate is crushed.

**(j) Mat Density Acceptance.** Delete this section.

**(k) Joints.** Replace with the following

**1. Longitudinal Joints.** Spread the ATPBC to overlap the edge of the lane previously placed by 25 mm to 50 mm (1 inch to 2 inches). Maintain the uniform uncompacted depth adjacent to a compacted lane necessary to provide a smooth joint after compaction.

**2. Transverse Joints.** At the end of each day's work and when more than a 30 minute interruption occurs in ATPBC paving operations, install a temporary vertical bulkhead to form a straight transverse construction joint. The joint shall be the full depth and width of the ATPBC. Instead of a temporary bulkhead, the Contractor may saw construction joints.

**(l) Surface Tolerance.** Replace the requirements for correcting irregularities with the following:

Test the finished surface at locations the Representative suspects are irregular and at transverse joints and paving notches. Test the surface in stages using a 3 m (10-foot) straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface

from one side to the other. Advance the test location to the next stage by moving the straightedge along the pavement centerline by not more than 1.5 m (5 feet).

Correct irregularities of more than 13 mm (1/2 inch) by loosening surface mixture and removing or adding ATPBC. For irregularities that develop after compaction is completed, correct the irregularity by a method that does not produce contaminating fines or damage the base. Do not grind or mill the ATPBC. The area is defective if irregularities or defects remain after final compaction.

**(m) Tests for Depth: Binder and Wearing Courses.** Replace with the following:

Carefully dig or drill one 150 mm (6-inch) diameter test hole to the full depth of the ATPBC for each 2500 $m^2$ (3,000 square yards), or less, of completed base course. The Representative may require additional test holes in areas the Representative suspects are deficient in depth. The Representative will measure the depth of the base course. Using material acceptable to the Representative, backfill the test holes and compact the material to fill the test hole flush with the completed base course.

Remove and replace sections deficient in depth by 13 mm (1/2 inch) or more. Start correction at the point of determined deficiency and continue correction longitudinally and transversely until the depth is within 13 mm (1/2 inch) of the indicated depth.

**(n) Protection of Courses.** Replace with the following:

Section 105.13 and as follows: Traffic is not permitted on the asphalt treated permeable base material, except for trucks and equipment required to place the next layer. Replace areas damaged or contaminated, as directed and at no cost to the Department. If necessary, re-compact the ATPBC before starting subsequent paving.

Protect the surface from damage before and during the concrete paving process.

**(o) Defective Work.** Replace with the following:

Unless otherwise directed in writing by the District Executive, remove and replace ATPBC deficient in surface tolerance, deficient in depth, defective in asphalt content, or excessive in percent passing the 75 µm (No. 200 sieve). The ATPBC is defective in asphalt content if production tolerances are exceeded, percent of coated aggregate particles is less than 95%, or the mixture contains observable runoff of excess bitumen.

With written permission from the District Executive, the Contractor may fill low areas during construction of the next pavement course.

Acceptance testing and QA testing does not relieve the Contractor of responsibility for defective material or workmanship.

**360.4 MEASUREMENT AND PAYMENT—**Square Meter (Square Yard) or Tonne (Ton)

# SECTION 400
# FLEXIBLE PAVEMENTS

## SECTION 401—CONVENTIONAL MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED HMA COURSES

**401.1 DESCRIPTION**—This work is standard and RPS construction of plant-mixed HMA courses on a prepared surface using a conventional mixture design (Modified Marshall Procedure).

**401.2 MATERIAL—**

**(a) Bituminous Material.**

**1. Virgin Mix or Mix Containing 5% to 15% RAP.** Furnish the type and class of bituminous material required by the applicable pavement section and as specified in Section 702, at the point of delivery and at the bituminous concrete plant. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative with a copy of a signed Certificate of Compliance (CS-4171), a Bill of Lading, and a Certificate of Analysis for bituminous material on the first day of paving and when the batch number changes.

**2. Mix Containing more than 15% RAP.** The MTD will evaluate the asphalt content in the RAP source material. The MTD will determine the class (grade) of asphalt cement and recycling agent the Contractor is required to use in the mixture.

Furnish the type and class of bituminous material required by the applicable pavement section and as specified in Section 702, at the point of delivery and at the bituminous concrete plant. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative with a copy of a signed Certificate of Compliance (CS-4171), a Bill of Lading, and a Certificate of Analysis for bituminous material on the first day of paving and when the batch number changes.

**(b) Aggregates and RAM.** Provide aggregate from sources listed in Bulletin 14 and conforming to the gradation of Table A. If using RAM, conform to the applicable quality requirements of Section 703.1, Table A, or Section 703.2, Table B. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method.

**(c) RAP.** If RAP material is proposed for use in the mixture, use at least 5% RAP consisting of cold-milled or crushed hot-mix bituminous mixtures. Include a plan to control RAP and the procedures to handle RAP of significantly different composition in the producer's QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAP so that the final mixture conforms to Section 401.2(e).

**(d) Filler.** If required, as specified in Section 703.1(c)1.

**(e) Mixture Composition for Standard and RPS Construction.**

**1. Virgin Material Mixtures.** Test materials, proportions, and the mixture at the producer's laboratory. Design the mixture according to the requirements of Bulletin 27. The JMF shall include a list of sources used to provide materials and identify the mixture producer. The JMF shall conform to the following:

- 3.0% to 5.0% voids for ID-2 and ID-3 wearing courses and for ID-2 binder courses.
- The production limits of this Section for apparent moisture content, stability, flow, and Voids in Mineral Aggregate (VMA).
- The aggregate and asphalt content requirements of Table A.

If the Department has not used the JMF on previous projects, provide test results from previous mixture production that show the mixture conformed to all JMF production tolerances. Submit a copy of each completed JMF, signed by a certified HMA Level 2 plant technician, to the District Materials Manager/District Materials Engineer (DMM/DME) at least 3 weeks before the planned start of mixture production. Do not start mixture production until after the DMM/DME reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

**1.a Producer QC Plan.** Each producer must prepare a QC Plan as specified in Section 106 and conforming to the additional QC requirements of this specification. Submit the QC Plan to the DMM/DME annually, but at least 3 weeks before the planned start of mixture production and do not start mixture production until the DMM/DME reviews the QC Plan.

**1.a.1 QC Organization Chart.**

- Names of personnel responsible for QC.
- Area of responsibility of each individual.
- List outside agencies, e.g., testing laboratories and a description of services provided.

**1.a.2 Testing Plan with Action Points.**

- List of all tests to be performed.
- Frequency of testing.
- List action points to initiate corrective procedures.
- Recording method to document corrective procedures.
- Procedures for conducting JMF verification testing.

**1.a.3 Materials Storage and Handling.**

- Aggregate/RAP/RAM stockpiles.
- Cold-feed systems for aggregates/RAP/RAM.
- Additives or modifiers for mixture.

- Modified asphalt/liquid additive storage tanks.
- Surge/storage silos for mixture.
- All measuring and conveying devices, including calibration procedures.
- Haul vehicle loading procedures.

**1.b Mixture Production.** During mixture production, provide a certified HMA Level 1 plant technician at the plant and an on-call certified HMA Level 2 plant technician, both meeting the requirements outlined in Publication 351. Instruct and train the certified technician to perform all tests and to control plant operation. The Department may use its own certified HMA plant technicians to verify tests and to work in close cooperation with producer's technician. All technicians must carry a valid certification card during mixture production.

**1.b.1 JMF Verification.** During initial production of each JMF for a project, verify, according to the QC Plan, that the mixture conforms to this specification. Within 2 days of production, if the mixture does not conform to the production limits for stability, flow, and volumetrics and to the single and multiple gradation and asphalt content tolerances of Table B, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the above requirements. During JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

**TABLE A (Metric)**
**Composition—Bituminous Surface Courses**

| | Total Percent by Mass (Passing Square Openings, Lab Sieve Tests) | | | | | | | | | | | | | Bitumen % By Mass | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Surface Course** | **50.0 mm** | **37.5 mm** | **25.0 mm** | **19.0 mm** | **12.5 mm** | **9.5 mm** | **4.75 mm** | **2.36 mm** | **1.18 mm** | **600 µm** | **300 µm** | **150 µm** | **75 µm** | **Stone or Gravel** | **Slag** |
| **ID-2 W.C./H.D. ID-2 W.C.** | — | — | — | — | 100 | 80-100 | *** 45-80 | 30-60 | 20-45 | 10-35 | 5-25 | 4-14 | 3-6 | ** 4.5-8.0 | ** 7.0-10.5 |
| **ID-2 B.C./H.D.** | 100 | 95-100 | 85-95 | — | *** 40-65 | — | 20-47 | 15-37 | 10-30 | 5-24 | 4-17 | 3-10 | 2-5 | ** 3.5-7.0 | ** 5.0-9.0 |
| **ID-2 B.C.** | — | 100 | 90-100 | — | *** 40-75 | — | 20-47 | 15-37 | 10-30 | 5-24 | 4-17 | 3-10 | 2-5 | ** 4.0-7.0 | ** 5.5-9.0 |
| **FJ-1 W.C.** | — | — | — | — | — | 100 | 90-100 | 60-100 | 40-80 | 20-60 | 10-40 | 7-25 | 3-15 | 6.0-12.0 | |
| **FJ-1C W.C.** | — | — | — | — | — | 100 | 80-100 | 60-80 | 40-60 | 20-40 | 10-35 | 7-25 | 3-15 | 6.0-12-0 | |
| **FJ-4 W.C.** | — | — | — | — | — | 100 | 90-100 | 60-100 | 40-80 | 20-60 | 10-40 | 7-25 | 3-15 | 6.0-12.0 | |
| **ID-3 W.C./H.D. ID-3 W.C.** | — | — | 100 | 90-100 | — | 60-80 | *** 40-65 | 25-50 | 20-40 | 12-28 | 5-25 | 4-14 | 3-6 | ** 4.2-7.5 | ** 6.2-9.7 |
| **FB-2 W.C.** | — | — | — | — | 100 | 85-100 | 20-40 | 4-20 | — | — | — | — | — | 4.2* | 5.7* |
| **FB-2 B.C.** | — | 100 | 90-100 | — | 40-65 | — | 5-20 | 4-16 | — | — | — | — | — | 3.0* | 3.5* |
| **FB-1 W.C.** | — | — | — | — | 100 | 85-100 | 20-30 | 0-10 | — | — | — | — | — | 4.0* | 5.7* |
| **FB-1 B.C.** | — | 100 | 95-100 | — | 40-60 | — | 0-10 | 0-5 | — | — | — | — | — | 3.0* | 3.5* |

* Minimum Residue
** As Per Design (Bulletin 27)
*** Supplemental Control Sieve

**TABLE A (English)**
**Composition—Bituminous Surface Courses**

| | Total Percent by Weight(Passing Square Openings, Lab Sieve Tests) | | | | | | | | | | | | | Bitumen % By Weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Surface Course** | **2"** | **1 1/2"** | **1"** | **3/4"** | **1/2"** | **3/8"** | **No. 4** | **No. 8** | **No. 16** | **No. 30** | **No. 50** | **No. 100** | **No. 200** | **Stone or Gravel** | **Slag** |
| **ID-2 W.C./H.D. ID-2 W.C.** | — | — | — | — | 100 | 80-100 | *** 45-80 | 30-60 | 20-45 | 10-35 | 5-25 | 4-14 | 3-6 | ** 4.5-8.0 | ** 7.0-10.5 |
| **ID-2 B.C./H.D.** | 100 | 95-100 | 85-95 | — | *** 40-65 | — | 20-47 | 15-37 | 10-30 | 5-24 | 4-17 | 3-10 | 2-5 | ** 3.5-7.0 | ** 5.0-9.0 |
| **ID-2 B.C.** | — | 100 | 90-100 | — | *** 40-75 | — | 20-47 | 15-37 | 10-30 | 5-24 | 4-17 | 3-10 | 2-5 | ** 4.0-7.0 | ** 5.5-9.0 |
| **FJ-1 W.C.** | — | — | — | — | — | 100 | 90-100 | 60-100 | 40-80 | 20-60 | 10-40 | 7-25 | 3-15 | 6.0-12.0 | |
| **FJ-1C W.C.** | — | — | — | — | — | 100 | 80-100 | 60-80 | 40-60 | 20-40 | 10-35 | 7-25 | 3-15 | 6.0-12-0 | |
| **FJ-4 W.C.** | — | — | — | — | — | 100 | 90-100 | 60-100 | 40-80 | 20-60 | 10-40 | 7-25 | 3-15 | 6.0-12.0 | |
| **ID-3 W.C./H.D. ID-3 W.C.** | — | — | 100 | 90-100 | — | 60-80 | *** 40-65 | 25-50 | 20-40 | 12-28 | 5-25 | 4-14 | 3-6 | ** 4.2-7.5 | ** 6.2-9.7 |
| **FB-2 W.C.** | — | — | — | — | 100 | 85-100 | 20-40 | 4-20 | — | — | — | — | — | 4.2* | 5.7* |
| **FB-2 B.C.** | — | 100 | 90-100 | — | 40-65 | — | 5-20 | 4-16 | — | — | — | — | — | 3.0* | 3.5* |
| **FB-1 W.C.** | — | — | — | — | 100 | 85-100 | 20-30 | 0-10 | — | — | — | — | — | 4.0* | 5.7* |
| **FB-1 B.C.** | — | 100 | 95-100 | — | 40-60 | — | 0-10 | 0-5 | — | — | — | — | — | 3.0* | 3.5* |

* Minimum Residue
** As Per Design (Bulletin 27)
*** Supplemental Control Sieve

**1.b.2 Production.** After JMF verification, sample and test the mixture according to the QC Plan. For daily production of each JMF greater than 45 tonnes (50 tons), obtain at least one sample each day large enough to determine asphalt content, gradation, and theoretical maximum specific gravity, and to perform volumetric analysis and stability and flow of compacted specimens from the same sample. Perform additional sampling and testing as directed. Produce a mixture within the following production limits:

**1.b.2.a Apparent Moisture Content.** If the water absorption of a coarse aggregate, as determined by AASHTO T 85, exceeds 2.0%, sample the mixture according to PTM No. 1 and at the frequency in the producer's QC Plan. Determine the apparent moisture content in the mixture according to PTM No. 749. Produce a mixture with the apparent moisture content not to exceed 0.5%.

**1.b.2.b Asphalt Content.** Use automated and recordated plants. Use printed tickets for controlling asphalt content of the mixture. If the producer is not currently approved to use printed tickets, request Department approval according to Bulletin 27. Include in the producer's QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify the automated plant is recording the actual asphalt content and to verify the mixture conforms to the tolerances of Table B.

After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table B. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table B using the running average of the last five consecutive test results. During mixture production, maintain 90% of the printed ticket results for each day of production within 0.2 percentage points of the JMF.

**1.b.2.c Gradation.** Sample the completed mixture, or sample the combined aggregate from the hot bins of a batch plant or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer's QC Plan.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table B. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for the mixture, determine compliance with the multiple-sample tolerance using the running average of the last five consecutive test results. Determine the running average of the last five gradation tests and produce a mixture with the average of the last five tests within the multiple-sample tolerances of Table B.

**TABLE B**
**Job-Mix Tolerance Requirements of Completed Mix**

| | | Single Sample (n = 1) | Multiple Samples (n ≥ 3) |
|---|---|---|---|
| **Gradation** | | | |
| Passing 12.5 mm (1/2 inch) and Larger Sieves | | ±8% | ±6% |
| Passing 9.5 mm (3/8 inch) to 150 µm (No. 100) Sieves (Inclusive) | | ±6% | ±4% |
| Passing 75 µm (No. 200) Sieve | | ±3.0% | ±2.0% |
| **Asphalt Content** | | | |
| Wearing Courses | | ±0.7% | ±0.4% |
| Binder Courses | | ±0.8% | ±0.5% |
| **Temperature of Mixture (°C (F))** | | | |
| **Class of Material** | **Types of Material** | **Minimum** | **Maximum** |
| PG 58-28 | Asphalt Cement | 125 (260) | 155 (310) |
| PG 64-22 | Asphalt Cement | 130 (265) | 160 (320) |
| PG 76-22 | Asphalt Cement | 140(285) | 165(330) |
| All other P.G. Binders | Asphalt Cement | As specified in Bulletin 25 (Specifications for Bituminous Materials) | |

**1.b.2.d Theoretical Maximum Specific Gravity.** Sample the mixture according to PTM No. 1 at the frequency required in Bulletin 27. Test the samples according to AASHTO T 209.

Calculate the percentage of unfilled air voids and the theoretical maximum density of the mixture using the most recently determined theoretical maximum specific gravity value or average value as specified in Bulletin 27.

**1.b.2.e Stability, Flow, Voids, and VMA** Produce a mixture that, when tested according to PTM No. 705, conforms to the following Marshall values:

- Stability at least 5300 N (1,200 pounds) at 60 °C (140F) for binder course and wearing courses except if the applicable paving section specifies another stability value.
- Flow from 6 to 16.
- Voids within 2.0 percentage points of the JMF and within the master range of 2.0% to 6.0%.
- VMA at least 15% for ID-2 wearing courses and at least 12% for ID-2 binder courses. Determine VMA from the Marshall specimen testing described above.

**1.b.3 Corrective Actions.** Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 2.36 mm (No.8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances of Table B.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content are not within the tolerances of Table B.
- QC test results on a single sample (n=1) for stability, flow, voids, VMA, are not within the production tolerances.

- Independent assurance (IA) or QA sample test results at the producer's plant are not within the tolerances of Table B, or not within the production tolerances for stability, flow, voids, or VMA.

After taking corrective actions, sample the completed mixture within 140 tonnes (150 tons) of production. After sampling, test the mixture and provide test results to the Representative before shipping additional mixture to the project. If the mixture does not conform to Table B or the production tolerances for stability, flow, voids, or VMA, suspend production and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

**2. Mixtures with RAM or RAP.** Section 401.2(e)1. and as follows:

**2.a RAM and RAP SRL.** For HMA wearing courses, limit the total combination of RAM and RAP to a maximum of 15% of the mixture by mass (weight) unless documentation of the SRL designation of the coarse aggregate in the RAM and RAP materials is provided to the DMM/DME and the RAM and RAP conform to the specified SRL or can be blended for SRL as specified in Section 401.2(b).

**2.b RAP Asphalt Content and Gradation.** Determine the average asphalt content and gradation of the RAP stockpile according to Bulletin 27. Determine the proportions of RAM, RAP, and virgin materials necessary to conform to the JMF requirements. Maintain and provide the Representative access to records of all sampling, testing, and calculations.

**(f) Mixture Acceptance.**

**1. General.** For standard construction, the Department will accept the mixture according to the appropriate level of Table C. At least 3 weeks before placing mixtures, submit a mixture-acceptance plan to the Department for approval. The mixture-acceptance plan shall propose an appropriate acceptance level based on the requirements of this specification and project-specific conditions. Identify the contract item number and description, plan locations, quantity, JMF, and the proposed acceptance level in the mixture-acceptance plan. Do not place mixtures until the Department approves the mixture-acceptance plan.

For RPS Construction, the Department will accept mixtures by lot acceptance as specified in Section 401.2(f)3.

**TABLE C**
**Mixture Acceptance**

| Acceptance Level | Acceptance Method |
|---|---|
| Certification | Producer Certification of Mixture |
| Lot Acceptance– MTD or Local Verification Testing | Producer QC Test Results, Verification Testing at the MTD or Local Laboratory |

**2. Certification.** Acceptance by certification is appropriate for the following mixtures, conditions, or applications:

- Scratch or leveling less than a minimum 50 mm (2 inch) depth, driveway adjustments, and other non-uniform depth courses less than a maximum 50 mm (2 inch) depth
- Mixtures used by Department maintenance forces
- Mixtures purchased by local or municipal governments

- Mixtures placed in quantities too small for consistent plant operation, but not to exceed 360 tonnes (400 tons) in a continuous placement operation

**2.a General.** Obtain certification from the mixture producer. Certify mixtures using Form CS-4171 or another acceptable form. Include the QC test results on the form. Provide the form to the Inspector-in-Charge within 1 working day after completing the QC tests. Certify mixtures as specified in Section 106.03(b)3 and the requirements below.

**2.b Certification.** Certify each mixture daily if QC test results conform to the production limits of 401.2(e)1.b.2 and at least 90% of the printed tickets for asphalt content are within 0.2 percentage points of the JMF. If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC tests results to the Inspector-in-Charge. Payment will be determined according to Table G based on the QC test results.

**2.c Maintaining Approval to Certify Mixtures.** The Department may suspend certification if QC is not performed according to the producer's QC Plan, mixtures are not produced according to Bulletin 27, less than 90% of the daily printed ticket results for asphalt content are within 0.2 percentage points of the JMF, or as described below.

The Department may take IA samples of the completed mixture at the plant. In the presence of the Department, test the IA samples for asphalt content and gradation according to the test methods indicated in the producer's QC Plan. Take immediate corrective actions if the mixture does not conform to Table B.

The Department may take QA samples of the completed mixture at the plant or from directly behind the paver. The Department will test QA samples according to PTM No. 757 for conformance to Table B. If the results of the QA samples do not comply with Table B, review the producer's QC Plan and the QC test results that followed the QA samples for conformance to Table B.

After completing corrective actions or the sample review, the Department will perform an on-site evaluation of the producer's plant operation and QC and then take a sample of the completed mixture at the plant. In the presence of the Representative, test the sample. If the sample does not comply with Table B, the Department will suspend certification. Immediately suspend shipping mixtures accepted by certification to the project.

After testing verifies that the produced mixture conforms to Table B, with the Department present, conduct JMF verification according to the QC Plan. After successfully completing JMF verification, resume both certification and shipping mixtures accepted by certification to the project.

**3. Lot Acceptance.** Lot acceptance is appropriate for standard construction mixtures placed in quantities that allow consistent operation of the plant and appropriate for RPS construction.

**3.a Lots and Sublots.** The normal lot size is the daily placement of each mixture up to a maximum of 1080 tonnes (1,200 tons). If daily placement exceeds 1080 tonnes (1,200 tons), the normal lot size is 1080 tonnes (1,200 tons), unless operational conditions or project size dictate otherwise. Each lot has three equal sublots (n=3), unless operational conditions or project size dictate otherwise. The normal sublot size is one-third the daily placement of each mixture up to a maximum of 360 tonnes (400 tons), unless operational conditions or project size dictate otherwise.

Terminate lots and sublots at the end of each day's placement or, for allowable night projects, at the end of a continuous placement operation that extends into the next calendar day. If a sublot is terminated before it is completed, combine the material with the previous sublot and the sublot may exceed 360 tonnes (400 tons). A completed sublot has all verification samples, and pavement cores if required, collected according to PTM No. 1. If the final lot is terminated before completing three sublots, the Inspector will combine the completed sublots with the previous lot for a lot that includes four or five sublots and the lot may exceed 1080 tonnes (1,200 tons).

**3.b Mixture Acceptance Samples.** Perform mixture acceptance sampling at the plant. The Department will verify the results of acceptance testing by testing verification samples obtained for each lot from directly behind the paver. Use printed tickets for asphalt content. Take three mixture or three combined aggregate samples per day according to PTM No. 1 for percent passing the 75 µm (No. 200) sieve. Mixture acceptance samples may be used to meet QC testing requirements. The Department will accept the mixture, as specified in Section 401.4(a).

**3.c Mixture Verification Samples.** The Inspector will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. For each sublot and in the presence of the Inspector, take one loose sample from directly behind the paver.

Identify the samples by lot number, location, date of placement, mixture type, and as acceptance samples type code LV (Local Verification Testing) or FV (MTD Verification Testing). Immediately package individual samples in cardboard boxes dimensioned approximately 95 mm x 120 mm x 240 mm (3 3/4 inches by 4 3/4 inches by 9 1/2 inches). Place the individually packaged samples in one container or tie the individually packaged samples for one lot together and submit the samples to the Inspector.

**3.d Verification Sample Testing.** One of the following testing options will be indicated in the proposal. These procedures apply to standard and RPS construction.

**3.d.1 MTD Testing.** The Department will test the samples according to PTM No. 757 or PTM No. 702, Modified Method D if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 µm (No. 200) sieve. The Department will use the calibration factors ($C_f$ and 200 $C_f$) provided with the JMF for PTM No. 757. The Department will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level.

If the asphalt content is not within the tolerances in Table B for two consecutive lots or a total of three lots or if the percent passing the 75 µm (No. 200) sieve is not within the tolerances in Table B for two consecutive lots or a total of three lots, stop all mixture production. Determine the cause of the problem and provide a written evaluation of the problem and the proposed solution to the Department. Do not resume production until the Representative reviews the proposed solution and authorizes paving to continue.

**3.d.2 Local Testing.** Prepare a separate QC Plan for local verification testing. Submit the QC Plan for approval at least 3 weeks before the scheduled start of mixture production. Detail in the QC Plan the method and procedures for sampling, packaging, securing, transporting, and handling verification samples. Identify in the QC Plan the location and address of the laboratory where the Representative's certified HMA plant technician will test the samples using the laboratory's equipment. The Contractor may use the producer's laboratory or designate another laboratory for testing verification samples. If using a laboratory other than the producer's laboratory, include the laboratory name, address, phone number, and contact person on the QC plan. The Department may perform an inspection of laboratories used to test verification samples.

Obtain and identify samples as specified in Section 401.2(f)3.d. Package samples according to the QC Plan for local verification testing and secure the packaged samples with individually numbered security ties. Transport samples to the local testing location according to the QC Plan. Do not remove the security tie. At the test location, the Representative's certified HMA plant technician will remove the security tie. If the Representative's certified HMA plant technician determines the samples were damaged or not secured, obtain additional samples for verification testing as directed. Immediately stop production if the Representative determines sample security was intentionally compromised. Determine the cause of the compromised security and provide a written explanation of the cause and a proposed solution. Do not resume production until the Representative reviews the written explanation and solution and authorizes production to continue.

With the producer's certified HMA plant technician present, the Representative's certified HMA plant technician will randomly select one sublot from each lot and test the sample according to PTM No. 757 or PTM No. 702, Modified Method D if previously identified problematic aggregates are used in the mixture, to determine the asphalt content and percent passing the 75 µm (No. 200) sieve. If the asphalt content is not within ±0.2% of the JMF or the percent passing the 75 µm (No. 200) sieve is not within ±1.0% of the JMF, the Representative's certified HMA plant technician will test the remaining sublot verification samples from the lot. The Representative will evaluate the test results for extreme values according to PTM No. 4 at the 5% significance level. The Department will accept the lot as specified in Section 401.4.

If the asphalt content is not within the tolerances in Table B for two consecutive lots or a total of three lots or if the percent passing the 75 µm (No. 200) sieve is not within the tolerances in Table B for two consecutive lots or a total of three lots, stop all mixture production. Determine the cause of the problem and provide a written evaluation of the problem and the proposed solution to the Department. Do not resume production until the Representative reviews the proposed solution and authorizes production to continue.

## 401.3 CONSTRUCTION—

**(a) Paving Operation QC Plan.** Prepare a paving operation QC Plan, as outlined on Form CS-401, for field control and evaluation of bituminous concrete paving operations for the Representative's review. Submit the QC Plan before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the bituminous concrete courses as specified in Section 401.2. Do not start paving until after the Representative reviews the QC Plan.

**(b) Weather Limitations.** Do not place bituminous paving mixtures from November 1 to March 31, unless allowed in writing by the District Executive. Do not place bituminous paving mixtures when surfaces are wet or when the air or surface temperature is 4 °C (40F) or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

**(c) Bituminous Mixing Plant.** Obtain bituminous mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 11.1 $m^2$ (120 square feet). For recycled mixtures, add the following requirements:

**1. Batch Plant.** Modify the batch plant to measure the mass (weight) of the RAP before adding it into the pug mill. Design the cold-feed bin, conveyor system, charging chute(s), and all special bins to prevent RAP from segregating and sticking. Dry the virgin aggregate and RAM and then heat the virgin aggregate and RAM to a temperature that, after adding RAP, produces a completed mixture temperature from 127 °C to 154 °C (260F to 310F). Ensure that virgin aggregate is free of unburned fuel oil when delivered to the pug mill.

**2. Drum Mixer Plant.** Modify the drum mixer plant to prevent RAP from directly contacting the burner flame and prevent RAP from overheating. Produce a completed mixture with a temperature from 127 °C to 154 °C (260F to 310F).

**(d) Hauling Equipment.** Haul the mixtures in tightly sealed vehicles that do not contain petroleum oils, solvents, or other materials that adversely affect bituminous concrete. Provide covers of sufficient size and quality to protect the entire load, under all conditions. Maintain the proper and uniform placement temperature specified in Section 401.3(h)1. Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 10 °C (50F) between October 1 and May 1.

**(e) Bituminous Pavers.** Provide self-contained, power-propelled units with activated screeds or activated strike-off assemblies and with automatic screed controls, capable of producing a finished surface of specified evenness and texture. Provide heated units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory laying of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the screeds.

Use hydraulic or other extension types against abutting lanes or longitudinal joints only if the unit feeds and activates the extension by the same method as the main screed. At the outside edge of pavement widths that cannot be uniformly placed, the Contractor may use a non-activated extension when approved by the Inspector-in-Charge.

Do not use equipment that tears, shoves, or gouges the mixture or that causes tracks, indented areas, flushing, or other permanent blemishes. Do not use blade graders or drags.

**(f) Rollers.** Use steel-wheel, pneumatic-tire, or vibratory rollers as specified in Section 108.05(c)3. Operate rollers according to manufacturer's recommendations. Use vibratory rollers with separate controls for vibration and propulsion.

**(g) Preparation of Existing Surface.**

**1. Conditioning of Existing Surface.** Before delivering bituminous mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a broom.

Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative's satisfaction.

Paint existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with bituminous mixtures with a uniform coating of bituminous material, Class E-6 (AASHTO SS-1 or CSS-1), E-8 (AASHTO SS-1h or CSS-1h), Class AET applied in two or more applications, or of the class and type designated for the bituminous course.

Before overlaying existing surfaces, apply a tack coat as specified in Section 460.3 unless otherwise indicated. Apply a tack coat to previously placed courses if the Representative determines a tack coat is necessary to ensure bonding between the two courses.

**2. Scratch and Leveling Courses.** Where indicated, place a separate scratch or leveling course ahead of resurfacing operations. Use the scratch course to fill wheel ruts and other local small depressions even with the surrounding pavement. Use the leveling course to provide a relatively uniform working platform for placing binder or wearing courses.

**(h) Spreading and Finishing.** Provide a certified HMA field technician with qualifications outlined in Publication 351 and dedicated to controlling the placement of bituminous mixtures. Instruct and train the certified HMA field technician to control the paving operation so that the completed paving work complies with the specified requirements. All certified HMA field technicians must carry a valid certification card during placement of all bituminous mixtures.

**1. General Requirements.**

**1.a Placing.** Unless otherwise allowed, deliver, place, and compact bituminous paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material.

Deliver and place virgin-material mixtures at the laying temperatures specified in Table B for the type and class of material used.

**1.b Spreading and Finishing.** Spread and strike off the mixture over the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth. After spreading, do not add mixture to the pavement mat that is segregated or below the minimum temperature, contains either a deficiency or an excess of asphalt content, or is otherwise unsuitable to add to the pavement mat.

If the course is more than 150 mm (6 inches) in compacted depth, construct it in two or more layers of approximately equal depth, with no layer less than 80 mm (3 inches) or more than 150 mm (6 inches) in compacted depth. For binder or leveling courses that have isolated areas exceeding 150 mm (6-inch) compacted depth, use a scratch or leveling course to eliminate the isolated areas before full-depth paving.

Immediately after placing the bituminous mixture, work the exposed outer edges to avoid a sharp, ragged, and open edges; to eliminate an unfinished appearance; and to reduce edge breakdown. Immediately repair edge breakdowns.

In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

Adjacent to flush curbs, gutters, and other abutting structures, place the wearing course mixture uniformly higher so that after compaction the finished surface is slightly above the edge of the abutting structure. Remove harmful material, clean, and seal the surface of wearing courses adjacent to curbs to form a bituminous gutter. Seal the mixture surface with bituminous material of the class and type designated for the wearing course. Evenly apply the bituminous material a minimum width of 300 mm (12 inches) from the curb. The Contractor may use Class AET, Class E-6 (AASHTO SS-1 or CSS-1), or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint along the curb. If necessary, apply emulsified asphalt in two or more applications. After sealing, remove excess sealant material.

**2. Pattern Segregation.** Pattern segregation is continuous or repeated areas of non-uniform distribution of coarse and fine aggregate particles in the finished mat. The Department will address pattern segregation as follows:

**2.a Evaluation of Pattern Segregation.** If the Representative observes pattern segregation that may result in defective pavement, then:

- The Inspector will immediately notify the Contractor of the observed pattern segregation.
- The Contractor may continue work at its own risk and immediately and continually adjust the operation and eliminate the pattern segregation from future work.
- As a minimum and in the presence of the Representative, determine the average depth of pavement surface macrotexture of areas with the pattern segregation and areas with non-segregated pavement according to PTM No. 751. The pattern segregation is unacceptable if the difference in pavement texture depth between the non-segregated and segregated areas exceeds 0.610 mm (0.024 inch). The Representative will determine the extent of defective pavement as specified in 401.3(h)2.c.

**2.b Test Section.** If the macrotexture tests idenfity unacceptable pattern segregation, then:

- Immediately suspend placement of the bituminous course. Evaluate the cause of pattern segregation according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative. Do not resume placing the bituminous course until after the Representative has reviewed the proposed corrective actions.
- After the Representative allows paving to resume, place a test section not to exceed 180 tonnes (200 tons). If the corrective actions do not eliminate unacceptable pattern segregation, the Department will suspend paving before the Contractor places the entire test section. Determine if the pattern segregation resulted in defective pavement as specified in Section 401.3(h)2.c, propose additional corrective actions, and construct another test section. Resume normal paving operations after constructing an entire test section without the Representative observing pattern segregation.

**2.c Defective Pavement.** At locations selected by the Inspector and with the Inspector present, drill a minimum of three 152 mm (6-inch) diameter cores from both the area of pattern segregation and the pavement representing non-segregated areas. Do not compress, bend, or distort samples during cutting and handling and immediately provide the cores to the Inspector. The Inspector will transport cores to the plant. With the Inspector present, test the cores at the plant for density, extraction, and gradation analysis. The Department may request additional tests as part of its evaluation of pattern segregation. Determine the maximum theoretical density according to AASHTO T 209 and core density according to PTM No. 715.

An area of pattern segregation contains defective pavement if two or more sieves vary 10% or more from the JMF, the summation of deviations from any two sieves is 20% or more from the JMF, the core density is defective, the mixture is defective in asphalt content, or the mixture is defective for percent passing the 75 µm (No. 200) sieve. Remove and replace the full width of the affected lane and a minimum of 1.5 m (5 feet) beyond each end of the area with unacceptable pattern segregation. For replacement, use the appropriate surface tolerances as specified in Section 305.3(l) or Section 401.3(l).

**(i) Compaction.** Compact the mixture to achieve the density acceptance requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, amplitude, frequency, pattern, and roller size to eliminate displacement, shoving, cracking, and aggregate breakage. Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels. Use suitable methods to clean pneumatic-tire roller wheels.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of bituminous material. Replace removed mixture with fresh hot mixture and compact the mixture even with the surrounding pavement surface.

**(j) Mat Density Acceptance (Standard and RPS Construction).**

**1. General.** The Department will accept the mat density of standard construction according to one of the levels in Table D. With the proposed mixture-acceptance plan, submit a proposed density-acceptance plan to the Department for approval. Include in the density-acceptance plan the contract item number and description, plan locations, quantity, JMF, and the proposed density acceptance level for the mixture. Do not place mixtures until the Inspector-in-Charge has approved the density-acceptance plan.

For courses with mixture acceptance by certification, the density acceptance level will be either non-movement or optimum-rolling pattern.

The Department will accept the mat density of RPS construction by lots and pavement cores as specified in Section 401.3(j)4.

**TABLE D**
**Density Acceptance**

| Density Acceptance Level | Acceptance Criteria |
|---|---|
| Non-Movement | Table F |
| Optimum-Rolling Pattern | Table F |
| Pavement Cores* | Table G |
| * Use only when mixture acceptance is by lots | |

**2. Non-Movement.** The Inspector-in-Charge will approve non-movement density acceptance for the following materials, conditions, or applications:

- Scratch or leveling courses less than 30 mm (1-inch) in depth or equal to or less than 60 kg/m$^2$ (110 pounds per square yard).
- Areas of paving or patching less than 1.2 m (4 feet) in width or too narrow to prevent bridging of the area by approved compaction equipment.

The Inspector-in-Charge will accept density by non-movement for the following materials, conditions, or applications that are also determined by the Representative to be non-critical for density:

- Materials placed in quantities too small for consistent operation of the plant, but not to exceed 360 tonnes (400 tons) in a continuous placement operation.
- Mixtures placed on unstable or non-uniform bases.
- Mixtures used for patching, road widening, shoulders, driveway adjustments, and other miscellaneous applications determined by the Representative.

The Department will accept the density of courses when the mixture does not move under the compaction equipment.

**3. Optimum-Rolling Pattern.** The Representative may accept density using an optimum-rolling pattern for the following materials, conditions, or applications:

- Materials placed in quantities too small for consistent operation of the plant.
- Mixtures placed on unstable or non-uniform bases.
- Leveling courses or other courses that are a minimum 30 mm (1-inch) in depth or equal to or less than 60 kg/m$^2$ (110 pounds per square yard).
- Mixtures used for patching, road widening, shoulders, driveway adjustments, and other miscellaneous applications determined by the Representative.

- Mixtures placed at less than the minimum compacted depths on Table E.

With the Inspector and the Contractor's certified HMA field technician present, determine density according to ASTM D 2950 with a licensed nuclear gauge operator, or determine density according to PTM No. 403, and follow the control strip technique specified in PTM No. 402, to construct at least one control strip to establish the optimum-rolling pattern for each course. Compact the course according to the optimum-rolling pattern. During paving, the Representative may require the Contractor to construct a new control strip to verify the optimum-rolling pattern.

Use one of the following gauges or approved equal:

- Troxler Electronic Laboratories, Model 4640-B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2
- TransTech Systems, Inc., PQI™, Model 300 or 301
- Troxler Electronic Laboratories, PaveTracker™

If requested by the Inspector, submit a copy of the certificate of nuclear gage annual calibration according to ASTM D 2950 and documentation of training of the nuclear gage operator. Recalibrate nuclear gauges that are damaged or repaired.

**4. Pavement Cores.**

**4.a General.** Pavement cores are required for accepting the density of RPS construction. Pavement cores are appropriate for accepting the density if the following materials, conditions, or applications exist:

- Mixture acceptance is by lots.
- Materials placed in quantities that allow consistent operation of the plant.
- Materials placed at uniform depths according to Table E.
- Materials placed on stable and uniform bases.

**TABLE E**
**Mixture Minimum Compacted Depths**

| Mixture | Minimum Depth |
|---|---|
| ID-2 and ID-2 H.D. Wearing Course | 40 mm (1 1/2 in.) |
| ID-3 and ID-3 H.D. Wearing Course | 50 mm (2 in.) |
| ID-2 and ID-2 H.D. Binder Course | 50 mm (2 in.) |

**4.b Lot/Sublot Size.** Section 401.2(f)3

**4.c Density Acceptance Samples.** The Inspector will select different sample locations in each sublot according to PTM No. 1, PTM No. 729, and PTM No. 746. With the Inspector present, drill 152 mm (6-inch) diameter cores as soon as possible but no later than the day following placement. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 300 mm (1 foot) of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

Identify the samples by lot number, location, date of placement, mixture type, and as acceptance samples (Type Code LA (Local Acceptance Testing) or AS (MTD Acceptance Testing)). Immediately package and deliver the samples to the Inspector according to the QC Plan. Use sample containers of sufficient strength to prevent samples from being damaged during transport. Submit samples for one lot in one container.

One of the following testing methods will be indicated in the proposal. These procedures apply to standard and RPS construction.

**4.c.1 MTD Acceptance Testing.** The MTD will test the samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. The Department will determine acceptance, with respect to density, as specified in Section 401.4.

If cores are not taken within 1 day after placing the mixture, or if the density for two consecutive lots or a total of three lots does not meet the density payment factor percentage of 100, stop paving operations as directed. Review and evaluate the operation and determine the cause of the problem. Provide a written explanation along with the proposed solution to the Department. Do not resume paving until after the Representative reviews the proposed solution and authorizes paving to continue.

**4.c.2 Local Acceptance Testing.** Prepare a separate QC Plan for local acceptance testing. The Contractor may submit one QC Plan for local acceptance testing of both mixture composition and density. Submit the QC Plan at least 3 weeks before the planned start of mixture production. Detail in the QC Plan the methods and procedures for taking, packaging, securing, tying, transporting, handling, and testing the acceptance samples for density. Identify in the QC Plan the location and address of the laboratory where the Representative's certified HMA plant technician will test the samples using the laboratory's equipment. The Contractor may use the producer's laboratory or designate another laboratory for testing acceptance samples. If using a laboratory other than the producer's laboratory, the QC Plan shall include the laboratory name, address, phone number, and contact person. The Department may perform an inspection of laboratories used for acceptance testing.

Obtain and identify samples as specified in Section 401.3(j)4.c. Package samples according to the QC Plan for local acceptance testing and secure the packaged samples with individually numbered security ties. Do not remove the security tie. Transport the samples to the local testing location according to the QC Plan. At the test location, the Inspector will remove the security tie. If the Inspector determines the samples were damaged or not secure, obtain replacement acceptance samples within 300 mm (1-foot) of the original sample location, as directed by the Inspector. Immediately stop paving if the Representative determines that sample security was intentionally compromised. Determine the cause of the compromised sample security and provide a written explanation of the cause and a proposed solution, Do not resume production until the Representative reviews the written explanation and solution and authorizes paving to continue.

With the producer's certified HMA plant technician present, the Representative's certified HMA plant technician will test the pavement core acceptance samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. The Department will determine acceptance, with respect to field density, as specified in Section 401.4.

If cores are not taken within 1 day after placing the mixture, or if the density for two consecutive lots or for a total of three lots does not meet the density payment factor percentage of 100, stop all paving operations as directed. Review and evaluate the operation and determine the cause of the problem. Provide a written explanation along with the proposed solution to the Department. Do not resume paving, until after the Representative reviews the proposed solution and authorizes paving to continue.

**(k) Joints.**

**1. Longitudinal Joints.**

**1.a General.** Offset joints in a layer from the joint in the layer immediately below by approximately 150 mm (6 inches). Plan joint locations to ensure the joint in the top layer is at the approximate pavement centerline for two-lane roadways and within 300 mm (12 inches) of the lane lines for roadways with more than two lanes.

Before placing abutting lanes, paint the entire area of the joint with a thin coating of bituminous material, Class AET, Class E-6 (AASHTO SS-1 or CSS-1), E-8 (AASHTO SS-1h or CSS-1h), or PG 64-22. Use two applications of AET emulsified asphalt.

Place and compact the mixture at the joint according to the Paving Operation QC Plan. Ensure the surface across the joint is smooth and the surface along the joint is within the surface tolerances specified in Section 401.3(l).

If traffic or other causes distort the lane edge, restore the land edge to its original shape using acceptable procedures.

**1.b Vertical Joints.**

- The Contractor may use vertical joints for base, binder, and wearing courses.
- If traffic or other cause distorts the lane edge, carefully saw a vertical lane edge before painting.
- Place the abutting lane on the same day, and if necessary, leave only short lane sections, normally less than 8 m (25 feet) in length, where the abutting lane is not placed the same day.

**1.c Notched Wedge Joints.**

- The Contractor can use notched wedge joints for wearing and binder courses.
- Remove and dispose of all loose and foreign material before opening the lane to traffic.
- Construct the joint according to Standard Drawing RC-28.
- If the joint is next to opposing traffic, place the abutting lane within 1 working day after placing the mixture. If the joint is next to traffic in the same direction, place the abutting lane within 10 working days after placing the mixture.
- If both lanes that make the joint are not placed on the same day, amend the Maintenance and Protection of Traffic Plan and install additional signing for uneven pavements at no additional cost to the Department. Install "Uneven Pavement" signs according to Publication 212 and 1 km (1/2-mile) before the notched wedge joint area and every 1 km (1/2-mile) within the uneven pavement area.

**2. Transverse Joints.** Construct joints perpendicular to the pavement surface. The Contractor may saw transverse joints. If used, install bulkheads straight and perpendicular to the surface. If bulkheads are not used and the roller moves over the rounded edge of new mixture, locate the joint a sufficient distance from the rounded edge to provide a true surface and cross section. Paint the joint face with a thin coating of bituminous material, Class AET, Class E-6 (AASHTO SS-1 or CSS-1), E-8 (AASHTO SS-1h or CSS-1h), or PG 64-22, before placing fresh mixture against the joint face. If necessary, use two applications of AET emulsified asphalt.

**3. Other Joints.** Where placing a wearing course abutting to existing pavement at locations such as paving notches, lane additions, or utility openings, seal the joint with hot bituminous material of the class and type designated for the wearing course. Evenly apply the sealant a minimum of 150 mm (6 inches) on both sides of the joint. The Contractor may use a Class AET, Class E-6 (AASHTO SS-1 or CSS-1) or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material. Before sealing, clean and remove harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint. If necessary, use two or more applications of emulsified asphalt. Remove excess bituminous material and immediately cover the sealed area with a light application of acceptable dry sand.

**(l) Surface Tolerance.** Test the finished surface with a 3 m (10-foot) straightedge at areas the Representative determines may be deficient or irregular, and at transverse joints and paving notches, and at longitudinal joints. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than one-half the length of the straightedge until the entire area is tested. The pavement is defective if irregularities are more than 5 mm (3/16 inch). View Animation.

**(m) Tests for Depth: Binder and Wearing Courses.** Construct the pavement to the depth indicated and within the specified tolerances.

For courses with density acceptance by lots, the Inspector will measure the depth of each sublot according to PTM No. 737 using the density acceptance samples. The Department will accept the course depth as specified in Section 401.4.

For courses with a designed course depth and density acceptance by non-movement or rolling pattern, the Inspector will calculate the mass per square meter (weight per square yard) for verification of yield. If yield results indicate insufficient course depth, drill one 152 mm (6 inch) diameter core for each 180 tonnes (200 tons) to determine the extent of pavement with deficient depth. Pavement deficient in depth by more than 6 mm (1/4 inch) and that cannot be satisfactorily corrected is defective. Pavement deficient by more than 3 mm in three adjacent core locations and that cannot be satisfactorily corrected is defective. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correction of courses deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 6 mm (1/4 inch) of the design depth.

**(n) Protection of Courses.** Do not allow vehicular traffic or loads on newly compacted courses for 24 hours or until the mixture uniformly cools to a temperature of 60 $^{o}$C (140F) or less. Provide alternate routes as indicated or as directed. If both lanes that form a longitudinal joint are placed on the same day and public safety is not restricted, do not allow vehicular traffic or loads on the lanes until adequate stability and adhesion are obtained and the material has uniformly cooled to 60 $^{o}$C (140F) or less. Maintain the course, as specified in Sections 105.13, 107.15, and 901.

**(o) Defective Work.** As specified in Section 105.12 and as follows:

Department acceptance and QA testing shall not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace, or repair defective work as directed. The BOCM will review Representative determinations of defective materials or workmanship.

Unless otherwise directed in writing by the District Executive remove and replace defective pavement for surface tolerance as specified in Section 401.3(l) or Section 305.3(l), depth as specified in Section 401.3(m) or Section 305.3(m), and pattern segregation as specified in Section 401.3(m). Remove and replace defective pavement as specified in Tables F and G.

## 401.4 MEASUREMENT AND PAYMENT—

**(a) Plant-Mixed Bituminous Concrete Courses.** Measurement as specified in applicable sections.

**1. Mixture Acceptance by Certification and Density Acceptance by Non-Movement and Optimum-Rolling Pattern.** The Representative will pay at the contract price, adjusted according to Table F. The total payment factor percentage is the sum of adjustments or each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%.

**TABLE F**
**Contract Price Adjustments**

| Mixture Acceptance by Certification | | | |
|---|---|---|---|
| **Course** | **Test Criteria** | **Test Value** | **Payment Factor Percentage** |
| **Asphalt Content** | | | |
| All Wearing, Binder, and Bituminous Concrete Base Courses (BCBC) | Printed Tickets | At least 90% of Daily Tickets Within 0.2% of JMF | 100 |
| | | Less than 90% of Daily Tickets Within 0.2% of JMF | 75 |
| **Gradation** | | | |
| All Wearing, Binder | % Passing 75 µm (No. 200) Sieve (n=1) | ±3.0% | 100 |
| | | ±3.1% to ±4.0% | 75 |
| | | > ±4.0% | * |
| **Mat Density** | | | |
| All Wearing, Binder, and BCBC | Non-Movement | Section 409.3(j)2 | 100 |
| | Optimum-Rolling Pattern | Section 409.3(j)3 | 100 |
| * Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 50% of the contract unit price. | | | |

**2. Mixture Acceptance by Lot and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores.** The Department will pay on a lot-by-lot basis at the contract price, adjusted for Payment Factor Percentages as specified in Table G. For the payment factor percentages based on percent within tolerance, the Department will determine the percent within tolerance according to Section 106.03(a)3, using the upper and lower specification limits in Table H.

**TABLE G**
**Contract Price Adjustments**

| Mixture Acceptance by Lots | | | |
|---|---|---|---|
| **Course** | **Test Criteria** | **Test Value** | **Payment Factor Percentage** |
| **Asphalt Content** | | | |
| All Wearing and Binder | Printed Tickets | At least 90% of daily tickets within 0.2% of the JMF, and verification sample test results are within the n=1 and n≥ 3 tolerances in Table B* | 100 |
| | | Less than 90% of daily tickets within 0.2% of the JMF, and verification sample test results are within the n=1 or n≥ 3 tolerances of Table B*. | 95 |
| | | Percent Within Tolerance if the verification sample test results are not within the n=1 or n≥ 3 tolerances of Table B | Table I |

| | | | |
|---|---|---|---|
| **Gradation** | | | |
| All Wearing and Binder | % Passing 75 µm (No. 200) Sieve | Producer QC test results are within the n=1 and n≥ 3 tolerances of Table B and verification sample test results are within the n=1 and n≥3 tolerances of Table B* | 100 |
| | | Percent Within Tolerance, if verification sample test results are not within the n=1 or n≥ 3 tolerances of Table B | Table I |
| **Mat Density** | | | |
| All Wearing, Binder and BCBC | Non-Movement | Section 409.3(j)2 | 100 |
| | Optimum-Rolling Pattern | Section 409.3(j)3 | 100 |
| All RPS Wearing and Binder | Pavement Cores | All individual sublot test results for the lot are ≥ 92% and <97% of daily maximum theoretical density | 100 |
| | | Percent Within Tolerance if any individual sublot test result for the lot is not ≥ 92% and <97% of daily maximum theoretical density | Table I |
| All Standard Wearing and Binder | Pavement Cores | All individual sublot test results are ≥ 90% and <97% and the lot average is ≥ 92% and <97% of the daily maximum theoretical density | 100 |
| | | Percent Within Tolerance if any individual sublot test result is not ≥90% and <97 or if the lot average is not ≥92% and <97% of the daily maximum theoretical density | Table I |
| All BCBC | Pavement Cores | All individual sublot test results are ≥ 88% and <97% and the lot average is ≥ 90% and <97% of the daily maximum theoretical density | 100 |
| | | Percent Within Tolerance if any individual sublot test result is not ≥ 88% and <97% or if the lot average is not ≥ 90% and <97% of the daily maximum theoretical density | Table I |

* The Department may elect to randomly select and test only one sublot verification sample from each lot to verify conformance to the specifications. If only one sublot verification sample is tested, tighter tolerances than those in Table B will be used to verify conformance to the specifications for the entire lot. If the one sublot is within ±0.2% of the JMF for asphalt content and within ±1.0% of the JMF for percent passing the 75 µm (no. 200) sieve, the lot will be considered to conform with the specifications and the lots payment factor percentage will be determined according to this table. If the one sublot fails to meet the tighter tolerances, all verification samples from the lot will be tested to determine the payment factor percentage according to this table.

**TABLE H**
**Upper and Lower Specification Limits for Calculating Percent Within Tolerance**

| | **Testing Criteria** | |
|---|---|---|
| Course | Lower Specification Limit (L) | Upper Specification Limit (U) |
| | **Asphalt Content from JMF Value, %** | |
| Wearing Courses | -0.4 | +0.4 |
| Binder and BCBC | -0.5 | +0.5 |
| | **Percent Passing the 75 µm (No. 200) sieve from JMF Value, %** | |
| All Wearing and Binder | -2.0 | +2.0 |
| | **Mat Density*** | |
| Wearing and Binder | 0.91T | 0.98T |
| BCBC | 0.88T | 0.98T |
| * Where T = Current Maximum Theoretical Density, $kg/m^3$ (lbs./cu.ft.) | | |

**TABLE I**
**Payment Factor Based on Percent Within Tolerance**
To be used in Adjusted Payment Formula specified in Section 402.4(a) and (b)

| Percent Within Tolerance | Payment Factor Percentage |
|---|---|
| 99 | 97 |
| 98 | 97 |
| 97 | 97 |
| 96 | 96 |
| 95 | 96 |
| 94 | 96 |
| 93 | 95 |
| 92 | 95 |
| 91 | 95 |
| 90 | 95 |
| 89 | 93 |
| 88 | 91 |
| 87 | 90 |
| 86 | 88 |
| 85 | 86 |
| 84 | 84 |
| 83 | 83 |
| 82 | 81 |
| 81 | 79 |
| 80 | 78 |
| 79 | 76 |
| 78 | 74 |
| 77 | 72 |
| 76 | 71 |
| 75 | 69 |
| 74 | 67 |
| 73 | 66 |
| 72 | 64 |
| 71 | 62 |
| 70 | 60 |
| 69 | 59 |
| 68 | 57 |
| 67 | 55 |
| 66 | 54 |
| 65 | 52 |
| 64 | 50 |
| Less than 64 | Defective Lot** |

** Remove and replace the lot. If only one lot characteristic has a percent within tolerance less than 64, the District Executive, with the concurrence of the Chief Engineer, may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

**2.a Payment.** The Representative will compute the percent of the contract price paid as follows:

Lot Payment = $C_p(2P_D + P_B + P_A)/400$

$C_P$ = Contract unit price per lot (unit price times lot quantity)

$P_D$ = Payment Factor Percentage for density

$P_B$ = Payment Factor Percentage for asphalt content.

$P_A$ = Payment Factor Percentage for percent passing 75 µm (No. 200) sieve

**2.b Retesting.** For mixture or density acceptance testing performed by the MTD, the Contractor may request that the Department retest a lot. The Department may allow retesting if the Contractor has a reasonable basis to conclude the test results do not represent the lot. With the Contractor present, the MTD will perform the retest. The MTD will not retest cores coated with paraffin wax as a result of PTM No. 716. The MTD will perform analysis of the original test values and the retest values according to PTM No. 5.

The MTD will evaluate a re-tested lot with:

- The original test values if repetition is established.
- The retest values if lack of repetition is established.

If the retest values indicate repetition of the original test values, the Department will deduct from the payment an amount equal to ten times the contract unit price per tonne (ton) or, for a contract with a unit price per square meter (square yard), ten times the calculated price per tonne (ton).

**(b) HMA RPS Construction.**

**1. Mixture Acceptance by Lot and Density Acceptance by Pavement Cores.** Section 401.4(a)2, except for RPS, the Department will determine mat density by pavement cores only.

# SECTION 404—EVALUATION OF BITUMINOUS PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE

**404.1 DESCRIPTION—**This work is evaluating a bituminous pavement surface profile and determining the ride-quality incentive associated with the pavement surface profile.

**(a) General Requirements**. Determine the ride quality of finished pavement surfaces, including overlaid bridge approach slabs and overlaid bridge decks. In the presence of the Inspector, measure the pavement surface profile according to PTM No. 428. Provide the resultant International Roughness Index (IRI) data to the Representative. The Representative will determine payment for each ride-quality lot based on the IRI.

Measure the pavement surface of the following excluded areas separate from the pavement surface profile of ride-quality lots. The Representative will not include measurements from excluded areas to determine lot incentive payment.

- Pavement surfaces not constructed as a full-depth overlay, as indicated, such as the vertical transition areas at the limits of paving and at the approaches to bridges.
- Bridge decks unless overlaid.
- Ramps less than 457 m (1,500 feet) in length.
- Tapered pavement less than 3.6 m (12 feet) wide.
- Shoulders, medians, and other pavement surfaces indicated.
- Pavement from 1.5m (5 feet) before and up to 1.5m (5 feet) after any appurtenances such as water boxes, manholes, railroad tracks, and inlets extending out into the pavement.
- Partial lots less than 30m (100 feet).
- Roadways with a posted speed limit of 65 km/hour (40 miles per hour) or lower.
- Pavement that is not reconstructed with at least two of the following operations: profile milling, scratch course, leveling course, binder course, and wearing course, and on bridge decks only, a waterproofing membrane.

**(b) Lot Size.** A full lot is 161 m (528 feet) of a single pavement lane. The Representative will designate lots starting at the beginning limit of paving and continuing to the ending limit of paving for each pavement lane and ramp that is 3.6 m (12 feet) or wider. Do not include the length of excluded areas in the 161 m (528 feet).

The Representative will designate a partial lot at the ending limit of paving and at an excluded area, when the lot length is less than 161 m (528 feet). The Representative will evaluate a partial lot as a percentage of a full lot.

**404.3 CONSTRUCTION—**

**(a) Equipment and Operator.** Provide pavement surface profile measuring equipment that has been verified by the Department according to PTM No. 428. In the presence of the Inspector, calibrate the distance sensor and check the profile system calibration before each day's testing.

Provide an operator that is Department certified according to PTM No. 428.

**(b) Testing.**

**1. Lots.** Provide the traffic control and station marking necessary to accommodate testing. Remove objects and equipment from the surface and sweep the surface as necessary to remove debris. In the presence of the

Inspector, determine the pavement surface profile for each lot according to PTM No. 428. At the completion of testing, immediately submit the lot IRI data, as defined in PTM No. 428, to the Representative.

**2. Excluded Areas.** Provide the traffic control necessary to accommodate testing. Test the entire surface of each excluded area in stages using a 3 m (10-foot) straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the roadway centerline and, in successive positions, test the pavement surface profile from one side of the excluded area to the other. Advance the test location to the next stage by moving the straightedge along the roadway centerline not more than 1.5 m (5 feet).

**(c) Acceptance.**

**1. Lots.** The Representative will compare the lot IRI to Table A in Section 404.4 to determine if the lot requires corrective action. Additionally, perform corrective action on any individual bump (must grind) where the irregularity is more than 5 mm (3/16 inch) when tested with a 3 m (10-foot) straightedge.

**2. Excluded Areas.** Perform corrective action where irregularities are more than 5 mm (3/16 inch) when tested with a 3 m (10-foot) straightedge. To improve the ride quality and at the Department's expense the Representative may require grinding of excluded areas that conform to the acceptable straightedge surface tolerances specified in Section 404.3(c).

**(d) Corrective Action.**

**1.** Do not produce a deviation, such as a ridge or valley with the adjacent pavement, of more than 3 mm (1/8 inch) when measured on the transverse profile. Correct a sufficient length of pavement to correct the pavement surface profile without producing additional high or low points. Retest the lots and excluded areas after completing corrective action. Perform additional measurements of the pavement surface profile, as necessary, for the Representative to determine which lots do not require additional corrective action. Correct surfaces to a uniform texture and cross section.

**2.** Perform all corrective action before testing for pavement depth. Use one or more of the following methods:

**2.a. Carbide Grinding.** Use carbide grinding for correcting areas 4.5 m (15 feet) in length or less. Use grinders of the walk-behind type that have cutting heads of carbide tipped shackles, stars, or blades and have a locking depth control to produce a uniform pavement surface texture.

Provide a pavement surface texture consisting of parallel grooves between 2 mm and 6 mm (3/32 inch and 1/4 inch) wide width a "land area" between grooves of 2 mm and 5 mm (1/16 inch and 3/16 inch). Operate the grinder by making multiple passes if necessary, with a maximum depth of any single pass of 3 mm (1/8 inch). Grind longitudinally or transversely across the pavement surface.

**2.b Diamond Grinding.** As specified in Section 514.3 and modified as follows:

**(d) Tolerance.** Delete this section.

Unless otherwise approved, grind the entire lane width.

**2.c Removal and Replacement.** Remove the surface course of the entire pavement lane width by milling and replace at least the minimum layer depth of the specified surface course. Place more than the minimum layer depth if necessary to correct the pavement surface profile.

**(e) Defective Work.** A ride-quality pavement lot is defective if:

- The IRI of the lot exceeds the maximum acceptable IRI specified in Table A of Section 404.4.

- Any individual bump (must grind) exists in the lot where the irregularity is more than 5 mm (3/16 inch) when tested with a 3 m (10-foot) straightedge.

- The surface adjacent to another ride-quality lot contains a ridge or valley of more than 3 mm (1/8 inch).

- The specifications for pavement construction require removal and replacement of pavement within the ride-quality lot.

Unless the Department and Contractor agree to leave a defective lot in place as specified in Section 404.4, remove and replace defective areas and retest the ride-quality lot.

**404.4 MEASUREMENT AND PAYMENT—**Dollar

The proposal will include an item and a predetermined amount of money for Evaluation of Bituminous Pavement Ride Quality and Payment of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation Of Bituminous Pavement Ride Quality And Payment Of Incentive item as follows:

If the lot is not defective, Table A and the IRI for each lot will be used to determine the incentive payment for ride quality.

The incentive payment for a lot subjected to corrective action will be determined using Table A and the IRI for the lot after the Contractor completes corrective action.

The incentive payment for a partial lot will be determined as a percentage of a full lot.

After corrective action, the Contractor may leave a defective lot in place if the District Executive provides written approval and the Contractor accepts a $4,000 downward adjustment (rebate) of the amount paid for the lot.

Costs associated with evaluating pavement ride quality will not be paid for separately.

TABLE A
Payment Schedule for Ride Quality Incentive

| **SCHEDULE A** | |
|---|---|
| **For Expressway Work Using Three Operations** | |
| **IRI mm/km/lot (inches/mile/lot)** | **Amount** |
| ≤ 553 (35) | $600 |
| ≤ 790 (50) | $300 |
| ≤ 948 (60) | $150 |
| ≤ 1105 (70) * | $0 |
| > 1105 (70) | Corrective action required |
| * Maximum acceptable IRI | |

| SCHEDULE B | |
|---|---|
| **For Expressway Work Using Two Operations and Non-Expressway Work Using Two or More Operations** | |
| **IRI mm/km/lot (inches/mile/lot)** | **Amount** |
| ≤ 710 (45) | $600 |
| ≤ 868 (55) | $300 |
| ≤ 1105 (70) | $150 |
| ≤ 1420 (90) * | $0 |
| > 1420 (90) | Corrective action required |
| * Maximum acceptable IRI | |

# SECTION 409—SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED HMA COURSES

**409.1 DESCRIPTION—**This work is the standard and RPS construction of plant-mixed HMA on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor.

**409.2 MATERIALS—**

**(a) Bituminous Material**

**1. Virgin Mix or Mix Containing 5% to 15% RAP.** Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for bituminous material on the first day of paving and when the batch number changes.

**2. Mix Containing More than 15% RAP.** The MTD will evaluate the asphalt cement in the RAP source material. The MTD will determine the class (grade) of asphalt cement that the Contractor is required to use in the mixture.

Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder, AASHTO M 320, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade. Provide QC testing and certification as specified in Sections 106.03(b) and 702.1(b)1. Provide the Representative a copy of a signed Bill of Lading for bituminous material on the first day of paving and when the batch number changes.

**(b) Aggregate and RAM.**

**1. General Requirements.** Provide aggregate from sources listed in Bulletin 14. Aggregate and RAM shall conform to the quality requirements for Superpave Asphalt Mixture Design as specified in Bulletin 27. For wearing courses, provide aggregate with at least the SRL designation specified. To achieve the specified SRL, the Contractor may provide a blend of two aggregates if the blend has an SRL designation equal to or better than that specified. Blends are 50% by mass (weight) of each aggregate. Blend the aggregates using an approved method.

**2. Fine Aggregate.** Section 703.1, except Table A gradation does not apply and as follows:

Determine the uncompacted void content according to AASHTO T 304, Method A, or use the value listed in Bulletin 14, and conform to AASHTO M 323, Table 4. Determine the sand-equivalent value according to AASHTO T 176 and conform to AASHTO M 323, Table 4.

**3. Coarse Aggregate.** Type A, Section 703.2, except Table C gradation does not apply and revise the following quality requirements of Table B:

- Abrasion, Maximum Percent as specified in Bulletin 27, Chapter 2A, Table 5A
- Thin and Elongated Pieces, Maximum Percent as specified in AASHTO M 323, Table 5, for Flat and Elongated
- Crushed Fragments, Minimum Percent, as specified in AASHTO M 323, Table 5, for Fractured Faces, Coarse Aggregate

**(c) RAP.** If RAP material is proposed for use in the mixture, use at least 5% RAP consisting of cold milled or crushed hot-mix bituminous mixture. Include a plan to control RAP and the procedures to handle RAP of

significantly different composition in the producer QC Plan. Maintain all processed material free of foreign materials and minimize segregation. Process the RAP so that the final mixture conforms to Section 409.2(e).

**(d) Filler.** Section 703.1(c)1. Do not use flyash if the design traffic is greater than or equal to 3 million Equivalent Single Axle Loads (ESALs).

**(e) Mixture Composition for Standard and RPS Construction.**

**1. Virgin Material Mixtures.** Size, uniformly grade, and combine aggregate fractions in proportions to produce a JMF that conforms to the material, gradation, and volumetric Superpave Asphalt Mixture Design requirements as specified in Bulletin 27, Chapter 2A, for the specified nominal maximum aggregate size and design ESALs.

Submit a copy of each completed JMF, signed by a certified HMA Level 2 plant technician, to the District Materials Engineer/District Materials Manager (DME/DMM) at least 3 weeks before the planned start of mixture production. Include a list of all material sources and the HMA producer in the JMF. Provide the calibration factors ($C_f$ and 200 $C_f$) required by PTM No. 757 with the JMF. Do not start mixture production until after the DME reviews the JMF.

Submit a new JMF with a change in material sources or if a new JMF is necessary to produce a mixture conforming to this specification.

**1.a Producer QC Plan.** Each producer must prepare a QC Plan as specified in Section 106 and conforming to the additional QC requirements of this specification. Submit the QC Plan to the DME annually at least 3 weeks before the planned start of mixture production and do not start production until the DME reviews the QC Plan.

**1.a.1 QC Organization Chart.**

- Names of personnel responsible for QC.
- Area of responsibility of each individual.
- List outside agencies, e.g., testing laboratories and a description of services provided.

**1.a.2 Testing Plan with Action Points.**

- List of all tests to be performed.
- Frequency of testing.
- List action points to initiate corrective procedures.
- Recording method to document corrective procedures.
- Procedures for conducting JMF verification testing.

**1.a.3 Materials Storage and Handling.**

- Aggregate/RAP/RAM stockpiles.
- Cold-feed systems for aggregates/RAP/RAM.
- Additives or modifiers for mixture
- Modified asphalt/liquid additive storage tanks.

- Surge/storage silos for mixture. Do not store more than one JMF in a surge/storage silo at any given time.
- All measuring and conveying devices, including calibration procedures.
- Haul vehicle loading procedures.

**1.b Plant Technicians.** During mixture production, provide a certified HMA Level 1 plant technician at the plant and an on-call certified HMA Level 2 plant technician, both meeting the requirements outlined in Publication 351. Instruct and train the certified technicians to perform all tests and to control plant operation. The Department may use its own certified HMA plant technicians to verify tests and to work in close cooperation with the producer's technicians. All technicians must carry a valid certification card during mixture production.

**1.c Annual JMF Verification.** During initial production of each JMF, verify, according to the QC Plan, that the mixture conforms to this specification. If the mixture does not conform to the single and multiple sample tolerances in Tables A and B within 2 days of production, suspend shipping the mixture to the project. Do not ship the mixture to the project until after the Representative reviews and verifies that results conform to the single and multiple sample tolerances in Tables A and B. During JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

**1.d Production.** After JMF verification, sample and test the mixture according to the QC Plan. For daily production of each JMF greater than 45 tonnes (50 tons), determine asphalt content, gradation, and theoretical maximum specific gravity from the same sample at least once each day. For daily production of each JMF greater than 140 tonnes (150 tons), determine asphalt content, gradation, theoretical maximum specific gravity and perform volumetric analysis of compacted specimens from the same sample at least once each day. Perform additional sampling and testing as directed. Produce a mixture within the following production limits:

**1.d.1 Apparent Moisture Content.** If the water absorption of a coarse aggregate, as determined by AASHTO T 85, exceeds 2.0%, sample the mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Determine the apparent moisture content in the mixture according to PTM No. 749. Produce a mixture with the apparent moisture content not to exceed 0.5%.

**1.d.2 Asphalt Content.** Include in the producer QC Plan a frequency of obtaining mixture samples according to PTM No. 1 and performing asphalt content tests to verify that the mixture conforms to the tolerances of Table A. Test the samples according to either PTM No. 757, PTM No. 702, or PTM No. 742. After obtaining a minimum of three test results, determine compliance with the multiple sample tolerances in Table A. After obtaining five or more test results, determine compliance with the multiple sample tolerances in Table A using the running average of the last five consecutive test results.

Printed ticket results may be used in place of laboratory test results for QC of asphalt content of the mixture if the producer is currently approved to use printed tickets according to Bulletin 27. During mixture production, maintain 90% of printed ticket results for each day of production within 0.2 percentage points of the JMF. If RAP is used in the mixture, determine asphalt content by testing samples of the completed mixture.

**1.d.3 Gradation.** Sample the completed mixture, or sample the combined aggregate from the hot bins of a batch plant or the combined aggregate belt of a drum plant, according to PTM No. 1 and at the frequency in the producer QC Plan. If mineral filler or RAP are used in the mixture, determine gradation by testing samples of the completed mixture.

- Test the completed mixture according to PTM No. 757 or according to PTM No. 702 and PTM No. 739.
- Test combined aggregate samples according to PTM No. 743.

Produce a mixture within the tolerances of Table A. Determine compliance with the multiple-sample tolerance after obtaining a minimum of three test results for the mixture. After obtaining five or more test results for

the mixture, determine compliance with the multiple-sample tolerances using the running average of the last five consecutive test results.

**1.d.4 Theoretical Maximum Specific Gravity.** Sample the mixture according to PTM No. 1 at the frequency required in Bulletin 27. Condition and test the samples according to Bulletin 27.

Calculate the percentage of unfilled voids and the theoretical maximum density of the mixture using the most recently determined theoretical maximum specific gravity value or average value as specified in Bulletin 27. Certify the theoretical maximum specific gravity value to the Inspector daily using Form CS-4171 or another acceptable form. If the theoretical maximum specific gravity value varies 0.030 or more from the previous test or from the JMF value, immediately notify the DME.

**1.d.5 Volumetric Analysis of Compacted Specimens.** Sample the completed mixture according to PTM No. 1 and at the frequency in the producer QC Plan. Prepare a minimum of two specimens from each sample according to AASHTO T 312.

Produce a mixture with volumetric properties conforming to the tolerances of Table B. Determine the bulk specific gravity of the specimens as specified in AASHTO T 312 and calculate air voids ($V_a$) and Voids in Mineral Aggregate (VMA) at $N_{design}$ according to AASHTO R 35 and as specified in Bulletin 27. Determine compliance with the multiple specimen tolerances using the average of the results for all specimens prepared from the sample.

**TABLE A**
**Job-Mix Formula**
**Composition Tolerance Requirements of the Completed Mix**

| | | **Single Sample (n = 1)** | **Multiple Samples (n ≥ 3)** |
|---|---|---|---|
| **Gradation** | | | |
| Passing 12.5 mm (1/2 inch) and Larger Sieves | | ±8% | ±6% |
| Passing 9.5 mm (3/8 inch) to 150 µm (No. 100) Sieves (Inclusive) | | ±6% | ±4% |
| Passing 75 µm (No. 200) Sieve | | ±3.0% | ±2.0% |
| **Asphalt Content** | | | |
| 19.0 mm HMA mixtures and smaller | | ±0.7% | ±0.4% |
| 25.0 mm HMA mixtures and larger | | ±0.8% | ±0.5% |
| **Temperature of Mixture (°C (F))** | | | |
| **Class of Material** | **Type of Material** | **Minimum** | **Maximum** |
| PG 58-28 | Asphalt Cement | 125 (260) | 155 (310) |
| PG 64-22 | Asphalt Cement | 130 (265) | 160 (320) |
| PG 76-22 | Asphalt Cement | 140 (285) | 165 (330) |
| All other PG Binders | Asphalt Cement | As specified in Bulletin 25 (Specifications for Bituminous Materials) | |

**TABLE B**
**Job-Mix Formula**
**Volumetric Tolerance Requirements of the Laboratory Compacted Mix**

| **Property** | **Each Specimen** | **Multiple Specimens** |
|---|---|---|
| Air Voids at $N_{design}$ ($V_a$) | **(±2%)** | **(±1.5%)** |
| Minimum VMA % for 9.5 mm mixes | 15.0 | - |
| Minimum VMA % for 12.5 mm mixes | 14.0 | - |

| | | |
|---|---|---|
| Minimum VMA % for 19.0 mm mixes | 13.0 | - |
| Minimum VMA % for 25.0 mm mixes | 12.0 | - |
| Minimum VMA % for 37.5 mm mixes | 11.0 | - |

**1.e Corrective Actions.** Immediately take corrective actions if one or more of the following occurs:

- QC test results on a single sample (n=1) for percent passing the 2.36 mm (No. 8) sieve, the 75 µm (No. 200) sieve, or asphalt content are not within the tolerances in Table A.
- The average of multiple samples (n≥3) for percent passing any sieve or asphalt content, as determined according to Section 409.2(e)1.d, are not within the tolerances in Table A
- QC test results on each specimen or on multiple specimens are not within the tolerances in Table B.
- Independent assurance (IA) or QA sample results tested at the producer's plant are not within the tolerances of Tables A or B.

After taking corrective actions, sample the completed mixture within 140 tonnes (150 tons) of production. After sampling, test the mixture and provide test results to the Representative within 450 tonnes (500 tons) of production. If less than three samples are tested for mixture composition, determine conformance with Table A by comparing each result to the multiple sample tolerances. If the mixture does not conform to the single and multiple sample tolerances in Table A and the single and multiple specimen tolerances in Table B, suspend production and shipping to the project and determine the cause of the problem. Provide a written explanation of the problem and a proposed solution to the Department. After the Representative reviews the proposed solution and authorizes production to continue, resume production and perform JMF verification according to the QC Plan. During corrective actions and JMF verification, mixture acceptance is according to the approved acceptance level of Table C.

**2. Mixtures with RAM or 5% or More RAP.** Section 409.2(e)1 and as follows:

**2.a RAM and RAP SRL.** For HMA wearing courses, limit the total combination of RAM and RAP to a maximum of 15% of the mixture by mass (weight) unless documentation of the SRL designation of the coarse aggregate in the RAM and RAP materials is provided to the DME and the RAM and RAP meet the specified SRL or can be blended for SRL as specified in Section 409.2(b)1.

**2.b RAP Asphalt Content and Gradation.** Determine the average asphalt content and gradation of the RAP stockpile according to Bulletin 27. Determine the proportions of RAP, RAM, and virgin materials necessary to conform to the JMF requirements. Maintain and provide the Representative access to records of all sampling, testing, and calculations.

**(f) Mixture Acceptance.**

**1. General.** For standard construction, the Department will accept the mixture according to the appropriate level in Table C. For RPS construction, the Department will accept the mixtures by lot acceptance as specified in Section 409.3(h)2.

**TABLE C**
**Mixture Acceptance**

| Acceptance Level | Acceptance Method |
|---|---|
| Certification Acceptance | Producer Certification of Mixture (Section 409.2(f)2) |
| Lot Acceptance | Mixture Acceptance Sample Testing (Section 409.3(h)2) |

**2. Certification Acceptance.** Acceptance by certification is appropriate for the following mixtures, conditions, or applications:

- Scratch courses, leveling courses less than 50 mm (2 inch) depth and driveway adjustments.
- Mixtures used by Department maintenance forces.
- Mixtures purchased by local or municipal governments.
- Mixtures placed in quantities not exceeding 450 tonnes (500 tons) in a continuous placement operation unless otherwise directed by the Representative.
- Other mixtures, conditions, or applications as approved by the Representative.

**2.a General.** Obtain certification from the mixture producer. Use all QC tests during mixture production as acceptance tests. Certify mixtures using Form CS-4171 or another acceptable form. Include, or attach, the QC test results on the form. Provide the form to the Inspector-in-Charge within 1 working day after completing the QC tests. Certify mixtures as specified in Section 106.03(b)3 and the requirements below.

**2.b Certification of Mixture.** Certify each mixture daily if QC test results conform to the single sample and multiple sample JMF production tolerances of Table A. The acceptance values will be:

- Asphalt Content
- Percent Passing the 2.36 mm (No. 8) sieve
- Percent Passing the 75 µm (No. 200) sieve

If using printed ticket results in place of laboratory test results for asphalt content, certify that at least 90% of each day's printed ticket results for asphalt content are within 0.2 percentage points of the JMF.

If the mixture does not conform to the above requirements, do not certify the mixture. Instead, provide all QC test results to the Inspector-in-Charge. If using printed ticket results for asphalt content, provide the percentage of daily printed ticket results within 0.2 percentage points of the JMF to the Inspector-in-Charge. Payment will be determined according to Table H based on the QC test results.

If a day's production is interrupted by corrective action, material produced after the corrective action may be certified if QC test results conform to production tolerances.

**2.c Maintaining Approval to Certify Mixtures.** The Department may suspend a plant's approval to certify mixtures if QC is not performed according to the producer QC Plan, mixtures are not produced according to Bulletin 27, a mixture cannot be certified on 2 consecutive production days, or as described below.

The Department may take IA samples of the completed mixture at the plant. In the presence of the Department, test the IA samples for asphalt content and gradation according to the test methods indicated in the producer QC Plan. Take immediate corrective actions if the mixture does not conform to Table A.

The Department may take QA samples of the completed mixture at the plant or from directly behind the paver. The Department will test QA samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, for conformance to Table A. If the results of the QA samples do not comply with Table A, review the producer QC Plan and the QC test results that followed the QA samples for conformance to Table A. If QC results do not conform to Table A, perform the corrective actions necessary to provide a mixture conforming to Table A.

After completing corrective actions or the sample review, the Department will perform an on-site evaluation of the producer's plant operation and QC and then take a sample of the completed mixture at the plant. In the presence of the Representative, test the sample. If the sample does not comply with Table A, the Department will suspend certification. Immediately suspend shipping mixtures accepted by certification to the project.

After testing verifies that the produced mixture conforms to Tables A and B and with the Representative present, conduct JMF verification according to the producer QC Plan. After successfully completing JMF verification, resume both certification and shipping mixtures accepted by certification to the project.

**409.3 CONSTRUCTION—**

**(a) Paving Operation QC Plan.** Prepare a paving operation QC Plan, as outlined on Form CS-401, for field control and evaluation of bituminous concrete paving operations. Submit the QC Plan to the Representative before or at the pre-construction conference. The QC Plan shall describe the construction equipment and methods necessary to construct and test the bituminous concrete courses as specified in Section 409.3. Do not start paving until after the Representative reviews the QC Plan.

**(b) Weather Limitations.** Do not place bituminous paving mixtures from November 1 to March 31, unless allowed in writing by the District Executive. Do not place bituminous paving mixtures when surfaces are wet or when the air or surface temperature is 4 °C (40F) or lower. If work is halted because of weather conditions, the Representative may allow the Contractor to place limited quantities of mixture that are en route to the project.

**1. Wearing Courses.** Do not place wearing courses specified with design ESALs of 10 million or greater or wearing courses specified with PG 76-22 from October 1 to March 31 in Districts 1-0, 2-0, 3-0, 4-0, 5-0 (Monroe and Carbon Counties), 9-0 (Cambria and Somerset Counties), and 10-0; and from October 16 to March 31 in Districts 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0, and 12-0. No exceptions to paving weather limitations will be allowed, unless directed in writing by the District Executive.

**(c) Bituminous Mixing Plant.** Obtain bituminous mixtures from a plant fully automated and recordated and currently listed in Bulletin 41. The necessary facilities for inspection include a plant office as specified in Section 714.5(a), except the minimum floor space is 11.1 $m^2$ (120 square feet). For recycled mixtures, add the following requirements:

**1. Batch Plant.** Modify the batch plant to measure the mass (weight) of the RAP before adding it into the pug mill. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP from segregating and sticking. Dry the virgin aggregate and RAM and then heat the virgin aggregate and RAM to a temperature that, after adding RAP, produces a completed mixture within the temperatures specified in Table A for the class and type of material used. Ensure that virgin aggregate is free of unburned fuel oil when delivered to the pug mill.

**2. Drum Mixer Plant.** Modify the drum mixer plant to prevent RAP from directly contacting the burner flame and prevent RAP from overheating. Design the cold-feed bin(s), conveyor system(s), charging chute(s), and all special bins to prevent RAP from segregating and sticking. Produce a completed mixture within the temperatures specified in Table A for the class and type of material used.

**(d) Hauling Equipment.** Haul the mixtures in tightly sealed vehicles that do not contain petroleum oils, solvents, or other materials that adversely affect bituminous concrete. Provide covers of sufficient size and quality to protect the entire load under all conditions. Maintain the proper and uniform placement temperature specified in Section 409.3(h)1. Provide insulation on all sides of the truck body, a double-walled truck body, or a heated truck body when the air temperature is below 10 °C (50F) from October 1 to April 30.

**(e) Paving Equipment.**

**1. Material Transfer Vehicle (MTV)** Provide a Material Transfer Vehicle (MTV) as specified in Section 108.05(c)5.

**2. Bituminous Pavers.** Provide self-contained, power-propelled units with activated screeds or activated strike-off assemblies and with automatic screed controls, capable of producing a finished surface of specified evenness and texture. Provide heated units capable of spreading and finishing the mixture to the widths and depths indicated. Provide units capable of being operated at forward speeds consistent with satisfactory laying of the mixture, equipped with receiving hoppers having sufficient capacity for uniform spreading, and equipped with distribution systems that place the mixture uniformly in front of the screeds.

Use hydraulic or other extension types against abutting lanes or longitudinal joints only if the unit feeds and activates the extension by the same method as the main screed. At the outside edge of pavement widths that cannot be uniformly placed, the Contractor may use a non-activated extension when approved by the Inspector-in-Charge.

Do not use equipment that tears, shoves, or gouges the mixture or that causes tracks, indented areas, flushing, segregation, or other permanent blemishes. Do not use blade graders or drags.

**(f) Rollers.** Use steel-wheel, pneumatic-tire, or vibratory rollers as specified in Section 108.05(c)3. Operate rollers according to manufacturer's recommendations. Use vibratory rollers with separate controls for vibration and propulsion.

**(g) Preparation of Existing Surface.**

**1. Conditioning of Existing Surface.** Before delivering bituminous mixtures, remove and dispose of loose and foreign material and excess joint sealer and crack filler from the surface of existing pavement or previously placed pavement courses. If necessary, use a broom.

Before placing a wearing course, correct irregularities in the binder course. If practical, do not allow traffic on the binder course to prevent contamination. Remove and replace binder course that cannot be cleaned to the Representative's satisfaction.

Paint existing vertical surfaces of curbs, structures, gutters, and pavements that will be in contact with bituminous mixtures with a uniform coating of bituminous material, Class E-6 (AASHTO SS-1 or CSS-1), E-8 (AASHTO SS-1h or CSS-1h), Class AET applied in two or more applications, or of the class and type designated for the bituminous course.

Before overlaying existing surfaces, apply a tack coat as specified in Section 460 unless otherwise indicated. Apply a tack coat to previously placed courses if the Representative determines a tack coat is necessary to ensure bonding between the two courses.

**2. Scratch and Leveling Courses.** Where indicated, place a separate scratch or leveling course ahead of resurfacing operations. Use a scratch course to fill wheel ruts and other local small depressions even with the surrounding pavement. Use a leveling course to provide a relatively uniform working platform for placing binder or wearing courses.

**(h) Spreading and Finishing.**

**1. General Requirements.**

**1.a Placing.** Unless otherwise allowed, deliver, place, and compact bituminous paving mixtures during daylight hours. Ensure the mixture does not contain lumps of cold material. Deliver and place mixtures at the laying temperatures specified in Table A for the type and class of material used.

Use a Material Transfer Vehicle (MTV) on all paving projects where there is 4 500 tonnes (47 000 m²) (5,000 tons (56,000 square yards)) or more material per course on the route at one location. Use the MTV on mainline, shoulders, and ramps for all leveling, 25 mm base course, binder, and wearing courses except scratch courses. Any paving pass that is less than 150 m (500 feet) may be performed without the use of the MTV.

**1.b Spreading and Finishing.** Spread and strike off the mixture for the entire lane width or as much lane width as practical. Adjust screed assemblies to provide the required cross section and depth. After spreading, do not add mixture to the pavement mat that is segregated, below the minimum temperature, contains either a deficiency or an excess of asphalt content, or is otherwise unsuitable to add to the pavement mat.

If the course is more than 150 mm (6 inches) in compacted depth, construct it in two or more layers of approximately equal depth, with no layer less than 80 mm (3 inches) or more than 150 mm (6 inches) in compacted depth. For binder or leveling courses that have isolated areas exceeding 150 mm (6-inch) compacted depth, use a scratch or leveling course to eliminate the isolated areas before full-depth paving.

Immediately after placing the bituminous mixture, work the exposed outer edges to eliminate sharp, ragged, and open edges, to eliminate an unfinished appearance, and to reduce edge breakdown. Immediately repair edge breakdowns.

In areas where mechanical spreaders cannot be used, place and screed the mixture with suitable hand tools. Do not use rakes.

Adjacent to flush curbs, gutters, and other abutting structures, place the wearing course mixture uniformly higher so that after compaction the finished surface is slightly above the edge of the abutting structure. Remove harmful material, clean, and seal the surface of wearing courses adjacent to curbs to form a bituminous gutter. Seal the mixture surface with a hot bituminous material of the class and type listed in Table A. Evenly apply the bituminous material a minimum width of 300 mm (12 inches) from the curb. The Contractor may use Class AET, Class E-6 (AASHTO SS-1 or CSS-1), or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material if allowed by the Inspector-in-Charge. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint along the curb. If necessary, apply emulsified asphalt in two or more applications. After sealing, remove excess sealant material.

**1.c Field Technician.** Provide a certified HMA field technician, with the qualifications outlined in Publication 351, to control the placement of bituminous mixtures. Instruct and train the certified HMA field technician to control the paving operation so that the completed paving work complies with the specified requirements. A certified HMA field technician must be onsite and carry a valid certification card during placement of all HMA mixtures.

**2. Mixture Lot Acceptance (Standard and RPS Construction).** Lot acceptance is appropriate for standard construction placed in quantities that allow consistent operation of the plant and is appropriate for RPS construction.

**2.a Lots and Sublots.** Material will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot consists of five equal sublots (n=5). A completed sublot has a mixture acceptance box sample as specified in Section 409.3(h)2.b and either a core collected according to PTM No. 1 or other density acceptance as specified in Section 409.3(j).

A normal lot size is 2 250 tonnes (2,500 tons) with five 450 tonnes (500 tons) sublots (n=5), unless operational conditions or project size dictate otherwise. If operational conditions or project size dictate, readjustment of the lot will be made as specified in Table D. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reason to adjust the lot size. The original lot will be continued when work resumes after short stoppages of less than 5 days. If a lot is terminated due to a stoppage of 5 days or more, adjust the lot size and number of sublots as specified in Table D. If work stoppages exceed 5 days, a new lot will be established.

**TABLE D**
**Re-adjustment of Lot Size and Associated Number of Sublots**

| Remaining Quantity* Following Last Full Lot | Action |
|---|---|
| Less than 450 tonnes (500 tons) without a combination of one mixture acceptance sample and one core** | Quantity combined with the previous lot, (n=5) |
| Less than 450 tonnes (500 tons) with a combination of one mixture acceptance sample and one core** | One new sublot defined and quantity combined with the previous lot, (n=6) |
| 450 tonnes (500 tons) to less than 900 tonnes (1,000 tons) without a combination of two mixture acceptance samples and two cores** | One new sublot defined and quantity combined with the previous lot, (n=6) |
| 450 tonnes (500 tons) to less than 900 tonnes (1,000 tons) with a combination of two mixture acceptance samples and two cores** | Two new sublots defined and quantity combined with the previous lot, (n=7) |
| 900 tonnes (1,000 tons) to less than 1 350 tonnes (1,500 tons) without a combination of three mixture acceptance samples and three cores** | Two new sublots defined and quantity combined with the previous lot, (n=7) |
| 900 tonnes (1,000 tons) to less than 1 350 tonnes (1,500 tons) with a combination of three mixture acceptance samples and three cores** | New lot defined, (n=3) |
| 1 350 tonnes (1,500 tons) to less than 1 800 tonnes (2,000 tons) without a combination of four mixture | New lot defined, (n=3) |

| | |
|---|---|
| acceptance samples and four cores** | |
| 1 350 tonnes (1,500 tons) to less than 1 800 tonnes (2,000 tons) with a combination of four mixture acceptance samples and four cores** | New lot defined, (n=4) |
| 1 800 tonnes (2,000 tons) to less than 2 250 tonnes (2,500 tons) without a combination of five mixture acceptance samples and five cores** | New lot defined, (n=4) |
| 1 800 tonnes (2,000 tons) to less than 2 250 tonnes (2,500 tons) with a combination of five mixture acceptance samples and five cores** | New lot defined, (n=5) |
| *For contract items bid on an area basis, compute equivalent tons based on design depth of paving course and design density as specified in Section 110.04(b)4.a.<br><br>** If mat density is accepted using pavement cores. | |

**2.a.1 Partially Completed Lots (n=2 or less).** When process conditions change to an extent that a partially completed lot cannot be combined with the most recently completed lot, samples will be independently evaluated on the partially completed lot. For asphalt content and percent passing the 75 µm (No. 200) sieve, mixture acceptance samples will be evaluated individually using Section 409.2(e), Table A (n=1) criteria. For density, mat density acceptance samples will be evaluated individually using the criteria in Table E.

If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve meet the n=1 criteria of Table A, and samples tested for density meet the criteria in Table E, payment will be 100 percent of the contract unit price. If samples tested for asphalt content and percent passing the 75 µm (No. 200) sieve do not meet the n=1 criteria of Table A, the material will be considered defective work. If samples tested for density are no more than 2 percent below the minimum or no more than 2 percent above the maximum limits of Table E, payment will be 90 percent of the contract unit price. If samples for density are more than 2 percent below the minimum or more than 2 percent above the maximum limits of Table E, the pavement will be considered defective work.

Unless otherwise directed in writing by the District Executive, remove and replace defective work.

**TABLE E**
**Density Limits for Partially Completed Lots**

| MIXTURE NOMINAL MAXIMUM AGGREGATE SIZE | DENSITY LIMITS |
|---|---|
| All RPS 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses | ≥ 92 and ≤ 97 |
| All Standard 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing or Binder Courses | ≥ 90 and ≤ 97 |
| All 25 mm and 37.5 mm Base Courses | ≥ 88 and ≤ 97 |

**2.a.2 For JMF's placed in quantities less than 2 250 tonnes (2,500 tons).** For JMF's placed in quantities of greater than 450 tonnes (500 tons) and less than 2 250 tonnes (2,500 tons) the tonnage will be considered a lot. The lot will be divided into five equal sublots.

For JMF's placed in quantities of 450 tonnes (500 tons) or less in a critical application, the tonnage will be considered a lot. The lot will be divided into three equal sublots.

**2.b Mixture Acceptance Samples.** The Inspector will select different sample locations in each sublot according to PTM No. 1 and PTM No. 746. In the presence of the Inspector, take one loose sample for each sublot from directly behind the paver.

Identify the samples by lot and sublot number, location, date of placement, mixture type, and as acceptance samples (Sample Class AS). Immediately package individual samples in cardboard boxes dimensioned approximately 95 mm x 120 mm x 240 mm (3 3/4 inches by 4 3/4 inches by 9 1/2 inches). Place the individually packaged samples for one lot in one container or tie the individually packaged samples for one lot together and submit the samples to the Inspector.

**2.c Mixture Acceptance Sample Testing.** Utilize MTD Testing unless otherwise indicated in the proposal. These procedures apply to standard and RPS construction.

**2.c.1 MTD Testing.** The MTD will test the mixture acceptance samples according to PTM No. 757 or PTM No. 702, Modified Method D, if previously identified problematic aggregates are used in the mixture, to determine asphalt content and the percent passing the 75 µm (No. 200) sieve. The MTD will use the calibration factors ($C_f$ and 200 $C_f$) provided with the JMF for PTM No. 757. The MTD will analyze the test results for extreme values according to PTM No. 4 at the 5% significance level. If discarding an extreme value reduces a lot to less than three remaining test results, the Department will accept the lot as specified in Section 409.3(h)2.a.1. The Department will accept lots with three or more test results as specified in Section 409.4(a)4 or Section 409.4(b).

If the asphalt content or the percent passing the 75 µm (No. 200) sieve is not within the single sample (n=1) or multiple sample (n≥3) tolerances in Table A for two consecutive lots or a total of three lots, stop all production of the JMF. Determine the cause of the problem and provide a proposed solution to the Department.

Do not resume production of the JMF until the Representative reviews the proposed solution and authorizes production to continue.

**3. Pattern Segregation.** Pattern segregation is continuous or repeated areas of non-uniform distribution of coarse and fine aggregate particles in the finished mat. The Department will address pattern segregation as follows:

**3.a Evaluating Pattern Segregation.** If the Representative observes pattern segregation that may result in defective pavement, then:

- The Inspector will notify the Contractor of the observed pattern segregation.
- The Contractor may continue to work at his or her own risk while he or she immediately and continually adjusts the operation to eliminate the pattern segregation from future work.
- As a minimum and in the presence of the Representative, determine the average depth of pavement surface macrotexture according to PTM No. 751 in areas with the pattern segregation and in areas with non-segregated pavement. The pattern segregation is unacceptable if the difference in average pavement texture depth between the non-segregated and segregated areas exceeds 0.610 mm (0.024 inch). The Representative will determine if the pavement is defective as specified in Section 409.3(h)3.c.

**3.b Test Section.** If the macrotexture tests identify unacceptable pattern segregation, then:

- Immediately suspend placing the bituminous course. Evaluate the cause of pattern segregation according to the Paving Operation QC Plan and as directed. Provide proposed corrective actions to the Representative and do not resume placing the bituminous course until after the Representative reviews the proposed corrective actions and authorizes paving to continue.
- Determine if the pattern segregation resulted in defective pavement as specified in Section 409.3(h)3.c.

- After the Representative allows paving to resume, place a test section not to exceed 180 tonnes (200 tons). If the corrective actions do not eliminate observed pattern segregation, the Department will suspend paving, even if it is before the Contractor places the entire test section. Propose additional corrective actions, and construct another test section. Resume normal paving operations after constructing an entire test section without pattern segregation as determined by the Representative.

**3.c Defective Pavement.** At locations selected by the Inspector and with the Inspector present, drill a minimum of three 152 mm (6-inch) diameter cores from the area of pattern segregation and a minimum of three cores from the pavement representing a non-segregated area. Do not compress, bend, or distort samples during cutting and handling and immediately provide the cores to the Inspector. The Inspector will transport cores to the producer's laboratory. With the Inspector present, test the cores at the plant for density, asphalt content, and gradation. The Department may request additional tests as part of its evaluation of pattern segregation. Determine the maximum theoretical density according to Bulletin 27, the core density according to PTM No. 715, and asphalt content according to PTM No. 757 if previously identified problematic aggregates are used in the mixture, PTM No. 702 modified Method D, or other test method identified in the producer QC Plan.

An area of pattern segregation contains defective pavement if the summation of absolute deviations from any two sieves is 20% or more from the JMF, the core density is defective, the mixture is defective in asphalt content, or the mixture is defective for percent passing the 75 µm (No. 200) sieve. Remove and replace the full width of the affected lane and a minimum of 1.5 m (5 feet) beyond each end of the area with unacceptable pattern segregation. Construct replacement pavement conforming to the appropriate surface tolerances as specified in Section 309.3(l)12 or Section 409.3(l).

**(i) Compaction.** Compact the mixture to achieve the density acceptance requirements and to eliminate all roller marks. Compact the mixture while it is in proper condition and adjust roller speed, amplitude, frequency, pattern, and roller size to eliminate displacement, shoving, cracking, and aggregate breakage. Satisfactorily correct displacement resulting from reversing roller directions and other causes.

Without using excess water, maintain wheels of steel-wheel rollers moist and clean to prevent the mixture from adhering to the wheels. Use suitable methods to clean wheels of pneumatic-tire rollers.

Use pneumatic-tire rollers for compacting scratch courses.

For areas inaccessible to rollers, compact with mechanical vibrating hand tampers.

Remove areas that are loose, broken, mixed with dirt, or show an excess or deficiency of bituminous material. Replace removed mixture with fresh hot mixture and compact the mixture even with the surrounding pavement surface.

**(j) Mat Density Acceptance.**

**1. General.** The Department will accept the mat density of standard construction according to one of the levels in Table F. Areas may be accepted by non-movement or optimum-rolling pattern based on the criteria in Sections 409.3(j)2 and 409.3(j)3. Do not place mixtures for non-movement or optimum-rolling pattern acceptance until the Department has approved the density-acceptance level. For courses with mixture acceptance by certification, the density acceptance level will be either non-movement or optimum-rolling pattern.

The Department will accept the mat density of RPS construction by lots and pavement cores as specified in Section 409.3(j)4.

**TABLE F**
**Density Acceptance**

| Density Acceptance Level | Acceptance Criteria |
|---|---|
| Non-Movement | Table H |
| Optimum-Rolling Pattern | Table H |
| Pavement Cores* | Table I |
| * Use only when mixture acceptance is by lots. | |

**2. Non-Movement.** The Inspector-in-Charge will approve density acceptance by non-movement for the following materials, conditions, or applications:

- Scratch courses or leveling courses less than 30 mm (1-inch) in depth or equal to or less than 60 kg/m$^2$ (110 pounds per square yard).
- Areas of paving or patching less than 1.2 m (4 feet) in width or narrow enough to cause bridging of the area by approved compaction equipment.

The Inspector-in-Charge will accept density by non-movement for the following materials, conditions, or applications if they are determined by the Representative to be non-critical for density:

- Materials placed in small quantities not exceeding 450 tonnes (500 tons) in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.
- Mixtures used for patching, road widening, shoulders, driveway adjustments, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 409.3(j)4.a.

The Department will accept the density when the mixture does not move under the compaction equipment.

**3. Optimum-Rolling Pattern.** The Inspector-in-Charge may accept density using an optimum-rolling pattern for the following materials, conditions, or applications:

- Materials placed in small quantities not exceeding 450 tonnes (500 tons) in a continuous placement.
- Mixtures placed on unstable or non-uniform bases.
- Leveling courses or other courses that are greater than or equal to 30 mm (1-inch) in depth or greater than or equal to 60 kg/m$^2$ (110 pounds per square yard).
- Mixtures used for patching, road widening, driveway adjustments, shoulders where density is not critical, and other miscellaneous applications determined by the Representative. Shoulders where density is critical will be accepted by pavement cores as specified in Section 409.3(j)4.a
- Mixtures placed at less than the minimum compacted depths in Table G.

With the Inspector and the Contractor's certified HMA field technician present, determine density with an approved nuclear gauge according to PTM 402, or determine density with an approved electrical impedance gauge according to PTM No. 403. Nuclear gauges must be operated by a licensed nuclear gauge operator. In the presence of the Inspector, follow the control strip technique specified in PTM No. 402 to construct at least one control strip to establish the optimum-rolling pattern for each course. Document readings using the forms provided in PTM No. 402 and provide the completed forms to the Inspector. Compact the course according to the optimum-rolling pattern. During paving, the Representative may require the Contractor to construct a new control strip to verify the optimum-rolling pattern.

Use one of the following gauges or approved equal:

- Troxler Electronics, Model 3411B or Model 4640B
- Campbell Pacific Nuclear, Model MC-2
- Seaman Nuclear, Model MC-2

- TransTech Systems, Inc., PQI™, Model 300 or Model 301
- Troxler Electronic Laboratories, PaveTracker™

Submit a copy of the certificate of nuclear gauge annual calibration according to ASTM D 2950 and documentation of training of the nuclear gauge operator. Recalibrate any nuclear gauge that is damaged or repaired.

**4. Pavement Cores (Standard and RPS Construction).**

**4.a General.** Pavement cores are required for accepting the density of RPS construction. Pavement cores are appropriate for accepting the density of standard construction if all of the following materials, conditions, or applications exist:

- Mixture acceptance is by lots.
- Materials placed at compacted depths greater than or equal to the minimum depths specified in Table G.
- Materials placed on stable and uniform bases.

**TABLE G**
**Mixture Minimum Compacted Depths**

| Mixture | Minimum Depth |
|---|---|
| 9.5 mm Wearing Course | 40 mm (1 1/2 in.) |
| 12.5 mm Wearing Course | 40 mm (1 1/2 in.) |
| 19 mm Wearing and Binder Courses | 50 mm (2 in.) |
| 25 mm Binder Course | 80 mm (3 in.) |

**4.b Lots and Sublots.** Section 409.3(h)2.a.

**4.c Density Acceptance Samples.** The Inspector will select different sample locations in each sublot according to PTM No. 1, PTM No. 729, and PTM No. 746. With the Inspector present, drill 152 mm (6-inch) diameter cores as soon as possible but no later than the day following placement. Do not compress, bend, or distort samples during cutting, handling, transporting, and storing. If samples are damaged, immediately obtain replacement samples, as directed by the Inspector, from within 300 mm (12 inches) of the original sample location. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture.

Identify the samples by lot number, location, date of placement, mixture type, and as acceptance samples (Sample Class AS). Provide the daily theoretical maximum specific gravity value from Section 409.2(e)1.d.4 for the density calculation of the lot. If density samples from the lot are taken from more than 1 day's placement, the average of the daily theoretical maximum specific gravity values from the days the lot was placed will be used to calculate the density. Immediately package and deliver the samples to the Inspector according to the QC Plan. Use sample containers of sufficient strength to prevent samples from being damaged during transport. Submit samples for one lot in one container.

**4.d Acceptance Sample Testing.** These procedures apply to standard and RPS construction.

**4.d.1 MTD Acceptance Testing.** The MTD will test the density acceptance samples according to PTM No. 715, and if necessary PTM No. 716, to determine the percent compaction. The Department will determine acceptance, with respect to density, as specified in Section 409.4(a)4 or Section 409.4(b).

If cores are not taken within 1 day after placing the mixture, or if the density for two consecutive lots or for a total of three lots does not meet the density payment factor percentage of 100, stop paving operations for the project as directed. Review and evaluate the operation and determine the cause of the problem. Do not resume paving until after the Representative reviews the proposed solution and authorizes paving to continue.

**(k) Joints.**

**1. Longitudinal Joints.**

**1.a General.** Offset joints in a layer from the joint in the layer immediately below by approximately 150 mm (6 inches). Plan joint locations to ensure that the joint in the top layer is at the approximate pavement centerline for two-lane roadways and within 300 mm (12 inches) of the lane lines for roadways with more than two lanes.

Before placing abutting lanes, paint the entire area of the joint with a uniform coating of bituminous material, the PG-Binder used in the pavement course or PG 64-22 .Painting of the joint face is not required for scratch courses.

Place and compact the mixture at the joint according to the Paving Operation QC Plan. Ensure the surface across the joint is smooth and the surface along the joint is within the surface tolerances specified in Section 409.3(l).

If traffic or other cause distorts the lane edge, restore the lane edge to its original shape, using acceptable procedures.

**1.b Vertical Joints.**

- The Contractor may use vertical joints for base, binder, and wearing courses.
- If traffic or other cause distorts the lane edge, carefully saw a vertical lane edge before painting.
- Place the abutting lane on the same day, and if necessary, leave only short lane sections, normally less than 8 m (25 feet) in length, where the abutting lane is not placed the same day.

**1.c Notched Wedge Joints.**

- The Contractor may use notched wedge joints for wearing and binder courses with nominal maximum aggregate size mixtures of 19.0 mm or smaller.
- Remove and dispose of all loose and foreign material before opening the lane to traffic.
- Construct the joint according to Standard Drawing RC-28.
- If the joint is next to opposing traffic, place the abutting lane within 1 working day after placing the mixture. If the joint is next to traffic in the same direction, place the abutting lane within 2 working days after placing the mixture.
- If both lanes that make the joint are not placed on the same day, amend the Maintenance and Protection of Traffic Plan and install additional signing for uneven pavements at no additional cost to the Department. Install "Uneven Pavement" signs according to Publication 212, Publication 213, and MUTCD and 1 km (1/2-mile) before the notched wedge joint area and every 1 km (1/2-mile) within the uneven pavement area.

**2. Transverse Joints.** Construct joints perpendicular to the pavement centerline. The Contractor may saw transverse joints. If used, install bulkheads straight and perpendicular to the surface. If a bulkhead is not used and the roller moves over the rounded edge of new mixture, locate the joint a sufficient distance from the rounded edge to provide a true surface and cross section. Paint the joint face with a thin coating of bituminous material, the PG-Binder used in the pavement course or PG 64-22, before placing fresh mixture against the joint face. Painting of the joint face is not required for scratch courses. .

**3. Other Joints.** Where placing a wearing course abutting to existing pavement at locations such as paving notches, lane additions, or utility openings, seal the joint with hot bituminous material of the class and type designated for the wearing course. Evenly apply the sealant a minimum of 150 mm (6 inches) on both sides of the

joint. The Contractor may use a Class AET, Class E-6 (AASHTO SS-1 or CSS-1) or E-8 (AASHTO SS-1h or CSS-1h) emulsified asphalt instead of hot bituminous material. Before sealing, clean and remove harmful material from the area to be sealed. Control the application rate so residual asphalt completely fills surface voids and provides a watertight joint. If necessary, use two or more applications of emulsified asphalt. Remove excess bituminous material and immediately cover the sealed area with a light application of dry sand that is acceptable to the Representative.

**(l) Surface Tolerance.** Test the finished surface with a 3 m (10-foot) straightedge at areas the Representative determines may be deficient or irregular, and at transverse joints and paving notches. Hold the straightedge in contact with the surface and in successive positions parallel to the road centerline to check the entire width of the pavement. Advance along the pavement in stages of not more than one-half the length of the straightedge until the entire area is tested. The pavement is defective if irregularities are more than 5 mm (3/16 inch).

**(m) Tests for Depth: Binder and Wearing Courses.** Construct the pavement to the depth indicated and within the specified tolerances.

For courses with density acceptance by lots, the Inspector will measure the depth of each sublot according to PTM No. 737 using the density acceptance samples.

For courses with a designed course depth and density acceptance by non-movement or optimum rolling pattern, the Inspector will calculate the mass per square meter (weight per square yard) for verification of yield. If yield results indicate insufficient course depth, drill one 152 mm (6 inch) diameter core for each 450 tonnes (500 tons) of material placed to determine the extent of the deficient depth. Core locations will be determined using PTM No. 1. For courses with density acceptance by lots, the inspector will measure the depth of each sublot according to PTM No. 737 using density acceptance samples.

Pavement deficient in depth by more than 6 mm (1/4 inch) is defective work. Pavement deficient in depth by more than 3 mm (1/8 inch) in three or more adjacent core locations is defective work. The extent of the defective work is the entirety of all sublots represented by the adjacent deficient core samples. After the Inspector completes depth measurements, backfill, compact, and seal core holes with the mixture used to construct the course. Immediately start correcting courses or pavement that are deficient in depth at the core location and proceed longitudinally and transversely until the depth is within 6 mm (1/4 inch) of the design depth.

**(n) Protection of Courses.** Do not allow vehicular traffic or loads on newly compacted courses for 24 hours or until the course uniformly cools to a temperature of 60 ºC (140F) or less. Provide alternate routes as indicated or as directed. If both lanes that form a longitudinal joint are placed on the same day and public safety is not restricted, do not allow vehicular traffic or loads on the lanes until adequate stability and adhesion is obtained and the material has uniformly cooled to 60 ºC (140F) or less. Maintain the course, as specified in Sections 105.13, 107.15, and 901.

**(o) Defective Work.** As specified in Section 105.12 and as follows:

Department acceptance and QA testing shall not relieve the Contractor of responsibility for material or workmanship that the Representative determines is defective before the Department issues the acceptance certificate. Remove and replace or repair defective work as directed. The BOCM will review Representative determinations of defective material or workmanship.

Remove and replace pavement defective for pattern segregation as specified in Section 409.3(h)3, surface tolerance as specified in Section 409.3(l) or Section 309.3(l) and depth as specified in Section 409.3(m), or Section 309.3(m). Remove and replace pavement defective for percent within tolerance or Payment Factor Percentages as specified in Tables H and I.

## 409.4 MEASUREMENT AND PAYMENT—

**(a) Standard HMA Construction.**

**1. HMA Courses.**

**1.a Superpave Asphalt Mixture Design, HMA Wearing Course.** Square Meter (Square Yard) or Tonne (Ton)

**1.b Superpave Asphalt Mixture Design, HMA Wearing Course (Scratch).** Tonne (Ton)

**1.c Superpave Asphalt Mixture Design, HMA Wearing Course (Leveling).** Tonne (Ton)

**1.d Superpave Asphalt Mixture Design, HMA Binder Course.** Square Meter (Square Yard) or Tonne (Ton)

**1.e Superpave Asphalt Mixture Design, HMA Binder Course (Leveling).** Tonne (Ton)

**2. Bituminous Tack Coat.** Section 460.4.

**3. Mixture Acceptance by Certification and Density Acceptance by Non-Movement and Optimum-Rolling Pattern.** The Representative will pay at the contract unit price, adjusted according to Table H. The total payment factor percentage is the sum of adjustments for each test criterion subtracted from 100%. The adjustment for an individual test criterion is the payment factor percentage subtracted from 100%. The pavement will be considered defective if the payment factor for asphalt content, percent passing the 75 µm (No. 200) sieve, and percent passing the 2.36 mm (No. 8) sieve are all 85%.

**TABLE H**
**Contract Unit Price Adjustments - Mixture Acceptance by Certification**

| Mixture Nominal Maximum Aggregate Size | Test Criteria | Test Value | | Payment Factor Percentage |
|---|---|---|---|---|
| **Asphalt Content** | | | | |
| All sizes | Printed Tickets | At least 90% of Daily Printed Tickets Within 0.2% of JMF | | 100 |
| | | Less than 90% of Daily Printed Tickets Within 0.2% of JMF | | 85 |
| 19.0 mm and smaller | QC Sample Testing** | Single Sample (n=1) | Multiple Samples (n≥2) | |
| | | ±0.7% | ±0.5% | 100 |
| | | ±0.8% to 1.0% | ±0.6% | 85 |
| | | > ±1.0% | ≥ ±0.7% | * |
| 25.0 mm and larger | QC Sample Testing** | ±0.8% | ±0.6% | 100 |
| | | ±0.9% to ±1.2% | ±0.7% | 85 |
| | | > ±1.2% | ≥ ±0.8% | * |
| **Gradation** | | | | |
| | | Single Sample (n=1) | Multiple Samples (n≥2) | |
| All sizes | QC Sample Testing for % Passing 75 µm (No. 200) Sieve** | ±3.0% | ±2.1% | 100 |
| | | ±3.1% to ±4.0% | ±2.2% to ±2.7% | 85 |
| | | > ±4.0% | ≥ ±2.8% | * |
| All sizes | QC Sample Testing for % Passing 2.36 mm (No. 8) Sieve** | ±6% | ±4% | 100 |
| | | ±7% to ±8% | ±5% | 85 |
| | | > ±8% | ≥ ±6% | * |
| **Mat Density** | | | | |
| All sizes | Non-Movement | Section 409.3(j)2. | | 100 |
| | Optimum-Rolling Pattern | Section 409.3(j)3. | | 100 |

* Defective pavement. Remove and replace or, when permitted by the District Executive in writing, leave in place and the Department will pay 50% of the contract unit price.

** For these test criterion, the daily Payment Factor Percentage will be determined by the single sample test result from the daily QC sample. If more than one QC sample test result is available for a day, the Payment Factor Percentage will be determined based on the average of the results using multiple sample tolerances. If corrective action is taken, Payment Factor Percentages will be independently determined for material placed before and after the corrective action.

**4. Mixture Acceptance by Lot and Density Acceptance by Non-Movement, Optimum-Rolling Pattern, or Pavement Cores.** The Department will pay on a lot-by-lot basis at the contract unit price, adjusted for Payment Factor Percentages as specified in Table I. For the payment factor percentages based on percent within tolerance, the Department will determine the percent within tolerance according to Section 106.03(a)3, using the upper and lower specification limits in Table J.

**TABLE I**
**Contract Unit Price Adjustments - Mixture Acceptance by Lots**

| Mixture Nominal Maximum Aggregate Size | Test Criteria | Test Value | Payment Factor Percentage |
|---|---|---|---|
| **Asphalt Content** | | | |
| All sizes | Acceptance Sample Testing | All individual sublot acceptance sample test results for the lot are within the n=1 tolerances in Table A and the lot average is within the n≥3 tolerances in Table A* | 100 |
| | | Percent Within Tolerance if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances in Table A or the lot average is not within the n≥3 tolerances in Table A | Table K |
| **Gradation** | | | |
| All sizes | Acceptance Sample Testing for % Passing 75 µm (No. 200) Sieve | All individual sublot acceptance sample test results for the lot are within the n=1 tolerances in Table A and the lot average is within the n≥3 tolerances in Table A* | 100 |
| | | Percent Within Tolerance, if any individual sublot acceptance sample test result for the lot is not within the n=1 tolerances in Table A or the lot average is not within the n≥3 tolerances in Table A | Table K |
| **Mat Density** | | | |
| All sizes | Non-Movement | Section 409.3(j)2. | 100 |
| | Optimum-Rolling Pattern | Section 409.3(j)3. | 100 |
| All RPS 9.5 mm, 12.5 mm, 19 mm and 25 mm Wearing or Binder Courses | Acceptance Sample Testing of Pavement Cores | All individual sublot test results for the lot are ≥92% and <97% of maximum theoretical density | 100 |
| | | Percent Within Tolerance if any individual sublot test result for the lot is not ≥ 92% and < 97% of maximum theoretical density | Table K |
| All Standard 9.5 mm, 12.5 mm, 19 mm and 25 mm Wearing or Binder Courses | Acceptance Sample Testing of Pavement Cores | All individual sublot test results are ≥90% and <97% and the lot average is ≥92% and <97% of the maximum theoretical density | 100 |
| | | Percent Within Tolerance if any individual sublot test result is not ≥90% and <97% or if the lot average is not ≥92% and <97% of the maximum theoretical density | Table K |
| All 25 mm and 37.5 mm Base Courses | Acceptance Sample Testing of Pavement Cores | All individual sublot test results are ≥88% and <97% and the lot average is ≥90% and <97% of the maximum theoretical density | 100 |
| | | Percent Within Tolerance if any individual sublot test result is not ≥88% and <97% or if the lot average is not ≥90% and <97% of the maximum theoretical density | Table K |

* The Department may elect to randomly select and test only one sublot mixture acceptance sample from each lot to verify conformance to the specifications. If only one sublot mixture acceptance sample is tested, tighter tolerances than those in Table A will be used to verify conformance to the specifications for the entire lot. If the one sublot is within ±0.2% of the JMF for asphalt content and within ±1.0% of the JMF for percent passing the 75 µm (No. 200) sieve, the lot will be considered to conform with the specifications and the lot's payment factor percentage will be determined according to this table. If the one sublot fails to meet the tighter tolerances, all mixture acceptance samples from the lot will be tested to determine the payment factor percentage according to this table.

**TABLE J**
**Upper and Lower Specification Limits for Calculating Percent Within Tolerance**

| | **Testing Criteria** | |
|---|---|---|
| **Mixture Nominal Maximum Aggregate Size** | **Lower Specification Limit (L)** | **Upper Specification Limit (U)** |
| | **Asphalt Content from JMF Value, %** | |
| 9.5 mm, 12.5 mm, and 19 mm | -0.4 | +0.4 |
| 25 mm and 37.5 mm | -0.5 | +0.5 |
| | **Percent Passing the 75 µm (No. 200) sieve from JMF Value, %** | |
| All sizes | -2.0 | +2.0 |
| | **Mat Density*** | |
| 9.5 mm, 12.5 mm, 19 mm, and 25 mm Wearing and Binder Courses | 0.91T | 0.98T |
| 25 mm and 37.5 mm Base Courses | 0.88T | 0.98T |
| * Where T = Current Maximum Theoretical Density, kg/m3 (lbs./cu. ft.) | | |

**TABLE K**
**Payment Factor Based on Percent Within Tolerance**

| Percent Within Tolerance | Payment Factor Percentage |
|---|---|
| 99 | 97 |
| 98 | 97 |
| 97 | 97 |
| 96 | 96 |
| 95 | 96 |
| 94 | 96 |
| 93 | 95 |
| 92 | 95 |
| 91 | 95 |
| 90 | 95 |
| 89 | 93 |
| 88 | 91 |
| 87 | 90 |
| 86 | 88 |
| 85 | 86 |
| 84 | 84 |
| 83 | 83 |
| 82 | 81 |
| 81 | 79 |
| 80 | 78 |
| 79 | 76 |
| 78 | 74 |
| 77 | 72 |
| 76 | 71 |
| 75 | 69 |
| 74 | 67 |
| 73 | 66 |
| 72 | 64 |
| 71 | 62 |
| 70 | 60 |
| 69 | 59 |
| 68 | 57 |
| 67 | 55 |
| 66 | 54 |
| 65 | 52 |
| 64 | 50 |
| Less than 64 | Defective Lot** |

**Remove and replace the lot. If only one lot characteristic has a percent within tolerance less than 64, the District Executive, with the concurrence of the Chief Engineer, may allow the Contractor to leave the defective lot in place. The Department will pay for the defective lot at 50% of the contract unit price.

**4.a Payment.** The Representative will compute the percent of the contract unit price paid as follows:

Lot Payment = $C_P(2P_D + P_B + P_A)/400$

$C_P$ = Contract unit price per lot (unit price times lot quantity)

$P_D$ = Payment Factor Percentage for density

$P_B$ = Payment Factor Percentage for asphalt content.

$P_A$ = Payment Factor Percentage for percent passing the 75 µm (No. 200) sieve

**4.b Retesting.** For mixture acceptance testing or density acceptance testing performed by the MTD, the Contractor may request in writing that the Department retest a lot if the initial test results indicated a defective lot (remove and replace). Provide written retest requests to the District Executive within 3 weeks of the date the MTD test results are released. Retests will not be allowed if a written retest request is not received within 3 weeks of the date the MTD test results are released. Provide quality control test results and control charts, companion sample test results (if available), test data trend evaluation, and any other pertinent information to justify the retest request. The Department will evaluate the information and may allow retesting if the information submitted provides a reasonable basis to conclude that the failing test results may not represent the in-place material. The MTD will perform the retest with the Contractor present, unless otherwise agreed to in writing with the Contractor.

For retesting of materials failing for asphalt content or percent passing 75 µm (No. 200) sieve, the Inspector will identify the locations where the original box samples were collected. The Inspector will select retest sample locations 610 mm (24 inches) from the original sample locations longitudinally in the direction of traffic. If the 610 mm (24 inch) offset causes the retest sample location to fall outside of the sublot, the Inspector will select the retest sample location 610 mm (24 inches) from the original sample locations longitudinally in the opposite direction from traffic.

With the Inspector present, provide appropriate traffic control and drill 152 mm (6-inch) diameter cores for retesting purposes. Within 24 hours after coring, backfill the hole with mixture of the same JMF or with mixture used for subsequent courses and compact and seal the mixture. Provide traffic control, core, and backfill the core holes at no cost to the Department. The test method used for asphalt determination during the original acceptance testing (PTM No. 757 or PTM No. 702) will be used for the retest, unless the (DME/DMM) grants written approval for a change in test method. The cores will be rinsed with water before testing. The results of the retest cores will be used to calculate payment for both asphalt content and percent passing the 75 µm (No. 200) sieve for the lot.

For retesting of density acceptance, the original cores will be utilized. The MTD will not retest cores coated with paraffin wax as a result of PTM No. 716.

The Department will deduct from the payment the cost per lot associated with conducting a retest as follows:

| Test | Retest Cost if Results Indicate<br><br>100% Pay Factor(s) | Retest Cost if Results Do Not Indicate<br><br>100% Pay Factor(s) |
|---|---|---|
| PTM No. 702/739 | $900 | $3,500 |
| PTM No. 715 | $200 | $750 |
| PTM No. 757 | $500 | $2,000 |

**(b) HMA RPS Construction.** Square Meter (Square Yard) or Tonne (Ton)

**1. Mixture Acceptance by Lot and Density Acceptance by Pavement Cores.** Section 409.4(a)4, except for RPS, the Department will determine mat density by pavement cores only.

# SECTION 420—BITUMINOUS WEARING COURSE ID-2 (STANDARD), BITUMINOUS WEARING COURSE ID-2 (HEAVY DUTY), BITUMINOUS WEARING COURSE ID-2, RPS (STANDARD), AND BITUMINOUS WEARING COURSE ID-2, RPS (HEAVY DUTY)

**420.1 DESCRIPTION**—This work is construction of plant-mixed bituminous concrete on a prepared surface.

**420.2 MATERIAL**—Section 401.2 and as follows:

**(a) Bituminous Material.**

**1. All Virgin Material Mix or Recycled Mix Containing 5% to 15% RAP.**

- Asphalt Cement, Class PG 64-22—Section 702.
- Asphalt Cement, Class PG 58-28 may be used instead of PG 64-22 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5-0 (Monroe, Carbon and Schuylkill counties only) for standard bituminous mixtures.

**(b) Aggregates.**

**1. Fine Aggregate.** Section 703.1. When combined with coarse aggregate, provide a gradation as specified in Section 401, Table A.

**2. Coarse Aggregate, Type A.** Provide combined gradation with fine aggregate as specified in Section 401, Table A.

**(c) Filler.** Section 703.1(c)1. Do not use flyash in the heavy-duty bituminous mixtures.

**(d) Mixture Composition.**

**1. Standard Bituminous Mixtures.**

**1.a Virgin Material Mix (Standard Construction).** Section 401.2(e)1

**1.b Virgin Material Mix (RPS Construction).** Section 401.2(e)

**2. Heavy Duty Bituminous Mixtures.** Section 401.2(e), except as revised below.
Add the following JMF requirements and production limits:

- Provide a fines (minus 75 µm (No. 200) sieve) to asphalt content ratio (F/A) between 0.6 and 1.2 in the JMF and between 0.6 and 1.35 during production.
- Compact Marshall specimens with 75 blows on each side.

Revise the following JMF requirements and production limits:

- Stability at 60 °C (140F), with a 100 mm (4-inch) test specimen, not less than 8900 N (2,000 pounds) for the JMF, and not less than 8000 N (1,800 pounds) during production.
- Flow value of not less than 6 or more than 16 with a 100 mm (4-inch) test specimen for the JMF and production limit.

- Percentage of unfilled voids to be 4.0% for the JMF and maintain 90% of the void test results within a range of 3% to 6% during production.

- Provide a minimum percent VMA (Voids in Mineral Aggregate) of 16.0 for the JMF and a minimum of 15.0% for 90% of the VMA test results during production.

**420.3 CONSTRUCTION—**

**(a) Standard Bituminous Mixtures.**

**1. Virgin Material Mix (Standard Construction).** Section 401.3

**2. RPS Construction.** Section 409.3

**3. Recycled Material Mix Containing 5% or More RAP.** Section 401.3

**(b) Weather Limitations.** Section 401.3(b). For heavy-duty bituminous mixtures, replace the paving time period limitations from November 1 and March 31 with the following:

Do not place wearing course from October 1 to March 31 in Districts 1-0, 2-0, 3-0, 4-0, 5-0 (Monroe and Carbon Counties only), 9-0 (Cambria and Somerset Counties), and 10-0; and from October 16 to March 31 in Districts 5-0 (except Monroe and Carbon Counties), 6-0, 8-0, 9-0 (except Cambria and Somerset Counties), 11-0, and 12-0. No exceptions to paving weather limitations will be allowed, unless directed in writing by the District Executive.

**(h) Spreading and Finishing.** Section 401.3(h). Add the following:

If underlying courses develop deficiencies, make corrections to the satisfaction of the Representative before placing the wearing course.

Place only one layer of the wearing course per day.

If the roadway is subjected to high temperatures and channelized traffic, do not place the wearing course until after completing all binder courses.

**420.4 MEASUREMENT AND PAYMENT—**

**(a) Bituminous Wearing Course ID-2 (Standard).** Square Meter (Square Yard) or Tonne (Ton)

**(b) Bituminous Wearing Course ID-2 (Heavy Duty).** Square Meter (Square Yard) or Tonne (Ton)

**(c) Scratch Course (Standard).** Tonne (Ton)

**(d) Scratch Course (Heavy Duty).** Tonne (Ton)

**(e) Leveling Course (Standard).** Tonne (Ton)

**(f) Leveling Course (Heavy Duty).** Tonne (Ton)

**(g) Bituminous Wearing Course ID-2, RPS (Standard).** Tonne (Ton)

**(h) Bituminous Wearing Course ID-2, RPS (Heavy Duty).** Tonne (Ton)

# SECTION 421—BITUMINOUS BINDER COURSE ID-2 (STANDARD), BITUMINOUS BINDER COURSE ID-2 (HEAVY DUTY), BITUMINOUS BINDER COURSE ID-2, RPS (STANDARD), AND BITUMINOUS BINDER COURSE ID-2, RPS (HEAVY DUTY)

**421.1 DESCRIPTION**—This work is construction of a binder course of plant-mixed bituminous concrete on a prepared surface.

**421.2 MATERIAL**—Section 420.2 with the following modifications:

**(d) Mixture Composition.**

**2. Heavy Duty Bituminous Mixtures.** Revised as follows:
Delete criteria for fines to asphalt content ratio and revise the JMF requirements and production limits as follows:

- JMF stability, at 60 °C (140F), not less than 8900 N (2,000 pounds) with a 100 mm (4-inch) test specimen, or not less than 20 000 N (4,500 pounds) with a 150 mm (6-inch) test specimen. Plant mixture stability, at 60 °C (140F), not less than 8000 N (1,800 pounds) with a 100 mm (4-inch) specimen, or not less than 18 000 N (4,000 pounds) with a 150 mm (6-inch) specimen.

- JMF flow value from 6 to 16 with a 100 mm (4-inch) test specimen, or from 9 to 24 with a 150 mm (6-inch) test specimen.

- JMF voids from 4.0% to 4.5%. Plant mixture voids from 3.5% to 6.5% for all plant compacted Marshall specimens.

- Minimum JMF percent VMA (Voids in Mineral Aggregate) of 13 and a minimum plant mixture VMA of 12.

**421.3 CONSTRUCTION**—Section 420.3

**421.4 MEASUREMENT AND PAYMENT**—

**(a) Bituminous Binder Course ID-2 (Standard).** Square Meter (Square Yard) or Tonne (Ton)

**(b) Bituminous Binder Course ID-2 (Heavy Duty).** Square Meter (Square Yard) or Tonne (Ton)

**(c) Leveling Course (Standard).** Tonne (Ton)

**(d) Leveling Course (Heavy Duty).** Tonne (Ton)

**(e) Bituminous Binder Course ID-2, RPS (Standard).** Square Meter (Square Yard) or Tonne (Ton)

**(f) Bituminous Binder Course ID-2 RPS (Heavy Duty).** Square Meter (Square Yard) or Tonne (Ton)

# SECTION 422—BITUMINOUS WEARING COURSE FJ-1 AND BITUMINOUS WEARING COURSE FJ-1C

**422.1 DESCRIPTION**—This work is construction of a wearing course of plant-mixed bituminous concrete on a prepared surface.

**422.2 MATERIAL**—Section 401.2 and as follows:

**(a) Bituminous Material.**

- Asphalt Cement, Class PG 64-22.
- The Contractor may use Asphalt Cement, Class PG 58-28 instead of PG 64-22 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5.0 (Monroe, Carbon, and Schuylkill counties only).

**(b) Fine Aggregate.** Section 703.1

**(c) Filler.** Section 703.1(c)1

**(d) Mixture Composition.** Section 401.2(e), except revise the following JMF and production limits:

- JMF and production stability of at least 4400 N (1,000 pounds) at 60 °C (140F).
- JMF unfilled voids from 3% to 6%. Production limit for voids of ±2 percentage points of the JMF voids and within the master range of 2.0% to 7.0%.

**422.3 CONSTRUCTION**—Section 401.3, except as follows:

**(b) Weather Limitations.** Revise as follows:
Do not place wearing course from September 15 to May 15 in Districts 1-0, 2-0 (except Juniata and Mifflin counties), 3-0, 4-0, 5-0 (Monroe and Carbon counties only), and 10-0; and from October 1 to May 1 in Districts 2-0 (Juniata and Mifflin counties only), 5-0 (except Monroe and Carbon counties), 6-0, 8-0, 9-0, 11-0, and 12-0. Exceptions to paving weather limitations require the written approval of the District Executive.

**(c) Bituminous Mixing Plant.**

**1. Plant Requirements.** The Contractor may produce the mixture using one bin. If the Contractor chooses to use more than one bin, combine the aggregate according to the JMF.

**422.4 MEASUREMENT AND PAYMENT—**

**(a) Bituminous Wearing Course FJ-1 or Bituminous Wearing Course FJ-1C.** Square Meter (Square Yard) or Tonne (Ton)

**(b) Scratch or Leveling Courses.** Tonne (Ton)

# SECTION 424—BITUMINOUS WEARING COURSE ID-3 (STANDARD), BITUMINOUS WEARING COURSE ID-3 (HEAVY DUTY), BITUMINOUS WEARING COURSE ID-3, RPS (STANDARD), AND BITUMINOUS WEARING COURSE ID-3, RPS (HEAVY DUTY)

**424.1 DESCRIPTION**—This work is construction of a wearing course of plant-mixed bituminous concrete on a prepared surface.

**424.2 MATERIAL**—Section 420.2 with the following modifications:

**(d) Mixture Composition.**

**1. Standard Bituminous Mixtures.** Section 401.2(e), except provide a minimum percent VMA (Voids in Mineral Aggregate) of 13.

**2. Heavy Duty Bituminous Mixtures.** Section 401.2(e), except revise the VMA requirements of ID-2 courses as follows:

Provide a minimum JMF percent VMA of 14 and a minimum plant mixture percent VMA of 13.

**424.3 CONSTRUCTION**—Section 420.3

**424.4 MEASUREMENT AND PAYMENT—**

**(a) Bituminous Wearing Course ID-3 (Standard).** Square Meter (Square Yard) or Tonne (Ton)

**(b) Bituminous Wearing Course ID-3 (Heavy Duty).** Square Meter (Square Yard) or Tonne (Ton)

**(c) Leveling Course (Standard).** Tonne (Ton)

**(d) Leveling Course (Heavy Duty).** Tonne (Ton)

**(e) Bituminous Wearing Course ID-3, RPS (Standard).** Square Meter (Square Yard) or Tonne (Ton)

**(f) Bituminous Wearing Course ID-3, RPS (Heavy Duty).** Square Meter (Square Yard) or Tonne (Ton)

# SECTION 430—BITUMINOUS WEARING COURSE FB-2

**430.1 DESCRIPTION**—This work is construction of a wearing course of plant-mixed bituminous concrete on a prepared surface.

**430.2 MATERIAL**—Section 401.2, with the following modifications:

**(a) Bituminous Material.** One of the following, at the mixing temperatures shown:

| Class of Material | Type of Material | Mixing Temperature °C (F) Minimum | Maximum |
|---|---|---|---|
| PG 64-22 | Asphalt Cement | 115 (240) | 150 (300) |
| PG 58-28 | Asphalt Cement | 115 (240) | 150 (300) |
| PG 52-28 | Asphalt Cement | 115 (240) | 150 (300) |
| PG 46-40 | Asphalt Cement | 115 (240) | 150 (300) |
| MS-2(E-4) | Emulsified Asphalt | 40 (100) | 70 (160) |
| CMS-2(E-5) | Cationic Emulsified Asphalt | 40 (100) | 70 (160) |
| SS-1(E-6A) | Emulsified Asphalt | 20 (70) | 65 (150) |
| CSS-1(E-6C) | Cationic Emulsified Asphalt | 20 (70) | 65 (150) |
| HFMS-2h(E-11-60) | High-Float Emulsified Asphalt | 60 (140) | 80 (175) |
| HFMS-2(E-11-90) | High-Float Emulsified Asphalt | 60 (140) | 80 (175) |
| HFMS-2S(E-11-150) | High-Float Emulsified Asphalt | 60 (140) | 80 (175) |

**(b) Aggregate.**

- Fine Aggregate—Section 703.1
- Coarse Aggregate, Type A—Section 703.2

**(e) Mixture Composition.** Add the following:

When asphalt cement is used, provide a completed bituminous mixture ranging in temperature from 90 °C to 120 °C (200F to 250F).

**430.3 CONSTRUCTION**—Section 401.3, except as follows:

**(c) Bituminous Mixing Plant.**Equipment for developing the design and control tests according to the Department's modified Marshall method is not required.

Use dry aggregate with all bituminous materials except the Contractor may use damp aggregate with emulsified asphalt. Add 6% to 12% by mass (weight) fine aggregate to the mixture as directed. Use dry-heated course aggregate with asphalt cement. For other bituminous materials requiring dry aggregate, dry the aggregate at a temperature not exceeding 43 °C (110F).Heat the bituminous material to the temperatures specified in Section 430.2.

Add the aggregate and bituminous material to the mixer. Mix the aggregate and bituminous material until the aggregate is thoroughly coated with a film of bituminous material sufficient to provide the required binding properties. Bulletin 27 requirements for mixing time and determining the percentage of aggregate coated do not apply to mixture preparation.

**(e) Bituminous Pavers.** The requirement for a heated unit does not apply to emulsified asphalt bituminous materials.

**(g) Preparation of Existing Surface.** Tack coat requirements apply only when designated in the contract.

**(h) Spreading and Finishing.** When using emulsified asphalt, spread the mixture without stripping the asphalt from the aggregate. Do not place the wearing course until the binder course is satisfactorily cured and at least 24 hours after placing the binder course. When using asphalt cement instead of emulsified asphalt, the 24-hour requirement is waived.

**(i) Compaction.** After uniformly spreading the mixture, allow the mixture to cure until the surface becomes tacky. Compact the mixture using a power roller to a firm, even surface that does not move under the compaction equipment. Intermediate rolling with a pneumatic-tire roller is not required.

**(j) Mat Density Acceptance.** The Representative will accept density when the mixture does not move under the compaction equipment.

**(o) Defective Work.** Revise to read:

Unless otherwise directed in writing by the District Executive, remove and replace pavement deficient in surface tolerance or depth as specified in Section 401.3 or defective in residual asphalt content as specified in Section 401.2.

**430.4 MEASUREMENT AND PAYMENT—**

**(a) Bituminous Wearing Course FB-2.** Square Meter (Square Yard) or Tonne (Ton)

**(b) Scratch Course.** Tonne (Ton)

**(c) Leveling Course.** Tonne (Ton)

# SECTION 431—BITUMINOUS BINDER COURSE FB-2

**431.1 DESCRIPTION**—This work is construction of a binder course of plant-mixed bituminous concrete on a prepared surface.

**431.2 MATERIAL**—Section 430.2

**431.3 CONSTRUCTION**—Section 430.3, except:

**(b) Bituminous Mixing Plant.**

**1. Plant Requirements.** In addition, use one bin and two bins.

**431.4 MEASUREMENT AND PAYMENT**—

**(a) Bituminous Binder Course FB-2.** Square Meter (Square Yard) or Tonne (Ton)

**(b) Scratch Course.** Tonne (Ton)

**(c) Leveling Course.** Tonne (Ton)

# SECTION 439—BITUMINOUS WEARING COURSE FB-1

**439.1 DESCRIPTION**—This work is construction of a wearing course of plant-mixed bituminous concrete on a prepared surface.

**439.2 MATERIAL**—Section 401.2 and as follows:

**(a) Bituminous Material.** Section 430.2(a), except exclude PG 64-22 and PG 58-28 asphalt cement.

**(b) Aggregate.**

- Fine Aggregate—Section 703.1, Type B, for surface finish only.
- Coarse Aggregate, Type A—Section 703.2

**(c) Mixture Composition.** Determine the optimum emulsion content using PTM No. 750.

**439.3 CONSTRUCTION—**Section 401.3, except as follows:

**(c) Bituminous Mixing Plant.**

**1. Plant Requirements.** Plants do not require equipment for developing the design and control tests according to the Department's modified Marshall method.

Use a synchronized, volume-proportioning, mobile plant; a stabilization plant; or a stationary plant conforming to the following requirements:

- Mobile plant—Equipped to mix, spread, and strike off surface.
- All plants—Aggregate bins and bituminous tank of sufficient capacity to provide a constant supply and proper proportioning of materials. Provide heating facilities when required to heat aggregate or bituminous materials.
- All plants—Capable of mixing materials to obtain a uniform coating of particles and a thorough distribution of bituminous material throughout the aggregate.
- All plants—Positive-driven feed to proportion coarse aggregate from bins and a positive pump to proportion bituminous material coming from the tank.
- All plants—Feeder and pump, synchronized to discharge coarse aggregate and bituminous material in desired proportions for mixing that are calibrated immediately before mixture production.

**2. Preparation of Mixture.**

**2.a Aggregates**. Dry the aggregate as necessary at a temperature not to exceed 66 °C (150F), except when using PG 46-40 or PG 52-28 asphalt cements. The Contractor may use damp aggregates with emulsified asphalt.

**2.b Bituminous Material.** Heat the bituminous material to the temperature specified in Section 430.2.

**2.c Mixing.** Add the required quantities of aggregate and bituminous material to the mixer. Mix the aggregate and bituminous material until uniformly coating the aggregate with a film of adequate thickness to

provide the required binding properties. Bulletin 27 requirements for mixing and determining the percentage of the aggregate coated do not apply to the mixture.

**(d) Hauling Equipment.** These requirements do not apply when using a mobile plant.

**(e) Bituminous Pavers.** These requirements do not apply when using a mobile plant. The requirement for a heated unit does not apply if the bituminous material is an emulsified asphalt.

**(g) Preparation of Existing Surface.** Tack coat requirements apply only when designated in the contract.

**(h) Spreading and Finishing.** When spreading courses using emulsified asphalt, do not strip asphalt from the aggregate. Unless the mixture contains PG 46-40 or PG 52-28, do not place the wearing course until the binder course is satisfactorily cured and at least 24 hours after placing the binder course To spread the mixture to the loose depth required to obtain the required compacted depth, the Contractor may use the mobile plant that produced the mixture. After uniformly spreading the mixture, allow the mixture to cure as specified in Section 439.3(g) or until the surface becomes tacky. Using a power roller, compact the mixture to a firm, even surface that does not move under the compaction equipment. Intermediate rolling with a pneumatic-tire roller is not required.

**(j) Mat Density Acceptance.** The Representative will accept density when the mixture does not move under compaction equipment.

**(l) Surface Tolerance.** After complying with the surface tolerance requirements specified in Section 401.3, while the surface is still tacky, and before opening to traffic, uniformly spread a layer of fine aggregate on the surface at a rate of 1.6 kg/m$^2$ to 2.7 kg/m$^2$ (3 pounds per square yard to 5 pounds per square yard). Sweep and roll the surface before opening to traffic.

**(o) Defective Work.** Revise to read:
Unless otherwise directed in writing by the District Executive, remove and replace pavement deficient in surface tolerance or depth as specified in Section 401.3 or defective in residual asphalt content as specified in Section 401.2.

## 439.4 MEASUREMENT AND PAYMENT—

**(a) Bituminous Wearing Course FB-1.**

**1. Area Basis.** Square Meter (Square Yard)

**2. Mass (Weight) Basis.** Tonne (Ton)

**3. Material Used Basis.**

**3.a Aggregate.** Square Meter (Square Yard) or Tonne (Ton)

**3.b Bituminous Material.** Liter (Gallon)

**(b) Scratch Course.**

**1. Mass (Weight) Basis.** Tonne (Ton)

**2. Material Used Basis.**

**2.a Aggregate.** Tonne (Ton)

**2.b Bituminous Material.** Liter (Gallon)

**(c) Leveling Course.** Section 439.4(b)

# SECTION 440—BITUMINOUS BINDER COURSE FB-1

**440.1 DESCRIPTION**—This work is construction of a binder course of plant-mixed bituminous concrete on a prepared surface.

**440.2 MATERIAL**—Section 439.2

**440.3 CONSTRUCTION**—Section 439.3, except conform to the surface tolerances specified in Section 401.3(l).

**440.4 MEASUREMENT AND PAYMENT—**

**(a) Bituminous Binder Course FB-1.**

**1. Area Basis.** Square Meter (Square Yard)

**2. Mass (Weight) Basis.** Tonne (Ton)

**3. Material Used Basis.**

**3.a Aggregate.** Square Meter (Square Yard) or Tonne (Ton)

**3.b Bituminous Material.** Liter (Gallon)

**(b) Scratch Course.**

**1. Mass (Weight) Basis.** Tonne (Ton)

**2. Material Used Basis.**

**2.a Aggregate.** Tonne (Ton)

**2.b Bituminous Material.** Liter (Gallon)

**(c) Leveling Course.** Section 440.4(b)

# SECTION 460—BITUMINOUS TACK COAT

**460.1 DESCRIPTION**—This work is the conditioning and treating of an existing surface with an application of bituminous bonding material.

**460.2 MATERIAL—**

**(a) Bituminous Material.** Emulsified Asphalt, Class AE-T, Section 702. Submit a certificate to the Representative indicating the asphalt residue content of the material being used.

**(b) Fine Aggregate (For Blotting).** Section 703.1

**460.3 CONSTRUCTION—**

**(a) Conditioning Existing Surface.** Section 401.3(g), except delete bituminous painting of existing surfaces.

**(b) Application of Bituminous Material.** Use a distributor designed, equipped, calibrated, maintained, and operated to uniformly apply material on surfaces with varying widths and up to 4.6 m (15 feet) wide. Provide a distributor capable of maintaining a uniform distributing pressure and controlling the application rate within a tolerance of 0.09 L/m$^2$ (0.02 gallon per square yard). Provide a distributor equipped with a tachometer, pressure gauges, accurate volume-measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power-operated pump, and full circulation spray bars with lateral and vertical adjustments.

The Contractor may use hand-spraying equipment in areas inaccessible to the distributor.

Determine the distributor's application rate in the field according to PTM No. 747.

Apply emulsified asphalt tack coat, at a rate approved by the Representative, to leave a uniform asphalt residue from 0.09L/m$^2$ (0.02 gallon per square yard) to 0.32 L/m$^2$ (0.07 gallon per square yard) on the treated surface, as directed. Obtain approval of the application rate. Apply the tack coat only when the air temperature is 4 °C (40F) and rising and when the existing surface is dry. Uniformly distribute the tack coat over the surface and as directed.

Uniformly distribute the tack coat at the junction of adjacent applications.

Correct all uncoated or lightly coated areas to the Representative's satisfaction. At designated locations, correct areas with an excess of bituminous material by covering the area with sufficient dry fine aggregate to blot up or remove excess tack coat.

Allow the tack coat to cure, without being disturbed, until the Inspector-in-Charge determines the water has completely separated and evaporated.

**(c) Protection of Treated Surface.** Maintain and protect the treated surface against damage. Repair damaged areas to the Representative's satisfaction before placing succeeding construction.

**460.4 MEASUREMENT AND PAYMENT—**

**(a) Area Basis.** Square Meter (Square Yard)

**(b) Material Used Basis.** Liter (Gallon)

# SECTION 461—BITUMINOUS PRIME COAT

**461.1 DESCRIPTION**—This work is the conditioning and treating of an absorbent non-bituminous base course or an absorbent existing surface with an application of bituminous material and, if required, a blotter material.

**461.2 MATERIAL—**

**(a) Bituminous Material.** One of the following, as specified in Section 702:

| Class of Material | Type of Material | Application Temperature °C (F) Minimum | Maximum |
|---|---|---|---|
| MC-30 | Cut-back Petroleum Asphalt | 20 (70) | 50 (120) |
| MC-70 | Cut-back Petroleum Asphalt | 40 (100) | 65 (150) |
| AE-P | Emulsified Asphalt | 30 (90) | 65 (150) |
| E-1 Prime | Emulsified Asphalt | 38 (100) | 77 (170) |

**(b) Fine Aggregate (for Blotting).** Section 703.1

**461.3 CONSTRUCTION—**

**(a) Conditioning Existing Surface.** Section 401.3(g), except delete bituminous painting of existing surfaces and the application of a tack coat.

**(b) Application of Bituminous Material.** Use a distributor as specified in Section 460.3(b). Within the specified temperature range, select application rates for cut-back petroleum asphalt from 0.90 L/m$^2$ to 2.25 L/m$^2$ (0.20 gallon per square yard to 0.50 gallon per square yard) and for AE-P and E-1 Prime emulsified asphalt from 1.35 L/m$^2$ to 3.20 L/m$^2$ (0.30 gallon per square yard to 0.70 gallon per square yard). Obtain approval of the application rates.

Uniformly distribute the tack coat at the junction of adjacent applications.

Following application, do not disturb the prime coat. Allow the bituminous material to penetrate the treated surface and the treated surface to absorb the bituminous material until the Inspector-in-Change determines the bituminous material is completely cured.

Apply additional bituminous material to uncoated or lightly coated areas.

Twenty-four hours after applying the prime coat, cover areas the Representative identifies as showing an excess of prime coat material with sufficient dry fine aggregate to blot up or remove excess prime coat material.

**(c) Protection of Treated Surface.** Maintain and protect treated surface against damage. Repair damaged areas to the Representative's satisfaction before placing succeeding construction.

**461.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 467—HEAVY DUTY MEMBRANES

**467.1 DESCRIPTION**—This work is placing heavy duty membranes over transverse and longitudinal joints and random cracks in existing concrete pavements at locations indicated or directed by the Representative.

**467.2 MATERIAL—**

**(a) Heavy Duty Membrane.** As listed in Bulletin 15 and include the certification specified in Section 106.03(b)3 with each shipment.

**(b) Asphalt Cement, Class PG 64-22 or PG 58-28.** Section 702

**467.3 CONSTRUCTION—**

**(a) General.** Provide a copy of the manufacturer's written installation instructions.

**(b) Surface Preparation.** Remove dirt and debris from all joints and cracks that will be under the membrane. Fill joints or cracks over 6 mm (1/4 inch) wide flush to the surface with PG 64-22 or PG 58-28. Before placing the membrane, ensure the pavement is sound, dry, and free of any debris or deteriorated and loose materials and prepare the surface according to the manufacturer's recommendations.

Do not apply heavy- duty membranes to milled surfaces.

**(c) Primers or Binders.** If required, apply primer or binder material according to the manufacturer's recommendations, including temperature requirements.

**(d) Membrane Placement.** Place the membrane according to the manufacturer's recommendations including temperature and equipment requirements. Unless otherwise specified by the manufacturer, place the membrane approximately centered over the joints and cracks. Slit the membrane and overlap the edges of wrinkles over 10 mm (3/8 inch) in width that cannot be smoothed out.

Securely bond the edges and corners of the strips to the surface. Before placing the overlay, re-bond or replace strips with loose edges or corners.

**(e) Traffic Control.** Before paving, the Contractor may only allow traffic on the membrane during the 7 calendar-day period immediately after placing the membrane.

**467.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 469—ASPHALT JOINT AND CRACK SEALING

**469.1 DESCRIPTION**—This work is cleaning and sealing longitudinal and transverse joints and cleaning and sealing cracks in existing pavement surfaces as part of routine maintenance and before placing an overlay.

**469.2 MATERIAL—**

**(a) Asphalt Rubber Sealing Compound.** Section 705.4(g)

**(b) Rubberized Joint Sealing Material.** Section 705.4(c)

**(c) Bituminous Wearing Course FJ-1.** Section 422.2

**469.3 CONSTRUCTION—**

**(a) General.** Obtain material from a source listed in Bulletin 15 or Bulletin 41 as applicable.

**(b) Heating Procedures.** Use a premixed, prepackaged material. Heat the material within the safe heating temperature range and recommended pouring temperatures found on the label on the manufacturer's shipping container. Place the material as close as possible to the manufacturer's recommended pouring temperature. Do not maintain batches of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer's recommendations.

**(c) Surface Preparation.** Clean, dry, and remove debris and loose material from cracks, joints, and adjacent pavement surfaces. If required, rout cracks to create a reservoir 12.5 mm (1/2 inch) deep. Clean the pavement for 100 mm to 150 mm (4 inches to 6 inches) on either side of the joint or crack. Immediately before sealing, use a compressed air stream of at least 700 kPa (100 pounds per square inch) measured at the source, or a hot compressed air lance to clean and dry damp cracks in bituminous pavements. If using the hot compressed air lance, do not damage the surrounding pavement area from overheating.

**(d) Sealing.** Seal joints and cracks from 6 mm to 25 mm (1/4 inch to 1 inch) wide with asphalt sealant and filling joints and cracks over 25 mm (1 inch) wide with Bituminous Wearing Course FJ-1.

If using asphalt sealant, fill prepared joints and cracks level with the pavement surface. Wipe the sealant flush with the pavement surface, leaving a thin film of sealant from 1 mm to 1.5 mm (1/32 inch to 1/16 inch) thick and from 25 mm to 75 mm (1 inch to 3 inches) wide. After wiping the joint or crack, remove and dispose of excess sealant. Unless allowed, do not place sealant when the air temperature is below 4 °C (40F) or above 32 °C (90F).

**469.4 MEASUREMENT AND PAYMENT—**

**(a) Asphalt Joint and Crack Sealing.** Meter (Linear Foot)
For the type specified.

**(b) Bituminous Wearing Course FJ-1.** Tonne (Ton)
Section 422.4(a)

# SECTION 470—BITUMINOUS SEAL COAT

**470.1 DESCRIPTION**—This work is application of bituminous material, immediately followed by application of coarse aggregate.

**470.2 MATERIAL—**

**(a) Bituminous Material.** One of the following, as specified in Section 702.

| Class of Material | Type of Material | Application Temperature °C (F) Minimum | Maximum |
|---|---|---|---|
| RS-2 (E-2) | Emulsified Asphalt | 60 (140) | 80 (175) |
| CRS-2 (E-3) | Cationic Emulsified Asphalt | 60 (140) | 80 (175) |
| RS-2PM (E-2M) | Polymer-Modified Emulsified Asphalt | 60 (140) | 80 (175) |
| CRS-2PM (E-3M) | Polymer-Modified Cationic Emulsified Asphalt | 60 (140) | 80 (175) |
| CRS-1PM | Low Temperature Polymer-Modified Cationic Emulsified Asphalt | 38 (100) | 60 (140) |
| PG 46-40 | Asphalt Cement | 120 (240) | 150 (300) |

Because of restrictive weather limitations governing the use of CRS-1PM emulsified asphalt, and the chemistry of the material, use CRS-1PM emulsions only with the written permission of the District Executive. Provide CRS-1PM produced by a source listed in Bulletin 15. The ambient temperature range for using CRS-1PM is 2 °C to 13 °C (35F to 55F). CRS-1PM is for only Low Temperature seal coat operations. Do not use CRS-1PM for summer seal-coat projects. Do not use CRS-1PM Low Temperature emulsions in rainy weather or on wet or damp surfaces.

Use PG 46-40 only on shoulders.

**(b) Coarse Aggregate.** Type A, No. 8—Section 703.2 and with the SRL designated in the Contract Item. Supply aggregate from a source listed in Bulletin 14. The Contractor may use an aggregate or blends of aggregates with an SRL equal to or better than that specified. Blends are 50% by mass (weight) of the two aggregates. Mix the aggregates using an approved method.

**470.3 CONSTRUCTION**—At least 2 weeks before the scheduled start work, submit a seal coat design for the Representative's review. Design the seal coat according to the method in Appendix E of Bulletin 27. If the source or gradation of aggregate changes or if type of bitumen changes, submit a new seal coat design.

**(a) Preparing Existing Surface.** Remove and dispose of all unsuitable material. Where indicated, seal cracks as specified in Section 469.

**(b) Application of Bituminous Material.** Apply bituminous material when the entire surface is in condition to allow satisfactory material penetration and adhesion and when the air, surface, and aggregate temperatures are above 16 °C (60F) or, if using CRS-1PM, from 2 °C to 13 °C (35F to 55F). Do not apply emulsified asphalt if, in the Representative's opinion, rain is imminent or if the Representative expects freezing temperatures within 24 hours after application.

Do not apply RS-2(E-2), CRS-2(E-3), RS-2PM(E-2M), CRS-2PM(E-3M), or PG 46-40 from September 15 to May 1 in Districts 1-0, 2-0, 3-0, 4-0, 9-0, 10-0, 11-0, 12-0, and 5-0 (Monroe, Carbon, and Schuylkill Counties only); and from October 1 to May 1 in Districts 6-0, 8-0, and 5-0 (Berks, Lehigh, and Northampton Counties only).

Use a distributor as specified in Section 460.3(b). Use a rate of application within ±10% of the design rate. Determine the distributor application rate in the field according to PTM No. 747.

For inaccessible areas, uniformly spread the bituminous material over the surface using portable pressure units. The quantity of material placed at one time shall be consistent with the facilities for handling, spreading, and rolling coarse aggregate, as well as the temperature of the surface and bituminous material.

Uniformly spread the bituminous material at the junction of separate applications.

**(c) Spreading and Rolling Coarse Aggregate.** Use dry aggregates, except the Contractor may use damp aggregates with emulsified asphalt. Before spreading aggregate, calibrate the spreader using a method acceptable to the Inspector-in-Charge.

Immediately after applying the bituminous material, uniformly spread a single layer of course aggregate at the design rate using a mechanical spreader capable of spreading 8.1 $kg/m^2$ to 13.6 $kg/m^2$ (15 pounds per square yard to 25 pounds per square yard).

Roll the aggregate with pneumatic-tire rollers, as specified in Section 108.05(c)3.f. Provide a sufficient number of rollers to roll the width of stone spread with one pass. Use a contact pressure from 280 kPa to 340 kPa (40 pounds per square inch to 50 pounds per square inch).

**(d) Protection of Surface.** Do not allow vehicular traffic or loads on the newly completed surface until the material obtains adequate stability and adhesion and the material is sufficiently cured to prevent distortion, flushing of bituminous material to surface, and loss of aggregate.

Provide sufficient flaggers and pilot vehicles to move traffic through the work zone or over the completed work at speeds that prevent aggregate distortion or pick-up. If required, sweep the surface with a power broom to remove loose aggregate before and after opening the road opened to traffic. Provide a pilot car for sweeping operations after opening the road to traffic.

## 470.4 MEASUREMENT AND PAYMENT—

**(a) Area Basis.** Square Meter (Square Yard)

**(b) Material Used Basis.**

1. **Coarse Aggregate.** Square Meter (Square Yard)

2. **Bituminous Material.** Liter (Gallon)

**(c) Crack Filling and Sealing.** Section 469.4

# SECTION 471—BITUMINOUS SEAL COAT USING PRECOATED AGGREGATE

**471.1 DESCRIPTION**—This work is application of bituminous material immediately followed by an application of bituminous precoated aggregate.

**471.2 MATERIAL—**

**(a) Bituminous Precoating Material.** One of the following, as specified in Section 702:

| Class of Material | Type of Material | Application Temperature °C (F) Minimum | Maximum |
|---|---|---|---|
| MC-30 | Cut-back Asphalt | 20 (70) | 50 (120) |
| MC-70 | Cut-back Asphalt | 40 (100) | 65 (150) |
| SS-1h (E-8A) | Emulsified Asphalt | 20 (70) | 65 (150) |
| CSS-1h (E-8C) | Cationic Emulsified Asphalt | 20 (70) | 65 (150) |
| PG 64-22 | Asphalt Cement | 135 (275) | 175 (350) |
| PG 58-28 | Asphalt Cement | 120 (250) | 165 (325) |

**(b) Bituminous Material.** One of the following, as specified in Section 702:

| Class of Material | Type of Material | Application Temperature °C (F) Minimum | Maximum |
|---|---|---|---|
| RS-2 (E-2) | Emulsified Asphalt | 60 (140) | 80 (175) |
| CRS-2 (E-3) | Cationic Emulsified Asphalt | 60 (140) | 80 (175) |
| PG 46-40 | Asphalt Cement | 120 (240) | 150 (300) |

Only use PG 46-40 on shoulders.

**(c) Coarse Aggregate.** Section 470.2(b)

**(d) Preparation of Pre-Coated Aggregate.** Use free-flowing, pre-coated aggregate so it can be stocked, handled, and uniformly spread by a self-propelled spreader. Prepare pre-coated aggregate as follows:

**1. Asphalt Cement.** Use an asphalt cement to pre-coat the aggregate only if it pre-coats the aggregate to the Representative's satisfaction. Provide a pre-coating with 0.6% to 1.2% residual bituminous binder (by mass (weight) of the mix). Dry the aggregate in a batch or continuous type bituminous plant conforming to the requirements of Bulletin 27. Precoat the aggregate in the pug mill. Mix the materials at a mixing temperature not exceeding 175 °C (350F). Stock mixed material on a suitable base area and no higher than 1.2 m (4 feet).

**2. Other Bituminous Materials.** The Contractor may use damp aggregate and a stabilization plant. Provide a pre-coating with 0.4% to 1.0% residual bituminous binder. If using damp aggregate with cut-back asphalts, sufficiently cure the pre-coated aggregate before use to prevent pickup. Do not exceed an aggregate temperature of 65 °C (150F) if using cutback asphalts.

Select an application rate sufficient to provide a thin, brownish, and translucent film on the aggregate. Cover at least 90% of the total visible surface area of the aggregate. Before producing the pre-coated aggregate, prepare a sample of the pre-coated aggregate for the Representative's inspection.

The Representative will use the sample to establish the visual inspection standard associated with at least 90% of the visible surface area covered.

During production, the Representative will determine if less than 90% of the visible surface area is covered. If the Representative determines less than 90% of the visible surface area is covered, the Contractor may determine the percent of uncoated material passing the 75 µm (No. 200) sieve after dry sieving for 10 minutes. The Representative will accept the pre-coated aggregate if the percent passing does not exceed 0.5%. Stock mixed material on a suitable base area and, if using heated aggregates, no higher than 1.2 m (4 feet).

**471.3 CONSTRUCTION—**Section 470.3 and as follows:

**(d) Protection of Surface.** If required, sweep the surface with a power broom to remove loose chips before and after opening the road to traffic. For emulsified asphalt, allow sufficient time for the seal coat to completely cure before opening the road to all traffic.

**471.4 MEASUREMENT AND PAYMENT—**

**(a) Area Basis.** Square Meter (Square Yard)

**(b) Material Used Basis.**

**1. Coarse Aggregate.** Square Meter (Square Yard)
The unit price includes the bituminous precoating material.

**2. Other Bituminous Material.** Liter (Gallon)

**(c) Crack Filling and Sealing.** Section 469.4

# SECTION 480—BITUMINOUS SURFACE TREATMENT

**480.1 DESCRIPTION**—This work is two applications of bituminous material, with each application of bituminous material immediately followed by an application of coarse aggregate.

**480.2 MATERIAL—**

**(a) Bituminous Material.** Section 470.2(a)

**(b) Coarse Aggregate.** Type A, No. 8 and No. 67, Section 703.2.

Provide aggregate to achieve at least the SRL designation indicated in the Contract Item and from sources supplying aggregate for use in wearing courses. The Contractor may provide a blend of two aggregates if the blend has an SRL equal to or better than that specified. Blends are 50% by mass (weight) of each aggregate. Mix the aggregates by an approved method.

**480.3 CONSTRUCTION**—At least 2 weeks before the scheduled start of work, submit a surface treatment design for the Representative's review. Design the surface treatment according to Appendix E of Bulletin 27.

**(a) Conditioning Existing Surface.** Section 470.3(a)

**(b) Application of Bituminous Material and Coarse Aggregate.** Section 470.3(b) and (c), except apply at the following rates and according to the following sequence:

**FIRST APPLICATION**

Apply bituminous material at a rate of 1.13 L/m$^2$ to 2.25 L/m$^2$ (0.25 gallon per square yard to 0.50 gallon per square yard). Use a mechanical spreader to spread 13.6 kg/m$^2$ to 24.4 kg/m$^2$ (25 pounds per square yard to 45 pounds per square yard) of No. 67 coarse aggregate. Roll the aggregate as specified below and then sweep off the loose material. Allow the first application to cure to the Representative's satisfaction before spreading the second application.

**SECOND APPLICATION**

Apply bituminous material at a rate of 1.13 L/m$^2$ to 2.25 L/m$^2$ (0.25 gallon per square yard to 0.50 gallon per square yard). Use a mechanical spreader to spread 8.1 kg/m$^2$ to 16 kg/m$^2$ (15 pounds per square yard to 30 pounds per square yard) of No. 8 coarse aggregate. Roll the aggregate as specified below.

**(c) Rolling.** Provide pneumatic-tire rollers as specified in Section 108.05(c)3.f and with a contact pressure from of 280 kPa to 340 kPa (40 pounds per square inch to 50 pounds per square inch). Use a sufficient number of rollers to cover the width of stone spread during the first pass. When the bituminous material has a tacky surface, backroll the aggregate with a pneumatic-tire roller or a steel-wheel tandem roller until the aggregate adheres to the bituminous material. If directed, eliminate backrolling. Do not roll in the vibratory mode.

**(d) Protection of Surface.** Section 470.3(d)

**480.4 MEASUREMENT AND PAYMENT—**

**(a) Area Basis.** Square Meter (Square Yard)

**(b) Material Used Basis.**

1. **Coarse Aggregate.** Square Meter (Square Yard)

2. **Bituminous Material.** Liter (Gallon)

**(c) Crack Filling and Sealing.** Section 469.4

# SECTION 481—BITUMINOUS SURFACE TREATMENT USING PRECOATED AGGREGATE

**481.1 DESCRIPTION**—This work is two applications of bituminous material, each immediately followed by an application of precoated aggregate.

**481.2 MATERIAL—**

**(a) Bituminous Precoated Material.** Section 471.2(a)

**(b) Bituminous Material.** Section 471.2(b)

**(c) Coarse Aggregate.** Section 480.2(b)

**(d) Preparation of Precoated Aggregate.** Section 471.2(d)

**481.3 CONSTRUCTION**—Section 480.3

**481.4 MEASUREMENT AND PAYMENT**—Section 471.4

# SECTION 482—SLURRY SEAL

**482.1 DESCRIPTION—**This work is construction of a bituminous slurry seal course of the type designated.

**482.2 MATERIAL—**

**(a) Bituminous Material.** Emulsified Asphalt, Class SS-1h(E-8A), or CSS-1h(E-8C), Section 702.

**(b) Fine Aggregate.** Section 703.1

Provide aggregate with the SRL designation in the Contract Item. Supply the aggregate from an acceptable source for use in wearing courses. The Contractor may supply an aggregate or aggregate blend with an SRL equal to or better than in the Contract Item. Blends are 50% by mass (weight) of each aggregate. Mix aggregates by an approved method.

**(c) Filler.** Section 703.1(c)1

**(d) Water.** Section 720.2, and free from harmful soluble salts. If water exceeds 150 g/m$^3$ (150 ppm (9 grains)) hardness, lower to below 150 g/m$^3$ (150 ppm (9 grains)) by adding water softener.

**(e) Mixture Composition.** Design and test the slurry seal mixture according to ASTM D 3910.

Provide fine aggregate, asphalt emulsion, water, and, if required, filler conforming to the Representative directed composition by mass (weight) percentages that are within the limits of Table A. Furnish a mix as specified in Section 401.2(e).

**TABLE A**
**Composition by Mass (Weight) Percentages**
**Combined Aggregate Gradations**

| | Percentages by Mass (Weight) | | |
|---|---|---|---|
| **Passing Sieve** | **Type I** | **Type II** | **Type III** |
| 9.5 mm (3/8-inch) | 100 | 100 | 100 |
| 4.75 mm (No. 4) | 100 | 90 - 100 | 70 - 90 |
| 2.36 mm (No. 8) | 90 - 100 | 65 - 90 | 45 - 70 |
| 1.18 mm (No. 16) | 65 - 90 | 45 - 70 | 28 - 50 |
| 600 µm (No. 30) | 40 - 60 | 30 - 50 | 19 - 34 |
| 300 µm (No. 50) | 25 - 42 | 18 - 30 | 12 - 25 |
| 150 µm (No. 100) | 15 - 30 | 10 - 21 | 7 - 18 |
| 75 µm (No. 200) | 10 - 20 | 5 - 15 | 5 - 15 |
| **Asphalt Residue Percent by Mass (Weight) of Dry Aggregate** | 10.0 - 16.0 | 7.5 - 13.5 | 6.5 - 12.0 |

**1. Type I.** Use to seal cracks, fill voids, and correct surface erosion. Apply dry aggregate at a rate from 3 kg/m$^2$ to 5 kg/m$^2$ (6 pounds per square yard to 10 pounds per square yard).

**2. Type II.** Use to fill surface voids, correct severe surface erosion conditions, and provide a minimum wearing surface. Apply dry aggregate at a rate of 5 kg/m$^2$ to 8 kg/m$^2$ (10 pounds per square yard to 15 pounds per square yard).

**3. Type III.** Use to provide a new moderate wearing surface or to build up a crown. Apply dry aggregate at a rate of 8 kg/m$^2$ (15 pounds per square yard) or more.

**482.3 CONSTRUCTION—**

**(a) Weather Limitations.** As specified in Section 401.3(b), except do not place mixture if the air temperature is 10 °C (50F) or lower, or if the pavement temperature is 10 °C (50F) or lower.

**(b) Equipment Requirements.** Produce the mixture in a self-propelled, continuous-flow mixing apparatus capable of accurately proportioning, combining, and mixing the materials into a homogeneous mixture with an asphalt film of sufficient thickness to furnish the desired binding properties.

Use an apparatus that contains bins, tanks, and receptacles of sufficient size and volume; proportioning feeders; liquid measuring meters or devices; and a mechanical mixer and distributor for placing the finished mixtures. Materials are to be delivered to the mixer simultaneously and in time-adjusted sequence by integrated, mechanized, and synchronized components.

**(c) Mixer.** A mixer of the spiraled, multi-blade type, or other acceptable type, with the following components, is required:

- mixing chamber having a stated capacity (not to be exceeded);
- mechanical equipment to regulate mixing time up to, but not exceeding, 4 minutes;
- equipment to pre-wet the aggregate before aggregate contact with asphalt emulsion; and
- a gate for controlling discharge of mixture into the distributor spreader.

**(d) Spreading Equipment.**

**1. Distributor.** A mechanically-operated, squeegee-type distributor is required, one which is integrally assembled with the slurry mixer and which includes the following:

- a strike-off, lined with flexible material to prevent loss of slurry mixture during spreading;
- a strike-off, with vertical adjustment available for changing grade and cross slope to ensure uniform spreading of mixture; and
- a pressure system and a fog-type spray bar, adequate for placing a complete fog coat of water over pavement surface immediately preceding spreading of mixture, with a maximum 0.23 L/m$^2$ (0.05 gallon per square yard) application rate of water.

**2. Auxiliary Equipment.** Provide hand squeegees, shovels, surface-cleaning machines, and other hand equipment, as necessary.

**(e) Conditioning of Existing Surface.** Section 401.3(g)1, except:

- Seal open joint and cracks with an acceptable crack sealer or emulsion.
- In addition to the surface cleaning specified, also remove heavy paint build-up.
- Cover and satisfactorily protect existing raised pavement markers.
- Replace damaged markers.

**(f) Placement.** Control the temperature of the components of the completed mixture so application temperature of the slurry seal is within the range designated, but not less than 10 °C (50F) or more than 50 °C (125F).

**(g) Joints.**

**1. Transverse Joints.** Construct by either overlapping previously cured slurry with 3 m to 4.6 m (10 feet to 15 feet) of fresh slurry, or by lightly wetting the area the spreader box will touch, while the slurry is in a completely uncured, semi-fluid condition.

**2. Longitudinal Joints.** Construct as follows:

Do not wet the slurry if it is completely uncured. Pull a burlap bag, or other suitable device, along the joint seam, to cause fresh slurry from the spreader box to distribute itself evenly over the joint.

Wet the slurry with the spring bar, if the slurry is completely cured.

**(h) Curing.** Do not allow traffic on the surface until directed, to allow the slurry seal to completely cure to a firm condition that will prevent pick-up of the mixture.

**482.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 490—REMOVAL OF EXISTING SURFACE COURSE

**490.1 DESCRIPTION**—This work is removal of an existing surface course.

**490.3 CONSTRUCTION**—Carefully remove the existing bituminous surface course, within limits shown on the plans or where the Representative directs. Use an acceptable removal method. Neatly trim the edges of remaining bituminous surface to a vertical line. At locations determined by the Representative, clean the surface of the existing base course and repair damage to the adjacent surface or underlying base.

**490.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 491—MILLING OF BITUMINOUS PAVEMENT SURFACE

**491.1 DESCRIPTION**—This work is the milling of an existing bituminous pavement surface.

**491.3 CONSTRUCTION—**

**(a) Equipment.** Provide a milling machine designed and built for milling existing bituminous pavements. The machine shall have an automatic grade and slope control system and be capable of milling concrete patches.

**(b) Milling Operation.** Mill to provide a finished surface that is free from gouges, grooves, and ridges and that conforms to the surface tolerance requirements of Section 401.3(l). Immediately after milling, remove milled material to include carefully removing the existing bituminous material around utility facilities within work areas. Repair or replace utility facilities that are damaged by the milling operation to the satisfaction of the utility owner. Control the rate of milling to avoid tearing of the mat, which causes chunky and non-uniformly milled material. If directed, separate oversize and chunky milled material. Maintain the milled pavement surface free of all loose materials and dust.

**(c) Disposition of Milled Material.** Satisfactorily dispose of the milled material.

**491.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 492—PROFILE MILLING OF BITUMINOUS PAVEMENT SURFACES

**492.1 DESCRIPTION—** This work is profile milling of existing bituminous pavement surface with parameters to control surface tolerances in both longitudinal and transverse directions.

**492.3 CONSTRUCTION—**

**(a) Equipment.** Provide a self-propelled milling machine capable of milling a full-lane width up to 3.6 m (12-feet) wide in one pass.

Equip the milling machine with a built in automatic grade control system to control the longitudinal profile and the transverse cross-slope. Provide longitudinal controls capable of operating from a longitudinal grade reference, including string line, ski 9 m (30 feet) minimum, mobile string line 9 m (30 feet) minimum, or matching shoe. Provide the transverse controls with an automatic system for controlling cross-slope at a given rate.

Mount profiler cutters to the carrier in order to adjust and control them according to depth of cut and cross-slope. Longitudinal milling action may be produced either by a suitable carrier wheelbase or use of an automatic control system having an external reference. Produce either a variable or a constant cross-slope with cross-slop adjustments or automatic controls.

Design, maintain, and operate milling cutters to produce a surface free from grooves, ridges, gouges, or other irregularities detrimental to the safe operation of vehicles in traffic routed onto the profiled surface.

Suitable supplemental equipment or methods, approved by the Representative, may be used in small or confined areas and around utility facilities. Complete adjustment of utility facilities before the milling operation, when pavement is not to be resurfaced. Repair or replace utility facilities that are damaged by the profiling operation to the satisfaction of the utility owner at no additional cost to the Department.

**(b) Profiling Operation.** Remove irregularities such as bumps, corrugations, and wheel ruts, and establish the specified pavement surface elevation or cross-slope with one or more passes over the designated area, operating the milling machine in automated mode.

Remove milled material from the surface following each pass of the equipment. Before opening the completed area to traffic, thoroughly clean the surface of all loose material that would create a hazard, a nuisance, or would be redeposited into the surface texture.

Maintain the milled surface free of all loose material and contaminants during milling and cleaning operations.

Repair areas where sound pavement has been damaged by milling operations at no additional cost to the Department, in a manner satisfactory to the Representative. The repaired area must conform to the adjacent pavement in smoothness and durability.

Place binder or surface material no more than 7 days after the start of the milling operation. Maintain milled surface and repair or replace areas damaged by methods accepted by the Representative at no additional cost to the Department.

**(c) Surface Patching.** Areas of the milled surface to be patched due to spalling or dislodgement of unsound pavement during profile milling operation will be designated by the Representative. Excavate to match depth of existing surface. Clean the areas of loose material, coat with Emulsified Asphalt Tack Coat (AE-T), and fill with HMA material of the same type. Level and compact the HMA material to conform to the adjacent pavement.

**(d) Surface Tolerances.** Profile the surface to a smoothness of 3 mm in 3.0 m (1/8 inch in 10 feet), and match the surface at the edge of adjacent passes within 3 mm (1/8 inches). Conform the cross-slope of the profiled surface to the specified cross-slope within 3 mm in 3.0 m (1/8 inch in 10 feet). Provide a positive cross slope, as shown in the plans, such that the pavement drains.

**(e) Disposition of Milled Material.** Satisfactorily dispose of the milled material.

**(f) Defective Work.** Profile milling that fails to meet the surface tolerances in Section 492.3(d) will be considered defective. Payment for defective work will be made at 50% of the Contract Unit Price (CUP) for the full-lane width of the defective area.

**492.4 MEASUREMENT AND PAYMENT—**

**(a) Profile Milling.** Square Meter (Square Yard)

**(b) Surface Patching.** The Department will separately measure and pay for the following item(s), when indicated or required:

1. **Class 1 Excavation.** Cubic Meter (Cubic Yard)

2. **Patching.** Square Meter (Square Yard)

# SECTION 500—RIGID PAVEMENTS

## SECTION 501—REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS

**501.1 DESCRIPTION**—This work is construction of normal strength or high early-strength (HES) cement concrete pavement, plain or reinforced, on a prepared surface, as indicated.

**501.2 MATERIAL—**

- Class AA Cement Concrete—Section 704
- High Early Strength Cement Concrete—Section 704
- Reinforcement—Sections 709.3 and 709.4
- Expansion Joint Filler—Section 705.1
- Longitudinal Joint Material—Section 705.2
- Load Transfer Units—Sections 705.3(a) and (b)
- Joint Sealing Material—Section 705.4(a), (b), or (d)
- Graphite Lubricant—Section 705.6
- Concrete Curing Material—Sections 711.1, 711.2(a), Type 2, and 711.2(b)
- Concrete Admixtures—Section 711.3
- Mortar—Section 705.7(b)
- Tape Bond Breaker—An acceptable self-adhesive tape the width of the sealant reservoir.
- Epoxy Bonding Compound – Section 706.1
- Joint Backing Material—Section 705.9
- Fiberglass Dowel Sleeve—An approved type as listed in Bulletin 15.
- Pre-Mixed Nonshrink Grout – An approved type as listed in Bulletin 15.

**501.3 CONSTRUCTION—**

**(a) General.** Construct pavements in one or two traffic lane widths as shown on Standard Drawings RC 20M, 21M, 23M, 24M, 25M, 26M, and 27M, unless otherwise directed. Use one-lane construction if two-lane construction interferes with traffic.

**1. Field Operation QC Plan.** Prepare a paving operation QC Plan, as specified in Section 704.1(d)1.a, for field control and evaluation of concrete paving operations for the Representative's review. Do not start paving until after the Representative reviews the QC Plan.

**(b) Weather Restrictions.**

**1. Cold Weather.** Unless otherwise permitted in writing, discontinue concreting operations when the descending air temperature, away from artificial heat, falls to 4 °C (40F). Do not resume operations until the air temperature, away from artificial heat, rises above 4 °C (40F). Do not let water with a temperature above 32 °C (90F) to come in direct contact with the cement, until the cement has been mixed with the aggregates. Place concrete when the concrete temperature is between 10 °C and 32 °C (50F and 90F). Do not use materials containing frost, lumps, or crusts of hardened materials. Do not place concrete on frozen base, subbase, or subgrade.

**2. Hot Weather.** When the air temperature in the immediate vicinity of concrete operations rises to 30 °C (85F), take thermometer readings of the plastic concrete, at 1/2-hour intervals and at the conclusion of the mixing cycles. Discontinue concrete operations if the plastic concrete temperature exceeds 32 °C (90F) after mixing. When the plastic concrete temperature rises to 32 °C (90F), cool the mixing water or aggregates to maintain a plastic concrete temperature within 10 °C to 32 °C (50F to 90F) at the time of placing.

**(c) Concrete Mixture.** Do not use mixtures from volumetric mixing plants or mobile mixers, unless approved by the District Executive in writing. For slip-form paving, the Contractor may use plant mixed cement concrete, volumetric mixing plants or mobile mixers as specified in Section 704.1(a).

**(d) Forms.** Use steel forms for concrete pavement except as specified herein. Use forms not less than 3 m (10 feet) in length, with form depth and base width equal to pavement depth. Do not exceed 3 mm (1/8 inch) in 3 m (10 feet) from the true plane of the face or top. The Contractor may use forms with a base of not less than 150 mm (6 inches) in width and meeting all other requirements for narrow strips of widening if approved by the District Executive in writing.

Use forms of an approved section without horizontal joints, and with flange bracing extending outward on the base not less than two-thirds of the form height. Use forms that do not deflect or deform more than 0.25 mm (0.01 inch) when a center load of 7 550 N (1,700 pounds) is applied within a 1.2 m (4-foot) span. Use form sections equipped with three stake pockets, each of which have positive non-detachable wedges, and positive interlocking devices, which form a neat tight joint. Use a sufficient quantity of steel pins to securely hold the forms in place and provide the necessary rigidity.

For curves with a radius of less than 45 m (150 feet), the Contractor may use wood forms. Use two 25 mm (1-inch) (nominal) seasoned, surfaced planks properly joined together. Brace all wood forms with steel pins. Do not exceed 600 mm (24 inch) spacing between pins.

Clean and oil forms before each concrete placement. Cut and firm the subbase under the forms true to grade, and set forms accurately to line and grade for their entire length and width. Forms may be shimmed provided that the material used to shim the forms creates continuous contact between the form and the base course surface. The forms and shimming material must result in a full vertical face of concrete when removed. If concrete extrudes outside the shims or forms, remove this extruded concrete, as directed, before placing the adjacent concrete.

**(e) Preparation and Protection of Base Course.** When placing concrete on the completed base course do not disturb the form line after final testing. Remove accumulation of material adjacent to forms, to full depth of forms, in conjunction with final testing. If the prepared area is disturbed by any operations, or by traffic, check and correct before placing concrete.

Thoroughly sprinkle water on the base course before paving, if necessary to ensure a moist base course and to cool the surface temperature of treated permeable base courses below 46 C (115 F). Discontinue paving operations if the surface temperature of treated permeable base courses can not be maintained below 46 C (115 F). Do not create water puddles or mud. Sprinkle the base course with as much water as it readily absorbs, well in advance of paving.

**(f) Placement and Initial Strike-Off of Concrete.** For pavement construction around manholes, inlets, valve boxes, and similar appurtenances, place premolded expansion joint filler not less than 13 mm (1/2 inch) in total thickness, for the full depth of the pavement, around the outer sides of structures within the paved areas. Where pavements adjoin other rigid structures, bridges, or culverts, place premolded expansion-joint filler, not less than

19 mm (3/4-inch) thick, adjacent to the structures. Before placing pavement adjacent to railway tracks, fill the spaces along the web and below the head and top flange of the rail with mortar. If construction crosses railway tracks, place a minimum 20 mm (3/4-inch) thick expansion joint filler against the mortar-filled rails. If constructing along tracks, place a minimum 6 mm (1/4-inch) thick expansion joint filler along each mortar-filled rail.

Do not use concrete that has developed an initial set.

If implanting dowel bars by mechanical means, the Contractor may deposit the concrete directly on the subgrade or prepared surface in front of the paver. Spread concrete as close as possible to joint assemblies to ensure proper concrete consolidation without disturbing the joint. Do not damage the prepared surface while transporting or depositing concrete ahead of the paver. If the prepared surface is an asphaltic leveling course on rubblized concrete, treated base course of cement or asphalt, or an aggregate subbase, travel on the prepared surface only in the immediate area of the paving operation for the purpose of depositing concrete ahead of the paver. Do not use the prepared surface for hauling. Satisfactorily repair or replace any damaged areas at no additional cost to the Department.

Use vibrators capable of transmitting vibration to concrete with a frequency of not less than 100 impulses per second. Operate the vibrator around, but not in contact with transverse or longitudinal joint assemblies. Do not cause segregation when vibrating. Do not operate manual vibrators in one place more than 5 seconds. Use vibrators only to consolidate concrete after it has been properly placed. Do not use vibrators to move or spread concrete. Remove and discard segregated concrete, as directed. Maintain sufficient reserve vibratory equipment to prevent shutdown due to failure of equipment.

**(g) Slip-Form Paving Method.**

**1. Equipment.** Use a fully energized, self-propelled, slip-form paving machine, equipped with side forms to support concrete laterally to prevent edge slumping. Use a paver that vibrates or tamps concrete for the full width and depth of the layer being placed.

**2. Line and Grade.** Unless otherwise specifically shown on the construction drawings, construct pavement so the longitudinal joints do not traverse a driving lane or conflict with the final pavement markings. Construct longitudinal joints parallel to and within 300 mm (12 inches) of final pavement markings unless otherwise detailed on the construction drawings.

**3. Placing Concrete.** Place the concrete and spread in one or more layers, provided the concrete is fully consolidated, the reinforcement is satisfactorily embedded, and a satisfactory finished surface is obtained.

Operate the slip-form paver in a continuous forward movement. Coordinate operations of mixing, delivering, placing, and spreading concrete to provide uniform progress with stopping and starting of the paver held to a minimum. If the paver's forward movement is stopped, immediately disengage vibrating and tamping elements.

**4. Joints.** When load transfer units are used, stake in place in advance of paving operations, at the designated locations. Implanting of dowel bars by mechanical means is permitted. Accurately mark the dowel-bar locations to ensure sawing the transverse joints over the center of dowels. Saw, cure, and protect transverse and longitudinal contraction joints, as specified in Sections 501.3(i) and (j).

**5. Edge Slumping.**

**5.a During Paving Operations.** Test the pavement surface for edge slumping with a 3.0 m (10-foot) straightedge, before the concrete becomes non-plastic. Strive to avoid edge slump. Edge slump not exceeding the following will be acceptable:

- 3 mm (1/8 inch) between adjacent lanes, and lanes and ramps.
- 6 mm (1/4 inch) between lanes and shoulders, and ramps and shoulders.

Measure edge slump for the 150 mm (6-inch) width contiguous to the pavement edge.

Suspend paving operations after 61 m (200 feet) if edge slumping can not be prevented or controlled within the above stated acceptable limits. The pavement within this 61 m (200-foot) section will be evaluated as specified in Section 501.3(g)5.b.

**5.b After the Concrete Hardens.** Test the pavement surface with a 3.0 m (10-foot) straightedge to ensure the requirements of Section 501.3(g)5.a have been met.

If testing confirms edge slumping exists in the hardened concrete, submit methods for correction to the District Executive for review. Make corrections according to the reviewed methods to eliminate the edge slumping. Remove and replace pavement determined defective, as specified in Section 501.3(u), at no additional cost to the Department.

**(h) Handling and Placing Reinforcement.** Use reinforcement free of rust, dirt, oil, grease, or other foreign substances, which impair bond of steel with concrete. A light, powdery coating of rust, formed during project storage, does not require cleaning. Remove loose, scaly, or thick rust by suitable methods. The Representative will reject reinforcement with rust that has caused detectable reduction in cross-sectional area.

If placing reinforced concrete pavement in two layers within fixed forms, strike off the entire bottom layer and lay the reinforcement full length on the concrete, in its final position, without further manipulation. Place reinforcement directly upon the concrete and place, strike-off, and screed the top layer of concrete. Remove and replace bottom-layer portions of concrete placed more than 1/2 hour without being covered with the top layer of freshly mixed concrete.

If placing reinforced concrete pavement in one layer, position mesh reinforcement on acceptable supports as specified in Section 1002.3(d)2 in advance of concrete placement. If a mechanical installer is used, avoid segregation of concrete or displacement of reinforcement.

**(i) Transverse Joints.** In new multilane pavements, place transverse joints perpendicular to centerline to form a continuous joint across the entire pavement width and locate dowels as shown on Standard Drawing RC 20M, except where paving operations must cease temporarily due to unavoidable conditions.

Before paving, apply graphite bond-breaker lubricant to one-half of the length of Type B coated dowel bars, unless a bondbreaker lubricant has been applied in the shop. Stir the lubricant well and apply to the free end of dowels by daubing, mopping, or with a gloved hand, to produce a thorough coating approximately 2 mm (1/16 inch) thick. Do not use brushes for lubricant application. Apply the lubricant, as specified, at least 1 hour before placing the concrete around the dowel assembly. Type A coated dowel bars do not need lubricant.

Where existing concrete pavements are widened, align transverse construction or contraction joints, if possible, with existing construction or contraction joints or cracks; otherwise, do not place within 3 m (10 feet) of a joint.

When constructing pavement one lane at a time or placing concrete shoulders after pavement construction, fill the ends of transverse joints with joint backing material, or cover with duct tape, to prevent intrusion of cement mortar into the joint. In these cases, when saw cutting transverse joints in the newly constructed lane or shoulders, saw cut the existing transverse joint in the previously placed lane to ensure the removal of any mortar that might have intruded into the joint.

**1. Construction Joints.** If more than a 30-minute interruption occurs in concreting operations, construct a transverse joint using a bulkhead. Place dowels in bulkheads by drilling or inserting into fiberglass dowel sleeves. Do not construct a transverse joint within 3 m (10 feet) of another transverse joint. If not enough concrete has been placed or mixed at the time of interruption to form a slab at least 3 m (10 feet) long, remove concrete to the preceding joint and dispose of excess mix.

**2. Contraction Joints.** Accurately mark using tacks or other approved methods the location for the center of the sawed transverse contraction joints. The sawed transverse joint must be located directly ±13 mm (±1/2 inch) over the centerline of the dowel basket assemblies or the centerline of the mechanically implanted dowels. Saw joints with equipment having guides, a blade guard, watercooling system, and cut-depth control. Provide adequate and extra equipment and parts at the site, before placing concrete and during sawing operations.

Other than white membrane curing compound, remove curing materials from pavement, at the location where a joint is to be cut. Only remove sufficient covering to provide space necessary for sawing joints. Immediately after sawing the initial saw cut, thoroughly flush the joint as necessary to remove slurry. Place oversized (width plus 50%) backer rod in the top of the sawed joint to maintain cure. Monitor the movement of the joint throughout the cure period and up to placement of permanent seal. If at any time the joint opens remove and replace backer rod with appropriate oversized backer rod. The maximum time period permitted for curing covers to be removed for sawing is 1/2 hour. If white membrane curing compound is used, reapply curing compound as specified in Section 501.3(l)1.c.

The Representative will not allow displacing coarse aggregate from the joint location by use of a vibrating T-bar, or by use of a filler strip at the joint.

In single-lane construction, mark the joints that have cracked and opened on the first lane placed. Align the location of the first joints sawed in the second lane with the marked joints on the first lane. In lanes adjacent to previously constructed lanes, saw joints before uncontrolled cracking occurs. Make the full required depth cut from edge to edge of the pavement. In formed paving, do this by loosening or removing the side forms or by other acceptable methods.

Saw all initial saw cuts to prevent random cracking, without damaging the pavement surface. If damage to the pavement surface occurs, repair in an approved method at no additional cost to the Department. Slight raveling along the joint edge is permissible. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions.

If a crack or spall occurs at any location and any time before final inspection and resolution of all issues regarding the condition of the pavement, repair the pavement in accordance with Table A, at no additional cost to the Department. Field coat the dowels with the graphite lubricant, as specified in Section 501.3(i), where necessary as determined by the Representative. Join original pavement to replacement pavement and test as specified in Section 507; if Ride Quality and Incentive are not applicable, test as specified in Section 501.3(p).

For joints requiring a second stage of sawing, saw the sealant reservoir 72 hours or more after placing the concrete.

Clean joints with pressurized water or water and air pressure immediately after sawing. Patch voids or spalls, in excess of the specified width, as specified in Section 525. Continue curing and protect joint until sealed.

**3. Expansion Joints.** Place transverse expansion joints, where indicated. If existing concrete pavements are widened, align transverse expansion joints, if possible, with existing expansion joints. Place transverse expansion joints, without load transfer units, in the plain cement concrete pavement in paved divisor areas. Conform to the dimensions and locations in adjacent concrete curb. Place expansion joint filler, as indicated or as directed.

**Table A**
**Repair Procedures for Deficiency in New Concrete Pavement**

| Item | Deficiency | Location | Description | Contractor Repair Options |
|---|---|---|---|---|
| 1 | Partial Depth Crack | Anywhere | ≤ 0.175 mm (0.007 inches) wide | Do nothing |
| | | | >0.175 mm (0.007 inches) wide AND ≤ D/3 deep | Epoxy inject crack as specified in Section 1091 |
| | | | > 0.175 mm (0.007 inches) wide AND > D/3 deep | Repair as specified in Section 516 Partial Panel Full Depth Patch[a, b, c] |
| 2 | Spall | Mainline or shoulder panel | Minimal spalling[d] ≤ 50 mm (2 inches) wide AND ≤ D/3 deep | Do nothing |
| | | | Significant spalling[e] > 50 mm (2 inches) wide (measured perpendicular to joint) AND ≤ D/3 deep or > 300 mm (12 inches) wide (not at a joint) AND ≤ D/3 deep | Spall Repair as specified in Section 525 (Repair must perform satisfactorily for 1 year or replace with Partial Panel Full Depth Patch as specified in Section 516)[a, b, c] |
| | | | Significant spalling[e] > 50 mm (2 inches) wide (measured perpendicular to joint) AND > D/3 deep or > 300 mm (12 inches) wide (not at a joint) AND ≤ D/3 deep | Repair as specified in Section 516, Partial Panel Full Depth Patch[a, b, c] |

| | | | | |
|---|---|---|---|---|
| 3 | Single Full Depth Crack<br><br>(any orientation) | Shoulder | Non-working crack with minimal spalling[d] | Epoxy inject crack as specified in Section 1091 |
| | | | Working crack with minimal spalling[d] | Seal crack as specified in Section 590 |
| | | | Crack with significant spalling[e] | Repair as specified in Section 516 Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c] |
| | | Mainline or Shoulder panel is affected by irregular geometry (construction joints do not line up) | Crack with minimal spalling[d] | Seal crack as specified in Section 590 |
| | | Mainline | Entire length of crack ≤ 230 mm (9 inches) from longitudinal joint<br>AND crack is parallel to longitudinal joint ± 25 mm (1 inch) | Seal crack as specified in Section 590 |
| | | Mainline crack is in center one-third of dowelled panel. | Crack ≤ 13 mm (1/8 inch) wide AND spalling ≤ 6.5 mm (1/4 inch) from edge of crack. | Dowel Retrofit as specified in Section 527: three dowels per wheel path (panels ≤ 250 mm (10 inches) thick); four dowels per wheel path (panels > 250 mm (10 inches) thick)<br>OR Partial Panel Full Depth Patch[a, b, c] repaired as specified in Section 516 OR Full Panel Replacement[c] |
| | | Mainline | All other conditions | Partial Panel Full Depth Patch[a, b, c]<br>OR Full Panel Replacement[c] |
| 4 | Multiple Cracks > D/3 deep (any orientation) | Mainline or Shoulder | Panel has more than 1 crack > D/3 deep | Partial Panel Full Depth Patch[a, b, c]<br>OR Full Panel Replacement[c] |

Notes:

a Minimum patch length is 1 800mm (6 foot) for Plain Cement Concrete (PCC) or 3 000 mm (10 foot) for Reinforced Concrete Pavement (RCP).

b Minimum amount of panel left in place is 1 800 mm (6 foot).

c All patches (partial panel and full panel replacements) must be full width and depth.

d Minimal spalling is defined as ≤ 50 mm (2 inches) total width AND ≤ 300 mm (12 inches) (combined length) along crack.

e Significant spalling is defined as > 50 mm (2 inches) total width OR > 300 mm (12 inches) (combined length) along crack.

D Design pavement depth.

Payment for new pavement where the crack has been removed is at the Contract Unit Price (CUP) with NO additional compensation for the repair.
Payment for new pavement where the crack has not been removed but sealed as specified in Section 590 is at five percent CUP for the slab with NO additional compensation for the repair. Payment for slabs with Partial depth Crack or Spall is at the CUP with NO additional compensation for the repair

Crack depth is to be determined by coring at no cost to the Department

**(j) Longitudinal Joints.** Place tie bars as indicated or directed. The Representative will select 15 tie bars from the first day's concrete placement according to PTM No. 1. Test each selected tie bar for pull-out resistance after the concrete has attained a compressive strength of 24 MPa (3,500 pounds per square inch), or epoxy anchoring material has met manufacturer's requirements. Use a center-pull hydraulic jack with a load measuring gage and bearing ring capable of testing each tie bar to 53 400 N (12,000 pounds) or to a 0.8 mm (1/32-inch) slippage. Do not use jack and gage having a calibration date older than 6 months. Record the gage reading at point of slippage or 53 400 N (12,000 pounds), whichever occurs first. Determine the average of pull-out test results. Divide pull-out test average by the tie bar spacing to determine pull-out resistance of tie bars, in newtons per meter (pounds per cubic foot), for compliance with Table B. If the newtons per meter (pounds per cubic foot) is not in compliance with Table B, replace failed tie bars or install additional tie bars until compliance with Table B is attained, at no additional cost to the Department. Install additional tie bars from the center of slab out in an approved pattern. Do not install additional tie bars within 750 mm (30 inches) of a transverse joint. Do not construct adjacent lanes until the tie bars comply with Table B. Perform additional testing as directed.

Saw tied, longitudinal contraction joints to prevent random cracking, as specified in Section 501.3(i)2. Clean joints with pressurized water or water and air pressure immediately after sawing. Continue curing and protect the joint until it is sealed, as specified in Section 501.3(n).

**TABLE B**
**Pull-Out Resistance of Tie Bars**

| Tied Width of Pavement (Distance from Joint Being Constructed to Nearest Free Edge) | Minimum Average Pull-Out Resistance of Tie Bars |
|---|---|
| | N/m (lb/ft) of Joint |
| 3.6 m (12 feet) or less | 32 000 (2,200) |
| Over 3.6 m (12 feet) to 5.2 m (17 feet) | 46 500 (3,200) |
| Over 5.2 m (17 feet) | 65 500 (4,500) |

If a longitudinal crack occurs within a lane, remove and replace slabs containing the crack at no additional cost to the Department. If damage to the pavement surface occurs, repair in an approved method at no additional cost to the Department. Join original and replacement pavements. Field coat dowels with graphite lubricant, as specified in Section 501.3(i), where necessary.

**(k) Final Strike-Off, Consolidation, and Finishing.** Complete these operations during hours of natural light, unless using an acceptable lighting system.

**1. Strike-Off and Consolidation.**

**1.a Machine Method.** Immediately after placing, strike off and screed the concrete, with a finishing machine, as necessary, to properly consolidate the concrete and to leave a uniform textured surface.

Keep the top of forms free from accumulation of concrete or of foreign material. Maintain true machine travel on the forms without lift, wobble, or other variations that affect accurate finishing. Use equipment that does not groove the concrete pavement edges for a width greater than can be eliminated by edging tools. Use a rubber-tired wheel to support the spreader and a transverse finishing machine on the adjoining concrete pavement surface, keeping the wheel approximately 300 mm (12 inches) from the pavement edge.

Maintain a uniform roll of concrete ahead of the finishing machine front screed for its entire length. Overlap the previously screeded concrete on the last pass.

Place and vibrate concrete adjacent to joints and other areas, as specified in Section 501.3(f), then bring the finishing machine forward. Operate the machine carefully to avoid damage, misalignment of joints, or concrete segregation.

Do not add water to the concrete surface to assist in finishing.

**1.b Manual Method.** Unless otherwise directed, do not use manual strike-off methods, except to strike off concrete already deposited on the subbase if a breakdown of mechanical equipment occurs or on small turnout areas and patches up to 3 m (10 feet) in length.

If finishing manually, use screeds contoured to the pavement cross section. Provide screeds sufficiently rigid to retain their shape and at least 600 mm (2 feet) longer than the maximum slab width to be struck off. Operate the equipment in a manner to obtain consolidation and a uniform textured surface free of porous areas. Consolidate as specified in Section 501.3(f).

**2. Floating.** After the concrete has been struck off and consolidated, smooth and fill in open-textured pavement areas with a float, as necessary. Do not add water to the surface. Mechanical floats or long handled floats may be used.

**3. Straightedge Testing and Surface Correction.** While concrete is still plastic, test the surface using a 3 m (10-foot) straightedge, swung from handles 1 m (3 feet) longer than one-half the slab width, as required. Hold the straightedge in contact with the surface in successive positions. Advance in successive stages of not more than 1.5 m (5 feet) a stage. Immediately correct low areas, then strike off, consolidate, and refinish. Cut down high areas and refinish. Make sure the surface across joints meets requirements for smoothness as specified in Section 501.3(p). Continue straightedge testing and surface corrections until the entire surface is free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section.

**4. Final Finish.** After straightedge testing and surface corrections have been completed and before concrete becomes non-plastic, texture the surface transversely for the full pavement width. Produce a textured finish with grooves that have the following characteristics: rectangular in shape; from 2.5 mm to 5 mm (3/32 inch to 3/16 inch) in width; and from 3 mm to 5 mm (1/8 inch to 3/16 inch) in depth.

For a 3 m (10-foot) rake use center-to-center tine spacing as follows:

**TABLE C (Metric)**
**Center-to-Center Tine Spacing**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 36 | 47 | 54 | 48 | 43 | 32 | 31 | 27 | 36 | 29 | 46 | 21 | 43 | 23 |
| 42 | 52 | 24 | 18 | 28 | 40 | 34 | 27 | 26 | 25 | 27 | 20 | 37 | 38 | 52 |
| 51 | 45 | 37 | 43 | 53 | 14 | 27 | 37 | 42 | 41 | 29 | 43 | 14 | 45 | 44 |
| 30 | 37 | 33 | 40 | 28 | 31 | 50 | 34 | 45 | 15 | 20 | 45 | 50 | 16 | 53 |
| 51 | 29 | 25 | 18 | 16 | 53 | 18 | 38 | 51 | 40 | 17 | 15 | 49 | 50 | 39 |
| 51 | 36 | 36 | 38 | 46 | 29 | 38 | 50 | 24 | 33 | mm | | | | |

**TABLE C (English)**
**Center-to-Center Tine Spacing**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 3/8 | 1 3/8 | 1 7/8 | 2 1/8 | 1 7/8 | 1 3/4 | 1 1/4 | 1 1/4 | 1 1/8 | 1 3/8 | 1 1/8 | 1 3/4 | 7/8 | 1 3/4 | 7/8 |
| 1 5/8 | 2 | 1 | 3/4 | 1 1/8 | 1 5/8 | 1 3/8 | 1 1/8 | 1 | 1 | 1 1/8 | 3/4 | 1 1/2 | 1 1/2 | 2 |
| 2 | 1 3/4 | 1 1/2 | 1 3/4 | 2 1/8 | 1/2 | 1 1/8 | 1 1/2 | 1 5/8 | 1 5/8 | 1 1/8 | 1 3/4 | 1/2 | 1 3/4 | 1 3/4 |
| 1 1/8 | 1 1/2 | 1 1/4 | 1 5/8 | 1 1/8 | 1 1/4 | 2 | 1 3/8 | 1 3/4 | 5/8 | 3/4 | 1 3/4 | 2 | 5/8 | 2 1/8 |
| 2 | 1 1/8 | 1 | 3/4 | 5/8 | 2 1/8 | 3/4 | 1 1/2 | 2 | 1 5/8 | 5/8 | 5/8 | 1 7/8 | 2 | 1 1/2 |
| 2 | 1 3/8 | 1 3/8 | 1 1/2 | 1 3/4 | 1 1/8 | 1 1/2 | 2 | 1 | 1 1/4 | (in) | | | | |

When using this chart begin in the upper left corner and read across the entire row then start again on the left side in the next row.

Produce the texture in one pass, without overlapping the previous pass, to provide a uniform finish. Keep the texturing device free of hardened concrete particles.

**(l) Curing Concrete.** Cure the entire surface immediately after finishing operations have been completed. Do not mar the concrete surface. After removing forms and correcting honeycombed areas, cure the sides with the same method as the surface. When using covers, secure over the entire surface and sides. The Representative will suspend concrete operations immediately if sufficient curing is not provided. Cure by the same method throughout the work unless directed to change by the Inspector. Have material available for emergency curing.

If normal curing is delayed, apply an intermediate monomolecular film curing agent to all cement concrete patches before normal curing.

Apply the monomolecular film in a light-fog application, using a pressure spray tank with an adjustable nozzle. Use a water-to-curing-agent ratio and rate of application both according to the manufacturer's recommendations. Agitate the solution before each application.

Apply the curing agent in a continuous film, immediately after finishing and texturing operations are completed on any area. Do not provide any additional finishing after application of the monomolecular film. Apply additional applications as required, if surface drying is taking place and curing covers have not been placed.

After application of the monomolecular film, provide normal curing as specified.

**1. Normal Curing.** Apply curing materials and maintain them as specified below, for a period of 96 hours for normal strength concrete or 72 hours for high early strength concrete. The Contractor may use methods other than those described below to protect and cure joints, if the procedure and materials are acceptable. The Representative may require a change in method if unsatisfactory results are obtained.

**1.a White Polyethylene Curing.** Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 300 mm (12 inches) and secure sides and seams to form a tight seal. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

**1.b White Polyethylene Burlap-Backed Curing.** Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 300 mm (12 inches), then secure sides and seams to form a tight seal. Saturate the burlap side with water, then place and secure with the burlap side down. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

**1.c White Membrane Forming Curing Compound.** The Representative will allow this method of curing if the air temperature is above 4 °C (40F) at the time of application and the air temperature is forecasted to remain above 4 °C (40F) a period of 4 hours after application.

Following the final finishing, immediately after free water has left the pavement surface and while the surface is still damp, seal exposed concrete areas with an application of curing compound. Apply at a rate of 1 L/4 $m^2$ (1 gallon per 150 square feet) ± 10% of surface area, or as directed. Using a self-propelled mechanical spreader, apply in a fine mist, without marring the concrete surface. Use atomizing type spraying equipment, equipped with a tank agitator providing continual compound agitation during application. Provide proper calibration to allow accurate control of the amount of material being placed. Use a hood to protect the spray device against the wind and control so the spray overlaps transversely 50%, to produce two coverages of a continuous, uniform membrane. Do not drip curing compound on the pavement. If rain falls on newly coated pavement before the film has dried sufficiently to resist damage or if film is damaged in any way before the pavement is cured, apply a new coat immediately, in an amount equal to the original specified application.

After form removal, apply a uniform coat to the sides, at the rate specified for the surface. Manual spraying equipment may be used for spraying the sides and for any small or irregular areas not reached by surface spraying equipment.

The Contractor may cure joints and protect them by use of tape, a strip of white polyethylene, or white polyethylene backed with burlap. During the curing period, to prevent moisture loss from concrete, in and adjacent to joints, use strips 75 mm to 150 mm (3 inches to 6 inches) wide, securely held in place on the pavement surface by an acceptable method, or place saturated rope strands in the joints. Just before the curing compound application or reapplication, carefully place rope without damaging or distorting the joints.

Keep workmen, materials, and equipment off the membrane film during curing, unless adequate precautions are taken to protect the film.

**1.d Burlap Curing.** Place burlap in double-thickness by overlapping each strip one-half its width on the pavement surface. Keep this covering saturated with water for the full curing period. After sides are exposed, fold burlap down over the sides and secure with suitable material.

**1.e White Polypropylene Fiber-Backed Curing.** Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 300 mm (12 inches), then secure sides and seams to form a tight seal. Saturate the burlap side with water, then place and secure with the burlap side down. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

**1.f Black Membrane-Forming Curing Compound.** Liquid Membrane-Forming Curing Compound, Black, may be used, provided the cement concrete pavement will be overlayed and is not accessible to traffic before the surface course is placed. Apply at a rate not to exceed 0.07 L/m$^2$ (0.015 gallon per square yard) to produce a uniform continuous film. Discontinue use of the compound if it becomes unsatisfactory as a curing agent; and resume curing by other methods, as specified.

**2. Cold Weather Curing.** If the forecasted air temperature during concrete curing is expected to fall blow 4 C (40 F), place high-low thermometers on the concrete surface and monitor concrete curing temperatures. Protect the pavement surface and sides to effectively maintain a temperature of not less than 4 °C (40F) for at least 4 days and until the concrete achieves a strength of 21 MPa (3,000 pounds per square inch). If at any time during this period the high-low thermometer falls between 4 °C and 2 °C (40F and 35F), extend the cure period by and additional day. If at any time during the curing period the high-low thermometer temperature falls below 2 °C (35F), the concrete will be considered defective. Remove and replace defective pavement as specified in Section 501.3(t) at no cost to the Department.

**(m) Removal of Forms.** Do not remove forms from freshly placed concrete until it has set. Remove the forms carefully to avoid pavement damage.

**(n) Sealing Joints and Cracks.** Seal joints before opening any pavement section to traffic including construction equipment, and before discontinuing work for the winter season. When permitted, the Contractor may open pavement to construction equipment provided an approved temporary sealing material is in place, and initial concrete strength and curing requirements are met. Provide construction equipment within vehicle code limits. Seal cracks as indicated or directed.

Do not place joint sealing material on the same day as the sawing or if joint is wet or damp due to weather conditions. Clean joints of all scale, dirt, curing compound, temporary joint sealing material, and other foreign material with a wire brush. Upon completion of the cleaning, thoroughly sand-blast or water-blast the joint sidewalls with sufficient pressure to clean but not damage joint. Immediately before placing bond breaker or joint sealing material, blow the joint clean with a compressed air stream of at least 700 kPa (100 pounds per square inch) measured at the source. Use compressed air free of oil, moisture, and other contaminants.

**1. Poured In Place Seal.** Do not place poured joint-sealing material if the air temperature is less than 4 °C (40F), unless permitted.

For hot-poured seals use heating equipment of an indirect heating type, constructed as a double boiler. Provide positive temperature control and mechanical agitation. Determine the safe heating temperature range and recommended pouring temperature from the manufacturer's shipping container. Heat and maintain the material temperature within these recommended safe temperatures. Place the material as close as possible to the recommended pouring temperature. Do not maintain any single batch of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer’s recommendations.

Fill the joint reservoir with sealing material to the level shown on the Standard Drawings. Do not let sealing material to spread over the pavement surface.

When required, place the tape bond breaker and/or backer rods on the bottom surface of the joint reservoir before sealing. Do not extend tape up the reservoir face more than 3 mm (1/8 inch). If necessary for support, install an acceptable joint backing material below the tape.

**2. Neoprene Seals.** Install preformed neoprene seals as specified, using installation equipment capable of placement without cutting, nicking, twisting, or damaging the seal. Install seals with lubricant adhesive applied, according to manufacturer's recommendations, to the contact surfaces of the joint faces or sides of the seal. Install seal in one piece to the depth indicated unless approved. Do not elongate the seal more than 3% or compress longitudinally more than 2%.

Prepare and submit a QC Plan to the Representative at the start of the project, as specified in Section 106.03(a)2. As a minimum include the following in the QC Plan: Contractor's and manufacturer's representatives; list of equipment and construction sequence; list of material, along with sampling and testing procedures; test section schedule; and procedure to replace unacceptable seals.

Before sealing joints, seal a minimum of three full-width pavement joints, according to the test section schedule specified in the QC Plan. Have the manufacturer's representative witness the test section(s) unless otherwise permitted in writing. The Representative will inspect the test section(s). Do not seal the remaining pavement joints until the Representative accepts an installation procedure. Conduct test(s) according to QC Plan when material is changed or seal installations are unacceptable.

Replace seals exceeding 3% elongation or 2% compression, or otherwise not conforming to the specifications at no expense to the Department. Patch pavement damaged by removing unacceptable seals and adhesive as specified in Section 525.

**3. Silicone Seals.** Prepare the joint and place silicone sealant material according to the manufacturers recommendations.

**(o) Surface Tolerance.** After the concrete has hardened, test the surface of pavement again, using straightedges, as specified in Section 501.3(k)3. Remove high points in excess of 6.5 mm (1/4 inch) by means of grinding or cutting tools, as directed. The Representative will consider pavement containing depressions of more than 6.5 mm (1/4 inch) to be defective.

**1. Longitudinal Joints.** Test the surface of pavement at all longitudinal joints, including the joint between the pavement and shoulder, again for the following tolerance requirements:

- Where there is no change in the design cross slope across a joint, the tolerance will not be greater than 6 mm (1/4 inch) as measured by holding a 3 m (10-foot) straightedge centered across and perpendicular to the joint.

- Where there is a change in the design cross slope across a joint, the tolerance will not be greater than 6 mm (1/4 inch) as measured by holding a 1.2 m (4-foot) straightedge perpendicular to and on each side of the joint.

- Remove high points in excess of 6 mm (1/4 inch) by means of grinding or with cutting tools, as directed. Pavement containing depressions of more than 3 mm (1/8 inch) between adjacent lanes will be considered defective.

**(p) Protection of Pavement.** Protect pavement, as specified in Section 901, and exclude traffic, including construction equipment. When required to complete adjacent pavement, the spreading, finishing, and subgrade machines may operate on the pavement surface after 96 hours if 21 MPa (3,000 pounds per square inch) is achieved.

**(q) Opening to Traffic.** The Representative will determine when pavement may be opened to traffic. However, do not open to traffic in less than 96 hours for normal strength concrete or 72 hours for HES concrete and until pavement develops the required 21 MPa (3,000 pounds per square inch) minimum compressive strength, determined by compressive tests made on cylinder specimens, according to PTM No. 604.

**(r) Protection Against Rain.** Provide sufficient materials on site, at all times, to properly protect the pavement edges and surface against rain, before initial set of concrete. If rain appears imminent, stop paving operations, immediately protect the pavement sides, and cover the concrete surface with protective material.

**(s) Tests for Depth.** Before final acceptance of the project, proceed as follows:

- The Department will divide the mainline pavement into lots representing not more than 2 500 $m^2$ (3,000 square yards) of pavement in each traffic lane. A traffic lane is defined as the pavement surface between longitudinal joints or between a longitudinal joint and the pavement edge. Include ramps in a separate lot or lots. The Inspector will select one coring location at random within each lot according to PTM No. 1. Drill cores according to AASHTO T 24 and in the presence of the Inspector. Thoroughly clean the vertical surface of the core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, nonshrink grout

- Provide a measuring apparatus conforming to PTM No. 614. The Inspector will determine the core depth according to PTM No. 614.

- If any core measurement is deficient by more than 6.5 mm (1/4 inch) in required depth, drill additional cores in the presence of and for measurement by the Inspector.

- Drill the additional cores at 30 m (100-foot) intervals in both directions longitudinally from each deficient core, in the same traffic lane, until the depth is no more than 6.5 mm (1/4 inch) deficient. Each core will represent the condition in the same traffic lane for a distance of 15 m (50 feet) in both directions longitudinally.

- If any core measurement is deficient by more than 12.5 mm (1/2 inch) in required depth, the Inspector will consider the pavement to be defective.

- Submit every tenth core to the MTD for 28 day compressive strength testing according to AASHTO T 24. For a partial lot, the Inspector will randomly select one core, according to PTM No. 1, for testing. If the core strength is less than 26 Mpa (3,750 pounds per square inch) immediately perform an investigation of the concrete operations to determine the cause of the low strength. Provide a written evaluation of the problem and the proposed solution to the Department.

**(t) Defective Work.** Unless otherwise directed in writing by the District Executive, remove and replace pavement that is: defective in construction or sawing of transverse joints as specified in Section 501.3(i); defective in curing requirements as specified in Section 501.3(l)2; defective in surface tolerance, as specified in Section 501.3(o); defective in depth, as specified in Section 501.3(s); defective in air content, as specified in Section 704.1(c)3; defective in compressive strength as specified in Section 704.1(d), or showing surface defects resulting from the effects of freezing and thawing, rain, improper final finish, or honeycombing which, in the Representative's opinion, cannot be repaired. Repair pavement that is cracked or spalled in accordance with Table A.

The minimum pavement removal and replacement length between transverse joints is 3 m (10 feet) if constructing reinforced cement concrete pavements or 2 m (6 feet) if constructing plain cement concrete pavements. After removal of defective pavement, construct required transverse joints according to the methods for joining pavements, as shown on the Standard Drawings. Where replacement extends to an existing transverse joint, satisfactorily salvage the joint or replace in kind, as directed.

If removing and replacing pavement defective in depth, start at the determined point of deficiency as determined by the Representative. Remove and replace defective work transversely for the full-lane width and longitudinally, until the pavement is not more than 6.5 mm (1/4 inch) deficient in depth, as specified in Section 501.3(s).

**501.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

**(a) Adjustment for Deficient Pavement.** Where a deficiency exists, as determined by cores, the Department will pay as follows:

| Deficiency in Depth Determined by Cores mm (inches) | Proportional Part of Contract Price Allowed |
|---|---|
| 0.0 to 6.5 (0.0 to 0.25) | 100% |
| 6.6 to 7.7 (0.26 to 0.30) | 95% |
| 7.8 to 8.9 (0.31 to 0.35) | 85% |
| 9.0 to 10.1 (0.36 to 0.40) | 75% |
| 10.2 to 11.3 (0.41 to 0.45) | 50% |
| 11.4 to 12.5 (0.46 to 0.50) | 25% |

**(b) Defective Pavement Left in Place.** The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective pavement be left in place, final payment for this pavement will be at 5% of the contract price.

**(c) Concrete Pavement Cores.** Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled if the depth is deficient by more than 6.5 mm (1/4 inch).

# SECTION 503—PROTECTIVE COATING FOR CEMENT CONCRETE PAVEMENT

**503.1 DESCRIPTION**—This work is the application of protective coating, to concrete pavements and shoulders.

**503.2 MATERIAL—**

- Boiled Linseed Oil, AASHTO M 233, from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

**503.3 CONSTRUCTION—**

**(a) General.** Thoroughly dry and clean concrete surfaces of all foreign matter, which would prevent protective coating penetration, adhesion, or drying. Allow a minimum of 28 days to elapse before applying protective coating on surfaces cured with white membrane curing compound. Allow 7 days to elapse after removing curing covers and before applying protective coating on all other types of curing methods. Apply the protective coating before subjecting the concrete surface to deicing chemicals.

**(b) Application.** Apply protective coating according to manufacturer recommendations. At a minimum, apply in two coats, at a rate of 1 L/11 $m^2$ (0.02 gallon per square yard) for each coat. Apply, as directed, by pressure-spray equipment, by portable hand spray equipment, by brushing, or by a combination of methods, to ensure complete coverage of treated concrete surfaces.

Unless otherwise permitted, apply in weather suitable for drying when the air temperature and concrete surface temperature are between 2 °C and 40 °C (35F and 100F).

Unless otherwise recommended by the manufacturer, allow the first application to dry for a period of at least 24 hours before the second application. If the initial application is made on concrete surfaces carrying traffic, close these surfaces for a period of at least 4 hours, until penetration is complete and tackiness has disappeared.

After the second application, close surface to traffic for a period of at least 6 hours or until tackiness has disappeared and no pickup results from use.

**(c) Safety Precautions.** Protect traffic, workers, and concrete surface against the occurrence of fire, if in the presence of flammable and volatile mineral spirits blended into the protective coating. Before using the treated pavement surface, satisfactorily correct slippery pavement conditions, other hazards, or inconvenience to traffic, resulting from the protective coating application as directed.

**503.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 504—PAVEMENT RELIEF JOINT

**504.1 DESCRIPTION**—This work is construction of a pavement relief joint, including subbase material and necessary excavation.

**504.2 MATERIAL**—

- Class AA Cement Concrete—Section 704
- High Early Strength Cement Concrete—Section 704
- Reinforcement Bars—Section 709.1
- Bituminous Paper—Section 727
- Asphalt Cement, PG 64-22—Section 702
- Subbase—Section 350.2
- Bituminous Wearing Course ID-2—Section 420.2
- HMA Wearing Course (Standard)—Section 409.2
- Bituminous Concrete Base Course—Section 305.2
- HMA Base Course (Standard)— Section 409.2
- Superpave Asphalt Mixture Design, HMA Wearing Course, SRL-L—Section 409.2 and as follows: PG 64-22, 3 to <10 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, HMA Base Course—Section 309.2 and as follows: PG 64-22, 3 to <10 million ESALs, or as indicated or directed.

**504.3 CONSTRUCTION**—As shown on the Standard Drawing RC 24M and as follows:

**(a) Excavation.** Excavate for the concrete subslab after constructing the subbase.

**(b) Subslab.** Construct the concrete subslab as specified in the applicable requirements of Section 501.3.

**(c) Base Course.** Construct the bituminous concrete base course as specified in Section 305.3 or Superpave Asphalt Mixture Design, HMA Base Course as specified in Section 309.3.

**(d) Wearing Course.** Construct either Bituminous Wearing Course ID-2 as specified in Section 420.3, or Bituminous Wearing Course FJ-1 as specified in Section 422.3, or Superpave Asphalt Mixture Design, HMA Wearing Course as specified in Section 409.3.

**504.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)
Measured transversely.

# SECTION 505—BRIDGE APPROACH SLABS

**505.1 DESCRIPTION**—This work is construction of reinforced cement concrete approach slabs, including the joint adjacent to bridge superstructures.

**505.2 MATERIAL—**

**(a) Reinforced Cement Concrete Pavement** – Section 505.2

**(b) Neoprene Strip Seal Dam** – Section 1026.2

**505.3 CONSTRUCTION**—As shown on the Standard Drawings and as specified in Section 501.3 and Section 1026.3, except that a longitudinal joint is not required.

**505.4 MEASUREMENT AND PAYMENT—**

**(a) Bridge Approach Slab.** Square Meter (Square Yard)

**(b) Neoprene Strip Seal Dam.** Section 1026.4

# SECTION 506—REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS, RPS

**506.1 DESCRIPTION**—This work is construction of normal strength or high early-strength (HES) cement concrete pavement, plain or reinforced, on a prepared surface, under restricted performance specifications (RPS).

**506.2 MATERIAL**—Section 501.2 with the following modification:

Once material control is established, as specified in Section 704.1(d)4.a, the frequency of testing may be reduced to a minimum of one test every 30 minutes.

**506.3 CONSTRUCTION**—Section 501.3, with the following modifications:

**(p) Surface Tolerance.** Test the surface of pavement as follows:

**1. Mainline Paving.** Test as specified in Section 507 and Section 501.3(o)1. These pavements include, but are not limited to any full width lane used for travel, passing, climbing, center turn, acceleration, deceleration, and ramps.

**2. Other than Mainline Pavement.** Test as specified in Section 501.3(o). These pavements include, but are not limited to approach slabs, bridge decks, tapers, shoulders, medians, or other pavement surfaces as directed.

**(t) Tests for Depth.** Replace with the following:

The Inspector will determine lots and sublots as specified in Section 506.3(v).

Complete any surface corrective work before testing for pavement depth. Test pavement depth by obtaining one core from each sublot. The Inspector will determine the location of each core using PTM No. 1.

Drill cores at each sublot location, as specified in AASHTO T 24, in presence of the Inspector. Thoroughly clean the vertical surface of the core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, nonshrink grout.

Provide a measuring apparatus conforming to the requirements of PTM No. 614.

The Inspector will:

- determine the core length as specified in PTM No. 614,
- determine the average lot pavement thickness by averaging the individual sublot core thicknesses,
- accept concrete as specified in Section 506.3(v)1, and
- determine price adjustments as specified in Section 506.4(a).

Submit every tenth core to the MTD for 28-day compressive strength testing according to AASHTO T 24. For a partial lot, the Inspector will randomly select one core, according to PTM No. 1, for testing. If the core strength is less than 26 Mpa (3750 pounds per square inch) immediately perform an investigation of the concrete operations to determine the cause of the low strength. Provide a written evaluation of the problem and the proposed solution to the Department.

**(u) Defective Work.** Replace with the following:

Unless otherwise directed in writing, as specified in Section 110.10(d)1.a, by the District Executive, remove and replace pavement determined defective as follows:

**1. Depth.** The lot will be defective if the average core depth of the lot is less than the design thickness (D) minus 12.5 mm (1/2 inch) or more than one individual sublot core depth is less than the design thickness minus 12.5 mm (1/2 inch).

**2. Compressive Strength or Air Content.** The lot is defective if PWL for compressive strength or the plastic air content is less then 55%, as specified in Section 506.3(v)2.

**3. Other Conditions.** The lot is defective if the pavement contains surface defects from rain, improper final finish, or honeycombing that cannot be satisfactorily repaired as determined by the Representative.

**4. Other Than Mainline Pavement Surface Tolerance.** The lot is defective if the pavement contains depressions or high points as specified in Section 506.3(p) that cannot be satisfactorily corrected as determined by the Representative.

**5. Edge Slumping.** The pavement is defective if the requirements specified in Section 501.3(g)5 are not met.

Remove and replace a minimum of 3 m (10 feet) of pavement between transverse joints of reinforced cement concrete pavements or an entire panel of plain cement concrete pavement. Longitudinal edge spall repairs are not considered satisfactory repairs for edge slumping or spalling between adjacent lanes or outside pavement edges.

Where replacement extends to an existing transverse joint, replace the joint in kind. Construct transverse joints at other locations resulting from removal of defective pavement using the methods for joining pavements shown on the Standard Drawings.

**(v) Acceptance.** Add this section as follows:

Lots and sublots for the combined pavement characteristics of depth, strength, and air content will be determined based on the full width of pavement placement. Lots and sublots will begin at the starting point of paving and continue until 4 680 $m^2$ (5,600 square yards) are placed. Lots and sublots will be calculated as the work progresses and will include any pavement designated as RPS pavement. Do not combine various depth pavement into any lot or sublot.

A full lot is defined as 4 680 $m^2$ (5,600 square yards) of pavement, of the same constant depth, and consists of four equal sublots of 1 170 $m^2$ (1,400 square yards) each.

Combine partial lots with the last full lot or make a separate lot according to the following procedure:

- If less than 3 510 $m^2$ (4,200 square yards) remain, combine the remaining pavement with the last full lot.
- If the remaining pavement is equal to or greater than 3 510 $m^2$ (4,200 square yards), consider the remaining pavement as a separate lot.
- Determine sublots for the last pavement lot by establishing a number of equal size sublots.
- Determine the number of sublots by dividing the area of the combined lot or partial lot by 1 170 $m^2$ (1,400 square yards) and then rounding to the nearest whole number.
- Determine the equal size of each sublot by dividing the combined lot or partial lot quantity by the number of whole sublots calculated.
- Determine lots and sublots based on the full width of pavement placement.

**1. Depth.** The Representative will accept each lot for compliance with the specifications, for depth if the average core depth of the lot is more than the design thickness (D) minus 12.5 mm (0.5 inch) and not more than one individual sublot core depth is less than the design thickness minus 12.5 mm (0.5 inch).

**2. Compressive Strength and Air Content.** The Representative will accept concrete for compliance with the specification requirements, for compressive strength and air content, on a lot-by-lot basis, as specified in Section 105 and Section 106. The Representative will determine locations where samples of plastic concrete will be lifted, using PTM No. 1. Make one compressive strength test and one test for percentage of plastic air content on samples from each sublot.

Sublot plastic air content acceptance test results that are outside specification limits will be included in the determination of the PWL.

Mold acceptance cylinders at the determined sublot location. The average of the test results from two cylinders, made from the same sample, tested as specified in PTM No. 604, will constitute the 28-day compressive strength. Cure test specimens according to Subsection 11.1 of PTM No. 611. The result of one sample of concrete obtained and tested according to AASHTO T 152 for stone and gravel, or AASHTO T 196 for slag coarse aggregate, will constitute the percentage of air content. The Representative will accept concrete based on the adequacy and uniformity of compressive strength at the age of 28 days, and, with respect to the air content, when the PWL is 55% or greater.

Calculate the value of Q by one of the following equations, where $\overline{X}_4$ is the average of the sublot test results. $Q_L$ is the lower quality index and $Q_U$ is the upper quality index. "s" is the Standard Deviation as specified in Section 106.03(a)3.a.4.

**2.a** For Class AA 28-day concrete compressive strength,

$$METRIC: \quad Q_L = \frac{\overline{X}_4 - 23\ MPa}{s}$$

$$ENGLISH: \quad Q_L = \frac{\overline{X}_4 - 3{,}300\ psi}{s}$$

**2.b** For percentage of air content of Class AA concrete,

$$Q_L = \frac{\overline{X}_4 - 4.5\%}{s} \quad and \quad Q_U = \frac{7.5\% - \overline{X}_4}{s}$$

Determine the percentage of material within specification limits as specified in Section 106.03(a)3.

**506.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

The Department will pay on a lot-by-lot basis at the contract price, adjusted for pavement characteristics relative to depth, compressive strength, and air content. The lot payment will be determined according to the multiple characteristic formula specified in Section 506.4(a)3.

**(a) Adjustment for Pavement Characteristics.**

**1. Depth.** The lot average core depth will be determined as specified in Section 506.3(t). The characteristic percentage for depth will be determined using Table A. The characteristic percentage for depth will be placed in the multiple characteristic formula as Pd specified in Section 506.4(a)3 to determine the lot payment.

**2. Compressive Strength and Air Content.** The Percent Within Limits will be determined for the lot as specified in Section 506.3(v)2. The characteristic percentages for compressive strength and air content will be determined by using Table B. The characteristic percentage for compressive strength and the characteristic percentage for air content will be used as Ps and Pa respectively in the multiple characteristic formula specified in Section 506.4(a)3 to determine the lot payment.

**3. Multiple Characteristic Formula.** The lot payment will be determined according to the following formula:

$$L_p = C_p\left[\frac{(2Ps + 2Pd + Pa)}{500}\right]$$

where:

$L_p$ = Lot Payment
$C_p$ = Contract price per lot (contract price times lot size)
Ps = Characteristic Percentage of Compressive Strength—(Table B)
Pd = Characteristic Percentage for Depth—(Table A)
Pa = Characteristic Percentage for Air Content—(Table B)

**TABLE A (Metric)**
**Characteristic Percentages for Concrete Pavement Cores (Pd)**
**Relative to Specification Limits**

**380 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 380.00 or greater | 100.0 |
| 377.50 - 379.99 | 97.1 |
| 375.00 - 377.49 | 94.4 |
| 372.50 - 374.99 | 91.4 |
| 370.00 - 372.99 | 88.0 |
| 367.50 - 369.99 | 86.4 |
| Less than 367.50 | * |

**360 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 360.00 or greater | 100.0 |
| 357.50 - 359.99 | 96.7 |
| 355.00 - 357.49 | 93.6 |
| 352.50 - 355.99 | 90.3 |
| 350.00 - 352.49 | 86.5 |
| 347.50 - 350.99 | 84.6 |
| Less than 347.50 | * |

**330 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 330.00 or greater | 100.0 |
| 327.50 - 329.99 | 96.3 |
| 325.00 - 327.49 | 92.8 |
| 322.50 - 324.99 | 89.2 |
| 320.00 - 322.49 | 85.0 |
| 317.50 - 319.99 | 82.8 |
| Less than 317.50 | * |

**300 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 300.00 or greater | 100.0 |
| 297.50 - 299.00 | 95.9 |
| 295.00 - 297.49 | 92.0 |
| 292.50 - 294.99 | 88.1 |
| 290.00 - 292.49 | 84.5 |
| 287.50 - 289.99 | 81.0 |
| Less than 287.50 | * |

**280 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 280.00 or greater | 100.0 |
| 277.50 - 279.99 | 95.5 |
| 275.00 - 277.49 | 91.2 |
| 272.50 - 274.99 | 87.0 |
| 270.00 - 272.49 | 83.0 |
| 267.50 - 269.99 | 79.2 |
| Less than 267.50 | * |

**250 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 250.00 or greater | 100.0 |
| 247.50 - 249.99 | 95.1 |
| 245.00 - 247.49 | 90.4 |
| 242.50 - 244.99 | 85.9 |
| 240.00 - 242.49 | 81.5 |
| 237.50 - 239.99 | 77.4 |
| Less than 237.50 | * |

**230 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 230.00 or greater | 100.0 |
| 227.50 - 229.99 | 94.0 |
| 225.00 - 227.49 | 89.3 |
| 222.50 - 224.99 | 84.4 |
| 220.00 - 222.49 | 79.6 |
| 217.50 - 219.99 | 75.1 |
| Less than 217.50 | * |

**200 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 200.00 or greater | 100.0 |
| 197.50 - 199.99 | 93.9 |
| 195.00 - 197.49 | 88.1 |
| 192.50 - 194.99 | 82.6 |
| 190.00 - 192.49 | 77.3 |
| 187.50 - 189.99 | 72.4 |
| Less than 187.50 | * |

**180 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 180.00 or greater | 100.0 |
| 177.50 - 179.99 | 93.7 |
| 175.00 - 177.49 | 87.7 |
| 172.50 - 174.99 | 80.8 |
| 170.00 - 172.49 | 75.1 |
| 167.50 - 169.99 | 69.7 |
| Less than 167.50 | * |

**150 mm Design Thickness**

| Average Core Thickness, mm | Characteristic Percentage Pd |
|---|---|
| 150.00 or greater | 100.0 |
| 147.50 - 149.99 | 93.4 |
| 145.00 - 147.49 | 86.8 |
| 142.50 - 144.99 | 78.7 |
| 140.00 - 142.49 | 72.6 |
| 137.50 - 139.99 | 66.8 |
| Less than 137.50 | * |

* Defective work, as specified in Section 506.3(u).

**TABLE A (English)**
**Characteristic Percentages for Concrete Pavement Cores (Pd)**
**Relative to Specification Limits**

**15-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 15.00 or greater | 100.0 |
| 14.90 - 14.99 | 97.1 |
| 14.80 - 14.89 | 94.4 |
| 14.70 - 14.79 | 91.4 |
| 14.60 - 14.69 | 88.0 |
| 14.50 - 14.59 | 86.4 |
| Less than 14.50 | * |

**14-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 14.00 or greater | 100.0 |
| 13.90 - 13.99 | 96.7 |
| 13.80 - 13.89 | 93.6 |
| 13.70 - 13.79 | 90.3 |
| 13.60 - 13.69 | 86.5 |
| 13.50 - 13.59 | 84.6 |
| Less than 13.50 | * |

**13-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 13.00 or greater | 100.0 |
| 12.90 - 12.99 | 96.3 |
| 12.80 - 12.89 | 92.8 |
| 12.70 - 12.79 | 89.2 |
| 12.60 - 12.69 | 85.0 |
| 12.50 - 12.59 | 82.8 |
| Less than 12.50 | * |

**12-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 12.00 or greater | 100.0 |
| 11.90 - 11.99 | 95.9 |
| 11.80 - 11.89 | 92.0 |
| 11.70 - 11.79 | 88.1 |
| 11.60 - 11.69 | 84.5 |
| 11.50 - 11.59 | 81.0 |
| Less than 11.50 | * |

**11-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 11.00 or greater | 100.0 |
| 10.90 - 10.99 | 95.5 |
| 10.80 - 10.89 | 91.2 |
| 10.70 - 10.79 | 87.0 |
| 10.60 - 10.69 | 83.0 |
| 10.50 - 10.59 | 79.2 |
| Less than 10.50 | * |

**10-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 10.00 or greater | 100.0 |
| 9.90 - 9.99 | 95.1 |
| 9.80 - 9.89 | 90.4 |
| 9.70 - 9.79 | 85.9 |
| 9.60 - 9.69 | 81.5 |
| 9.50 - 9.59 | 77.4 |
| Less than 9.50 | * |

**9-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 9.00 or greater | 100.0 |
| 8.90 - 8.99 | 94.0 |
| 8.80 - 8.89 | 89.3 |
| 8.70 - 8.79 | 84.4 |
| 8.60 - 8.69 | 79.6 |
| 8.50 - 8.59 | 75.1 |
| Less than 8.50 | * |

**8-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 8.00 or greater | 100.0 |
| 7.90 - 7.99 | 93.9 |
| 7.80 - 7.89 | 88.1 |
| 7.70 - 7.79 | 82.6 |
| 7.60 - 7.69 | 77.3 |
| 7.50 - 7.59 | 72.4 |
| Less than 7.50 | * |

**7-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 7.00 or greater | 100.0 |
| 6.90 - 6.99 | 93.7 |
| 6.80 - 6.89 | 87.4 |
| 6.70 - 6.79 | 80.8 |
| 6.60 - 6.69 | 75.1 |
| 6.50 - 6.59 | 69.7 |
| Less than 6.50 | * |

**6-inch Design Thickness**

| Average Core Thickness, inches | Characteristic Percentage Pd |
|---|---|
| 6.00 or greater | 100.0 |
| 5.90 - 5.99 | 93.4 |
| 5.80 - 5.89 | 86.8 |
| 5.70 - 5.79 | 78.7 |
| 5.60 - 5.69 | 72.6 |
| 5.50 - 5.59 | 66.8 |
| Less than 5.50 | * |

* Defective work, as specified in Section 506.3(u).

**TABLE B**
**Characteristic Percentages for Concrete Pavement**
**Compressive Strength (Ps) or Air Content (Pa)**
**Relative to Specification Limits**

| Percent Within Specification Limits | Characteristic Percentage |
|---|---|
| 90 - 100 | 100 |
| 85 - 89 | 99 |
| 75 - 84 | 94 |
| 65 - 74 | 83 |
| 55 - 64 | 66 |
| Below 55 | * |

* Defective work, as specified in Section 506.3(u).

**(b) Defective Pavement Left in Place.** The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive.

**(c) Concrete Pavement Cores.** Each

The price includes measuring apparatus, which remains the Contractor's property upon completion of the project.

**(d) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive.** As specified in Section 507.4.

# SECTION 507—EVALUATION OF CONCRETE PAVEMENT RIDE QUALITY AND PAYMENT OF INCENTIVE

**507.1 DESCRIPTION**—This work is evaluating a concrete pavement surface profile and determining the ride-quality incentive associated with the pavement surface profile.

**(a) General Requirements.** Determine the ride quality of finished pavement surfaces, including approach slabs and pavement relief joints. In the presence of the Inspector, measure the pavement surface profile according to PTM No. 428. Provide the resultant International Roughness Index IRI data to the Representative. The Representative will determine payment for each ride-quality lot based on the IRI.

Measure the pavement surface of the following excluded areas separate from the pavement surface profile of ride-quality lots. The Representative will not include measurements from excluded areas to determine lot incentive payment.

- Bridge decks.
- Ramps less than 457 m (1,500 feet) in length.
- Tapered pavements less than 3.6 m (12 feet) wide.
- Shoulders, medians, and other pavement surfaces indicated.
- Partial lots less than 30 m (100 feet).

**(b) Lot Size.** A full lot is 161 m (528 feet) of a single pavement lane with the same lot type. The lot types are Type 1 (posted speed limit greater than 70 km/hour (45 miles per hour)) and Type 2 (posted speed limit less than or equal to 70 km/hour (45 miles per hour)). The Representative will designate lots starting at the beginning limit of paving and continuing to the ending limit of paving for each pavement lane and ramp that is 3.6 m (12 feet) or wider. Do not include the length of excluded areas in the 161 m (528 feet). If the lot type changes, end the lot and begin a new lot.

The Representative will designate a partial lot at the ending limit of paving, at a change in the lot type, and at an excluded area, when the lot length is less than 161 m (528 feet). The Representative will evaluate a partial lot as a percentage of a full lot.

**507.3 CONSTRUCTION—**

**(a) Equipment and Operator.** Provide pavement surface profile measuring equipment that has been verified by the Department according to PTM No. 428. In the presence of the Inspector, calibrate the distance sensor and check the profile system calibration before each day's testing.

Provide an operator that is Department certified according to PTM No. 428.

**(b) Testing.**

**1. Lots.** Provide the traffic control and station marking necessary to accommodate testing. Remove objects and equipment from the surface and sweep the surface as necessary to remove debris. In the presence of the Inspector, determine the pavement surface profile for each lot according to PTM No. 428. At the completion of testing, immediately submit the lot IRI data, as defined in PTM No. 428, to the Representative.

**2. Excluded Areas.** Provide traffic control necessary to accommodate testing. Test the entire surface of each excluded area in stages using a 3 m (10-foot) straightedge. At each stage, hold the straightedge in contact with the surface and parallel to the road centerline and, in successive positions, test the pavement surface profile from one side of the excluded area to the other. Advance the test location to the next stage by moving the straightedge along the roadway centerline not more than 1.5 m (5 feet).

**(c) Acceptance.**

**1. Lots.** The Representative will compare the lot IRI to Table A in Section 507.4 to determine if the lot requires corrective action. Additionally, perform corrective action on any individual bump (must grind) where the irregularity is more than 6 mm (1/4 inch) when tested with a 3 m (10-foot) straightedge.

**2. Excluded Areas.** Perform corrective action where irregularities are more than 6 mm (1/4 inch) when tested with a 3 m (10-foot) straightedge. Correct longitudinal joints not conforming to the requirements specified in Section 501.3(o)1. To improve the ride quality and at the Department's expense, the Representative may require grinding of excluded areas that conform to the acceptable straightedge surface tolerances specified in Section 507.3(c).

**(d) Corrective Action.**

**1.** Do not produce a deviation, such as a ridge or valley with the adjacent pavement, of more than 3 mm (1/8 inch) when measured on the transverse profile. Correct a sufficient length of pavement to correct the pavement surface profile without producing additional high or low points. Retest the lots and excluded areas after completing corrective action. Perform additional measurements of the pavement surface profile, as necessary, for the Representative to determine which lots do not require additional corrective action. Correct surfaces to a uniform texture and cross section.

**2.** Perform all corrective action before testing for pavement depth. If protective coating was applied before grinding, reapply to ground area. Use one or more of the following methods:

**2.a. Carbide Grinding.** Use carbide grinding for correcting areas 4.5 m (15 feet) in length or less. Use grinders of the walk-behind type that have cutting heads of carbide tipped shackles, stars, or blades and have a locking depth control to produce a uniform pavement surface texture.

Provide a pavement surface texture consisting of parallel grooves between 2 mm and 6 mm (3/32 inch and 1/4 inch) wide width a "land area" between grooves 2 mm and 5 mm (1/16 inch and 3/16 inch). Operate the grinder by making multiple passes if necessary, with a maximum depth of any single pass of 3 mm (1/8 inch). Grind longitudinally or transversely across the pavement surface.

**2.b. Diamond Grinding.** As specified in Section 514.3 and modified as follows:

**(d) Tolerance.** Delete this section.

Unless otherwise approved, grind the entire lane width.

**2.c. Removal and Replacement.** Remove and replace a minimum of 3 m (10 feet) of pavement between transverse joints of reinforced cement concrete pavements or an entire panel of plain cement concrete pavement. Where replacement extends to an existing transverse joint, replace the joint in kind as directed. Construct transverse joints at other locations resulting from removal of defective pavement using the methods for joining pavements shown on the Standard Drawings.

**(e) Defective Work.** A ride-quality pavement lot is defective if:

- The IRI of the lot exceeds the maximum acceptable IRI specified in Table A of Section 507.4.
- Any individual bump (must grind) exists in the lot where the irregularity is more than 6.5 mm (1/4 inch) when tested with a 3 m (10-foot) straightedge.
- The surface adjacent to another ride-quality lot contains a ridge or valley of more than 3 mm (1/8 inch).
- The specifications for pavement construction require removal and replacement of pavement within the ride-quality lot.

Unless the Department and Contractor agree to leave a defective lot in place as specified in Section 507.4, remove and replace defective areas and retest the ride-quality lot.

**507.4 MEASUREMENT AND PAYMENT**—Dollar

The proposal will include an item and a predetermined amount of money for Evaluation Of Bituminous Concrete Pavement Ride Quality And Payment Of Incentive. The contract item will have a unit of measure of DOLLAR, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Evaluation Of Bituminous Pavement Ride Quality And Payment Of Incentive item as follows:

If the lot is not defective, Table A and the IRI for each lot will be used to determine the incentive payment for ride quality.

The incentive payment for a lot subjected to corrective action will be determined using Table A and the IRI for the lot after the Contractor completes corrective action.

The incentive payment for a partial lot will be determined as a percentage of a full lot.

After corrective action, the Contractor may leave a defective lot in place if the District Executive provides written approval and the Contractor accepts a $4,000 downward adjustment (rebate) of the amount paid for the lot.

Costs associated with evaluating pavement ride quality will not be paid for separately.

**TABLE A**
**Payment Schedule for Ride Quality Incentive**

| **Type 1 Lots** | |
|---|---|
| **IRI mm/km/lot (inches/mile/lot)** | **Amount** |
| ≤ 553 (35) | $1,500 |
| ≤ 790 (50) | $1,000 |
| ≤ 948 (60) | $500 |
| ≤ 1105 (70)* | $0 |
| > 1105 (70) | Corrective Action Required |
| * Maximum acceptable IRI | |

| **Type 2 Lots** | |
|---|---|
| **IRI mm/km/lot (inches/mile/lot)** | **Amount** |
| ≤ 710 (45) | $1,500 |
| ≤ 868 (55) | $1,000 |
| ≤ 1105 (70) | $500 |
| ≤ 1420 (90)* | $0 |
| > 1420 (90) | Corrective Action Required |
| * Maximum acceptable IRI | |

# SECTION 510—LONGITUDINAL GROOVING OF EXISTING CONCRETE PAVEMENT

**510.1 DESCRIPTION**—This work is the cutting of longitudinal grooves in existing cement concrete pavement.

**510.3 CONSTRUCTION**—Satisfactorily groove the existing pavement surface longitudinally between the limiting stations indicated. Do not use flailing type equipment. Do not cut grooves on bridge decks. Cut 2.5 mm (3/32-inch) wide grooves, with a tolerance of plus 1.5 mm (1/16 inch), a 19 mm (3/4 inch) center-to-center spacing, and a minimum depth of 5 mm (3/16 inch). Do not cut grooves within 150 mm (6 inches) of the outside edge and centerline pavement joint. Do not allow the cutting slurry to accumulate on adjacent lanes. Remove the slurry and satisfactorily clean the grooves as the work progresses.

**510.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)
Measured on the finished grooved area.

# SECTION 511—PRESSURE RELIEF JOINT

**511.1 DESCRIPTION**—This work is construction of a pavement pressure relief joint.

**511.2 MATERIAL—**

**(a) Pressure Relief Material.** Section 705.4(e) or (f)

**(b) Approved Sealant or Lubricant.** As recommended by the manufacturer of the pressure relief material.

**511.3 CONSTRUCTION**—Saw the joint opening 100 mm (4 inches) wide, full depth, and full width of the pavement. Remove the existing concrete material. Immediately before placing the sealing material, sandblast all vertical faces of the joint, clean with a compressed air stream measuring 700 kPa (100 pounds per square inch) at the source and ensure the joint is free of oil, moisture, and other contaminants. Coat joint sides with either the sealant or lubricant adhesive according to the manufacturer's recommendations.

**511.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 512—LONGITUDINAL JOINT CLEANING AND SEALING

**512.1 DESCRIPTION**—This work is cleaning and sealing longitudinal joints in existing cement concrete pavements.

**512.2 MATERIAL**—Section 705.4(b) or (c)

**512.3 CONSTRUCTION**—Thoroughly clean the longitudinal joints of all existing sealing material, bituminous material, and other foreign material by sawing, sandblasting, or water blasting. Clean original saw-cut joints to a minimum depth of 40 mm (1 1/2 inches). Clean original formed construction joints to a minimum depth of 20 mm (3/4 inch). If sawing is used, immediately flush the joint with water. If water blasting, use a waterblaster with a minimum operating capacity of 0.6 L/s (10 gallons per minute) at 48 MPa (7,000 pounds per square inch).

Seal the joint, as specified in the applicable parts of Section 501.3(n), to a level 3 mm to 6 mm (1/8 inch to 1/4 inch) below the pavement surface.

**512.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 513—JOINT REHABILITATION

**513.1 DESCRIPTION**—This work is construction of a sealant reservoir and sealing transverse contraction, construction, or expansion joints in existing Portland cement concrete pavements of the type indicated.

Joint Rehabilitation is classified into two types as follows:

**(a) Type 1.** Joint Rehabilitation of existing saw-cut joints.

**(b) Type 2.** Joint Rehabilitation of existing metal plate joints.

**513.2 MATERIAL—**

**(a) Joint Sealing Material.** Section 705.4(b) or (c)

**(b) Joint Backing Material.** Section 705.9

**(c) Tape Bond Breaker.** Duct tape, the width of the sealant reservoir.

**513.3 CONSTRUCTION**—As shown on the Standard Drawings, and as follows:

**(a) Type 1.**

**1. General.** Perform this work after spall repairs at the joint are completed. Clean and seal any unrepaired spalls 50 mm (2 inches) or less in dimension. Construct the joint sealant reservoir by sawing to the width and depth indicated for the appropriate existing joint spacing. In general, center the sealant reservoir around the existing joint opening. Immediately after sawing, flush the joint with water.

Place tape bondbreaker on bottom of joint reservoir immediately before sealing. Do not allow tape to extend up reservoir face more than 3 mm (1/8 inch).

**2. Existing Wide Joint.** If the existing joint is as wide as or wider than the required width of sealant reservoir, thoroughly clean the joint to the depth required for the sealant reservoir. Instead of sawing, the vertical faces of the joint may be thoroughly cleaned by sandblasting, or water blasting. If water blasting, use a waterblaster with a minimum operating capacity of 0.6 L/s (10 gallons per minute) at 48 MPa (7,000 pounds per square inch). Place joint backing material to the depth required for the sealant reservoir, if necessary.

**3. Sealing.** Immediately before placing the sealing material, sandblast all vertical faces of the joint and clean, with a compressed air stream measuring 700 kPa (100 pounds per square inch) at the source, free of oil, moisture, and other contaminants. Seal as specified in the applicable parts of Section 501.3(n).

**(b) Type 2.** Construct as specified for Joint Rehabilitation Type 1, except remove the portion of the existing steel plate that lies within the new sealant reservoir before sealing the joint. A maximum of 6 mm (1/4 inch) of the plate may protrude into the reservoir.

**513.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

The unit price includes cleaning and sealing of small unrepaired spalls.

Repair any damage to the existing shoulders because of this work at no additional expense to the Department.

# SECTION 514—DIAMOND GRINDING OF CONCRETE PAVEMENT

**514.1 DESCRIPTION**—This work is the diamond grinding of existing cement concrete surfaces as indicated or directed.

## 514.3 CONSTRUCTION—

**(a) Equipment.** Use a power driven, self-propelled machine having diamond blades and capable of grinding the surface of the pavement to the specified smoothness tolerances and texture. Do not use equipment that causes spalls at joints or cracks, or fractures the aggregate at the surface.

**(b) Grinding.** Grind the pavement in the longitudinal direction beginning and ending at lines normal to the pavement centerline. Grind in either direction unless it is otherwise determined by the Representative that traffic safety considerations mandate grinding with traffic flow. Provide a uniform finished surface, eliminate joint or crack faults, and provide positive lateral surface drainage. Operate grinding machine parallel to centerline. Texture the entire pavement surface; however, do not perform extra depth grinding to eliminate minor depressions. Do not exceed 50 mm (2 inches) of overlap.

Remove slurry or residue resulting from the grinding in a continuous operation. Do not allow grinding slurry to flow across lanes occupied by traffic or to flow into gutters or other drainage facilities. Satisfactorily clean the pavement surface.

**(c) Texture.** Provide a surface texture consisting of parallel grooves between 2.3 mm and 3.3 mm (0.09 inch and 0.13 inch) wide with a "land area" between grooves of 1.52 mm to 2.79 mm (0.060 inch to 0.110 inch) and a difference between the peaks of the ridges and the bottom of the grooves of approximately 1.6 mm (1/16 inch).

**(d) Tolerance.**

**1. Transverse Tolerance.** Restore original pavement cross slope. Maintain a uniform cross slope. Check the uniformity of cross slope at 30 m (100-foot) intervals longitudinally.

Correct any areas with deviations greater than 6 mm (1/4 inch) in 3.6 m (12 feet). Provide a positive cross slope such that the pavement drains.

Provide the Representative with documentation recording the test location and the maximum depth of depression or slope misalignment at that location.

**2. Longitudinal Tolerance.** Supply and operate equipment as specified in Section 507.3(a), for all longitudinal roughness tests. Test the pavement surface roughness in the longitudinal direction and submit the record of the information to the Inspector-in-Charge before beginning any pavement rehabilitation work. Following grinding of the pavement surface, test the longitudinal roughness as specified in Section 507.3(c)1.

Regrind pavement segments as specified in Section 507.3(d).

## 514.4 MEASUREMENT AND PAYMENT—

- Square Meter (Square Yard) if minimum IRI specified in Section 507.4 is attained.

- Incentive payment specified in Table A, in Section 507.4, if IRI meets incentive levels specified in Section 507.

# SECTION 515—SAWING AND SEALING OF BITUMINOUS OVERLAYS

**515.1 DESCRIPTION**—This work is the saw cutting of new bituminous concrete courses directly above existing or constructed transverse joints in the underlying concrete pavement as directed, and sealing the reservoir.

**515.2 MATERIAL—**

**(a) Sealing Material.** Section 705.4(b), (c), or (g)

**(b) Tape Bond Breaker.** Section 513.2(c)

**515.3 CONSTRUCTION—**

**(a) General.** Locate and reference the location of each existing transverse joint before placing any bituminous courses. Make all saw-cuts directly above the existing transverse joints.

Do not saw cut until the bituminous course has thoroughly cooled. Perform saw cutting within 7 days after placing the wearing course. Perform this work on all finished overlay areas before discontinuing work due to seasonal paving limitations.

Make saw-cuts only in the lane in which the existing joint is located. Extend the saw-cuts through any existing widening. Provide separate saw-cuts in each lane if existing transverse joints are offset more than 25 mm (1 inch).

If placing the wearing course the following construction season due to seasonal paving limitations, provide a 25 mm (1-inch) deep, 3 mm (1/8-inch) wide saw-cut in the last placed bituminous concrete course.

**(b) Sawing.** Use the following table to determine saw-cut reservoir size:

| Overlay Thickness (millimeters) | Reservoir (millimeters) |
|---|---|
| 38 or less | 13 deep by 13 wide |
| greater than 38 | 25 deep by 13 wide |

| Overlay Thickness (inches) | Reservoir (inches) |
|---|---|
| 1 1/2 or less | 1/2 deep by 1/2 wide |
| greater than 1 1/2 | 1 deep by 1/2 wide |

Additionally, if the total depth of overlay is 90 mm (3 1/2 inches) or greater make a preliminary saw-cut 3 mm (1/8 inch) wide to a depth of 38 mm (1 1/2 inches) or one-third of the total overlay thickness, whichever is greater. Indicated overlay depths do not include scratch or leveling courses.

If wet sawing, immediately flush the reservoir with water.

If not placing the wearing course within the same construction season, provide a 3 mm (1/8-inch) wide saw-cut in the last placed bituminous course to a minimum depth of 25 mm (1 inch) or one-third the thickness of the bituminous material placed, whichever is greater.

**(c) Sealing.** Do not place sealing material unless the reservoir faces are thoroughly clean and dry. Do not place on the same day as wet sawing. Clean the reservoir by using compressed air immediately before placing sealing material. Use compressed air free of oil, moisture, or any other substance that would prevent bonding of sealing material to the reservoir faces.

Do not place sealing material if the air temperature is less than 4 °C (40F), or above 32 °C (90F), unless otherwise allowed by the Representative.

Determine the safe heating temperature and recommended pouring temperature from the manufacturer's shipping container. Heat and maintain the material temperature within these recommended safe temperatures. Place the material as close as possible to the recommended pouring temperature. Do not maintain any single batch of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer's recommendations.

Place tape bondbreaker on bottom of joint reservoir immediately before sealing. Do not allow tape to extend up reservoir face more than 3 mm (1/8 inch).

Fill the reservoir with sealing material to a level 3 mm to 6 mm (1/8 inch to 1/4 inch) below the pavement surface. Do not allow sealing material to spread over the pavement surface.

**515.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 516—CONCRETE PAVEMENT PATCHING

**516.1 DESCRIPTION**—This work is the construction of one course, full depth, normal strength and accelerated strength, cement concrete pavement patches. Do not patch less than one lane width. If diamond grinding is to be performed, test the pavement surface in the longitudinal direction as specified in Section 514.3(d)2.

**(a) Patching Joint.** Provide full depth saw-cuts at the existing pavement/patch interface, install load transfer dowels in the transverse faces of the existing pavement, construct a sealant reservoir, and seal the joint.

**(b) New Pavement Joint.** Provide load transfer unit, construct sealant reservoir, and seal the joint.

**(c) Normal and Accelerated Concrete Pavement Patching, Type A.** Construct patches between 1.80 m and 6.00 m (6 feet and 20 feet) long.

**(d) Normal and Accelerated Concrete Pavement Patching, Type B.** Construct patches between 6.01 m and 20.00 m (20.1 feet and 65 feet) long.

**(e) Normal and Accelerated Concrete Pavement Patching, Type C.** Construct patches between 20.01 m and 150.00 m (65.1 feet and 500 feet) long.

**516.2 MATERIAL—**

**(a) Cement Concrete—Class AA.** For normal strength, use Section 704.
For accelerated strength, use Section 704, except delete Table A. Provide concrete for acceptance having a 28-day minimum compressive strength of 26 MPa (3,750 pounds per square inch) when tested according to PTM No. 604. Submit mix design, as specified in Section 704.1(c), having a minimum target value compressive strength of 10 MPa (1,500 pounds per square inch) at 7 hours when tested according to PTM No. 604.

**(b) Reinforcement.** Sections 709.2, 709.3, and 709.4

**(c) Expansion Joint Filler.** Section 705.1

**(d) Dowels and Load Transfer Units.** Section 705.3

**(e) Joint Sealing Material.** Section 705.4(b) or (c)

**(f) Graphite Lubricant.** Section 705.6

**(g) Concrete Curing Materials.** For normal strength, use Section 711.1(a), (b), (c), (d), and (e); or Section 711.2(a), Type 2.
For accelerated strength, use Section 711.1(b) and Section 711.2(a), Type 2, or 711.2(b).

**(h) Concrete Admixtures.** Section 711.3
If accelerating admixtures are used, provide only accelerating admixtures that contain no chlorides.

**(i) Subbase.** Section 350.2

**(j) Tape Bond Breaker.** An approved self-adhesive tape the width of the sealant reservoir.

**(k) Anchor Material.** An approved adhesive anchoring material as listed in Bulletin 15.

**(m) Preformed Cellular Polystyrene.** ASTM C 578

**(n) Intermediate Curing Compound.** Section 711.2(c)

**516.3 CONSTRUCTION**—As shown on Standard Drawing RC 26M, and as follows:

**(a) General.** Prepare a QC Plan as specified in Section 106.03(a)2.a and submit it for review. Detail appropriate action points for all phases of construction, including concrete mixing and curing, joint sawing and sealing, and sampling and testing for opening to traffic. For normal strength patches, do not place concrete if the air temperature falls below 4 °C (40F). For accelerated strength patches, do not place concrete if the air temperature falls below 7 °C (45F). Before placing concrete, ensure adequate equipment and trained personnel are available, and sufficient hauling units scheduled, to maintain continuity in placement.

If patching both lanes, construct concrete pavement patches in one-lane or two-lane widths, except where two-lane width construction would interfere with traffic. The Representative will surface mark patch areas in advance of the sawing operations.

Do not allow excavated patch areas to remain unpatched for more than 2 calendar days or over weekends or holidays. When excavated patch areas are adjacent to open traffic lanes, use temporary fill or other approved methods to protect traffic at all times.

If it rains while the patch area is open, excavate an outlet through the shoulder at the lowest point of the patch as directed.

Repair any damage to the existing shoulders as a result of this work, at no expense to the Department.

After saw cutting the existing pavement, allow traffic on patch areas of existing pavement for a maximum of 72 hours.

Do not wheel saw cut and open to traffic.

**(b) Saw Cutting.** Where one lane only is being patched, make a full depth saw-cut in the existing longitudinal joint for the full length of the patch. Where two lanes are being patched one lane at a time, perform one of the following:

- Make a full depth saw-cut parallel to the existing longitudinal joint and not more than 300 mm (1 foot) within the second lane to be patched. Form the patch and backfill behind the forms with aggregate at no additional cost to the Department.

- Make a full depth saw-cut in the existing longitudinal joint for the length of the patch and insert a temporary rigid separator between the second lane and the patch area. Do not use a temporary rigid separator greater than 3 mm (1/8 inch) thick.

Make full depth transverse saw-cuts as indicated. Do not break back the underside of the existing pavement. If break back occurs, make a new full depth transverse saw-cut beyond the area of break back. Place the additional length of patch at no expense to the Department.

**(c) Removal of Existing Pavement.** Remove concrete between narrowly spaced saw-cuts at the end of a proposed patch area with air hammers and hand tools.

As an alternate, a wheel saw having carbide steel tips may be used before making the full depth transverse saw-cuts necessary for the patching joint. Limit penetration of wheel into the subbase to a maximum of 13 mm (1/2 inch). Do not allow the wheel to cut into pavement that is remaining in place. Discontinue using a wheel saw if unsatisfactory results are obtained as determined by the Representative.

Install lifting devices and lift the concrete in the patch area out in one or more pieces without disturbing the subbase and subgrade. Do not use drop hammers or hydro-hammers.

If the surface of the subbase is disturbed by the removal technique, recompact the surface using small vibratory compactors. If the disturbed material is deeper than 25 mm (1 inch), remove the disturbed material with hand tools and replace with concrete during paving at no expense to the Department.

Correct all subbase surface irregularities exceeding 25 mm (1 inch) in depth by loosening the surface and removing or adding material as required. Compact the corrected area and surrounding surface by rolling to proper grade and slope.

**(d) Removal of Existing Subbase.** Remove unsuitable subbase material, as directed. Replace as specified in Section 350.3.

**(e) Transverse Joints.**

**1. General.** If any patch is replacing an existing expansion joint, and the existing expansion joint in the adjacent lane is remaining in place, install 19 mm (3/4-inch) expansion joint material in the joint nearest to the remaining expansion joint. Provide a tube with a minimum 25 mm (1-inch) clearance packet, over the lubricated end of all coated dowel bars.

**2. Patching Joint.** Drill holes into the face of the existing pavement that has been saw cut full depth. Provide holes a maximum of 3 mm (1/8 inch) larger in diameter than the coated dowel bars. Mount drilling machines in a frame that maintains the proper horizontal and vertical alignment during drilling.

Do not use hand held drills or drills that rest upon the subbase or subgrade. Drill holes to the alignment tolerances shown on the Standard Drawings. Change location of drill holes ±25 mm (±1 inch) to avoid existing reinforcing steel.

Securely embed the coated dowel bars into place with an approved anchoring material. Inject all the mixed anchoring material into the rear of the hole before inserting the dowel bar. Rotate the dowel three to five complete rotations while inserting the dowel to purge air voids as completely as possible. Immediately trowel all excess anchoring material flush with the vertical face of the patch until the anchoring material reaches its initial set. Do not leave voids in the anchoring material. Use a plastic retainer washer to hold anchoring material in place, if directed, and remove before placement of concrete in the patch. Provide anchoring material formulated to reach an initial set within 5 minutes of application. Provide a material specification data sheet for the anchoring material used.

Render exposed portion of each coated dowel bar bondless as specified in Section 501.3(i).

**3. New Pavement Joint.** As indicated and when directed, provide load transfer units adjacent to existing joints and at the same joint spacing as the existing pavement. When patching all adjacent lanes, make the joint spacing correspond to Standard Drawing RC-21M or RC-27M as applicable. Make all joints normal to the centerline of the roadway. Place coated dowel bars parallel to the centerline and surface of the pavement.

Install load transfer units as specified in Section 501.3(i).

**(f) Forms.** Form all patch sides not in contact with pavement remaining in place. Use steel or wood forms with adequate bracing to maintain proper position. Extend all forms to the full depth of the existing pavement. Furnish forms plumb, clean, and free of any warping or surface defects. Make all formed joints vertical.

**(g) Concrete.** Design, mix, and place as specified in Section 501.3(a) through (h). Concrete will be accepted by lot as specified in Section 704.1(d)4.

**(h) Final Strike-Off and Consolidation.** As specified in Section 501.3(k).

**(i) Final Finish for Pavements Not Being Overlaid.** For Type A and B patches, finish the surface of the patch to match the existing pavement cross section. Include any existing wheel ruts. For Type C patches, taper the wheel ruts at both ends of the patch to a straight pavement cross slope, within the patch, with a minimum transition length of 6 m (20 feet).

Texture Type A and B patches to correspond with the texture of the surrounding pavement. Texture Type C patches as specified in Section 501.3(k)4.

Following the final finishing and before application of curing materials, scribe the date of the patch placement in the surface of the fresh concrete along the shoulder edge of the patch.

If the contract includes grinding of the pavement surface, then the matching of wheel ruts and the texturing of the patch surface is not necessary. Make the scribing of the patch dates deep enough that the grinding will not eliminate them.

**(j) Curing of Concrete.** For normal strength patches, immediately after finishing operations have been completed, cover and cure the patch surface as specified in Section 501.3(l).

For accelerated patches, cure concrete as specified in Section 501.3(l)1.b or using approved curing insulation materials. Apply white membrane-forming curing compound as specified in Section 501.3(l)1.c. The Contractor may use black membrane-forming curing compound provided the patch area will not be accessible to traffic before placement of a surface course. Discontinue use of black membrane-forming curing compound if it performs unsatisfactorily as a curing agent, and resume curing by other methods as specified. Cure test cylinders under the same conditions as the concrete pavement patch. Provide insulation or heating of patches if the ambient temperature drops below 27 °C (80F) during the curing operation. Control the curing temperature and monitor at least hourly to ensure that the concrete pavement patch does not experience a temperature change in excess of 22 °C (40F) within any 1-hour period during the curing operation. If a temperature change in excess of 22 °C (40F) occurs in the concrete pavement patch within any 1-hour period, considered the work defective.

**(k) Stabilizing Around Patches.** After curing and before opening to traffic, grout around the patches. Use the hole pattern shown on the Standard Drawings. If directed, stabilize as specified in Section 679.

**(m) Longitudinal Joints.** In two-lane width patching being performed at the same time, construct a Type L joint as shown on the Standard Drawings.

In two-lane patching being performed one lane at-a-time, or one-lane patching, provide a 6 mm (1/4-inch), full depth, polystyrene board bond breaker in the longitudinal joint of Type A and B patches. Do not provide a bond breaker in the longitudinal joint of Type C patches. For all patch types, saw cut the longitudinal joint 6 mm (1/4 inch) wide and 25 mm (1 inch) deep. Center the saw-cut over the board bond breaker. Do not provide tie bolts unless directed. If the pavement is to be overlaid, the saw-cut is not necessary.

**(n) Sealing.** Seal all longitudinal and transverse joints constructed as part of this work, except if the pavement is to be overlaid, then only expansion joint sealing is necessary. Seal joints as specified in Section 501.3(n).

Seal all saw-cuts extending beyond the patch limits.

When the pavement will not be overlaid during the same construction season, construct a sealant reservoir and seal joints as specified in Section 501.3(n).

**(p) Ride Acceptance.** Test the surface of the patch area, in the longitudinal direction, and across patch joints using a 3 m (10-foot) straightedge. Correct, by grinding, any high points or depressions in excess of 3 mm (1/8 inch) at no expense to the Department. After grinding, retest the area with the 3 m (10-foot) straightedge. If the surface still exceeds the above limits, then the area is defective. Remove and replace the defective area at no expense to the Department.

**(q) Opening to Traffic.** For normal strength patches, do not open the repaired area to traffic until the concrete has obtained a minimum compressive strength of 21 MPa (3,000 pounds per square inch), when tested according to PTM No. 604.

For accelerated strength patches, obtain samples of plastic concrete, for compressive strength testing for opening to traffic, from each 76 $m^3$ (100 cubic yards) or fraction thereof of the day's placement, and, unless otherwise required, from the last mixer load of the day, according to the approved QC Plan. Sample locations will be selected according to PTM No. 1. Test concrete for compressive strength according to PTM No. 604, at the time of opening to traffic. Concrete lots that have not attained a minimum compressive strength of 8.3 MPa (1,200 pounds per square inch) at the time of opening to traffic will be considered defective work.

**(r) Defective Work.** Remove and replace concrete pavement patches that are considered defective, at no cost to the Department. The 28-day minimum compressive strength testing for acceptance will not be conducted for any work that is considered defective.

## 516.4 MEASUREMENT AND PAYMENT—

**(a) Patching Joint.** Meter (Linear Foot)

**(b) New Pavement Joint.** Meter (Linear Foot)

**(c) Concrete Pavement Patching.** Square Meter (Square Yard)

For the type indicated. When longitudinal joint cleaning and sealing is part of the contract, the sealing of longitudinal joints is incidental to that item, not to concrete pavement patching.

The unit price includes removal of the existing pavement and all repairs or corrections specified in Section 516.3 that are needed as a result of patching operations.

**(d) Subbase Material.** Cubic Meter (Cubic Yard)
The unit price includes excavation.

**(e) Slab Stabilization.** Section 679.4(b) and (c)

# SECTION 517—TRANSVERSE GROOVING OF CONCRETE PAVEMENT FOR RETEXTURING

**517.1 DESCRIPTION**—This work is the cutting of transverse grooves in existing cement concrete pavement after the original texture has been lost.

**517.3 CONSTRUCTION**—Satisfactorily groove the existing pavement surface transversely between the limiting stations indicated. Do not use flailing type equipment. Cut grooves 2.5 mm (3/32 inch) in width, with a tolerance of plus 1.5 mm (1/16 inch), a 19 mm (3/4-inch) center-to-center spacing, and a minimum depth of 5 mm (3/16 inch). Do not cut grooves within 150 mm (6 inches) of the outside edge or centerline pavement joint. Do not allow cutting slurry to accumulate on adjacent lanes. Remove the slurry and satisfactorily clean the lanes as work progresses.

**517.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)
Measured on the finished grooved area.

# SECTION 518—CONTINUOUSLY REINFORCED CONCRETE PAVEMENT PATCHING

**518.1 DESCRIPTION**—This work is the construction of one course, full-depth, continuously reinforced cement concrete pavement patches. Do not patch less than one lane width.

**(a) Patching Joint.** Provide partial depth saw-cuts at the existing pavement/patch interface, construct a sealant reservoir, and seal the joint.

**(b) Continuously Reinforced Concrete Pavement Patching, Type A.** Construct patches between 1.80 m and 6.00 m (6 feet and 20 feet) long if using tied splices and between 1.20 m and 6.00 m (4 feet and 20 feet) long if using welded splices.

**(c) Continuously Reinforced Concrete Pavement Patching, Type B.** Construct patches between 6.01 m and 20.00 m (20.1 feet and 65 feet) long.

**(d) Continuously Reinforced Concrete Pavement Patching, Type C.** Construct patches between 20.01 m and 150 m (65.1 feet and 500 feet) long.

**518.2 MATERIAL—**

**(a) Cement Concrete.** Class AA or Class HES, Section 704.

**(b) Reinforcement Bars.** Section 1002.2

**(c) Concrete Curing Materials.** Section 711.1(a), (b), (c), (d), and (e).

.

**(d) Concrete Admixtures.** Section 711.3

**(e) Bondbreaker.** Use polyethylene sheeting, clear or opaque, minimum 150 µm (6-mil) thickness, or a double application of Type 2, white pigmented, wax-based curing compound as specified in Section 711.1(a) and Section 711.2(a) respectively.

**(f) Subbase.** Section 350.2

**(g) Joint Sealing Material.** Section 705.4(b) or (c)

**(h) Tape Bond Breaker.** An acceptable self-adhesive tape the width of the sealant reservoir.

**(i) Preformed Cellular Polystyrene.** Section 516.2(m)

**(j) Welding Material.** Section 1105.02(t)

**(k) Anchoring Material.** Section 516.2(k)

**518.3 CONSTRUCTION**—As specified in Section 516.3, modified as follows:

**(b) Saw Cutting.** Replace the second paragraph of Section 516.3(b) with the following:

Make initial, full-depth, transverse saw-cuts from the outside edge of the pavement toward the longitudinal saw-cut. Make a second, 25 mm (1-inch) minimum depth, transverse saw-cut at each end of the patch area, parallel to and outside the initial saw-cut the distance shown on the Standard Drawings for the type of rebar splices to be used. Do not saw cut across an existing crack. Do not locate saw-cuts within 610 mm (24 inches) of an existing

crack. Do not cut reinforcement bars when making the partial depth saw-cuts. If any of the reinforcement bars are cut, take corrective action by making the partial depth saw-cut a full-depth cut and making another partial depth (25 mm (1-inch) minimum) saw-cut located as specified above. Place the additional length of patch at no expense to the Department.

**(c) Removal of Existing Pavement.** Replace Section 516.3(c), with the following:

**(c) Removal of Existing Pavement.** Remove concrete between the two full-depth, transverse saw-cuts, before making the 25 mm (1-inch) minimum depth saw-cuts. A wheel saw having carbide steel tips may be used, while making the full-depth transverse saw-cuts, to provide a trench across the slab to relieve compression in pavement before lifting out failed area. Limit penetration of wheel into the subbase to a maximum of 13 mm (1/2 inch). Do not allow the wheel to cut into pavement that is remaining in place. Discontinue use of the wheel saw if unsatisfactory results are obtained as determined by the Representative.

Install lifting devices and lift out the concrete in the area enclosed by the full-depth saw-cuts, in one or more pieces, without disturbing existing subbase.

Remove the concrete strips at each end of the patch area with jackhammers and hand tools. Limit jackhammer size to 67 N (15 pounds) maximum. Do not damage existing reinforcement bars within the concrete strips. Do not break back the underside of the existing pavement. If break back greater than 50 mm (2 inches) occurs, make a new full-depth, transverse saw-cut beyond the area of break back. Saw cut a new outside edge, maintaining the appropriate bar length at the edge of patch. Place the additional length of patch at no cost to the Department.

If the existing pavement was constructed on top of a bond breaker, remove the bond breaker from the top of pavement base. Place new bond breaker, of the existing type and thickness, before placing concrete. If polyethylene sheeting is used, cut to the surface dimensions of the patch.

If the surface of the subbase is disturbed by the removal procedure, recompact the surface using small vibratory compactors. If subbase material is disturbed to a depth greater than 25 mm (1 inch), remove the disturbed material with hand tools and replace with concrete during paving at no cost to the Department.

**(e) Transverse Joints.** Replace Section 516.3(e), with the following:

**(e) Reinforcement.** Place reinforcement in the patch area as specified in Section 1002.3 and as shown on the Standard Drawings. Firmly support and tie bars at every intersection to re-establish the continuous reinforcing. Use tied or welded splices. Lap the new reinforcement bars with the existing bars as shown on the Standard Drawings for the type of rebar splices to be used. Weld splice as specified in Section 1105.03(m) and as shown on the Standard Drawings. When weld splicing, lap tie bars at the center of the patch, as shown on the Standard Drawings, to allow for expansion.

## 518.4 MEASUREMENT AND PAYMENT—

**(a) Patching Joint.** Meter (Linear Foot)

**(b) Continuously Reinforced Concrete Pavement Patching.** Square Meter (Square Yard)

For type indicated. The unit price includes removal of the existing pavement and repairs or corrections specified in Section 516.3 that are needed as a result of patching operations.

**(c) Subbase Material.** Cubic Meter (Cubic Yard)

The unit price includes excavation.

# SECTION 521—TRANSVERSE JOINT CLEANING AND SEALING

**521.1 DESCRIPTION**—This work consists of cleaning and sealing existing transverse joints in cement concrete pavements.

**521.2 MATERIAL—**

- Joint Sealing Material—Section 705.4(b) or (c)
- Joint Backing Material—Section 705.9

**521.3 CONSTRUCTION**—Clean transverse joints of all existing sealing material, bituminous material, and other foreign material in a manner that provides a clean, newly exposed concrete surface. Clean to a minimum depth of 38 mm (1 1/2 inches).

Immediately before placing backer rod, clean the joint faces by sandblasting and airblasting. For airblasting use a compressed air stream of at least 700 kPa (100 pounds per square inch) measured at the source. Use air free of oil, moisture, and other contaminants.

Immediately before sealing the joint, place the backer rod to a depth of 25 mm (1 inch) below the pavement surface. Use a backer rod 25 to 35 % larger in diameter than the joint opening.

Seal joint as specified in Section 501.3(n) and as follows:

- Do not place sealant unless joint is dry.
- Do not place joint sealant unless the ambient air and the pavement temperatures are 4 °C (40F) or greater.
- Fill the joint reservoir to a level of 3 mm (1/8 inch) to 6 mm (1/4 inch) below the pavement surface.

**521.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 523—ULTRA-THIN PORTLAND CEMENT CONCRETE OVERLAY

**523.1 DESCRIPTION**—This work is the construction of an accelerated strength ultra-thin Portland cement concrete overlay as indicated.

**523.2 MATERIAL—**

**(a) Accelerated Strength Portland Cement Concrete.** Section 704.1(b), modified as follows:

- Delete Table A.

- Use concrete reinforced with polypropylene fibers according to ASTM C 1116, Type III 4.13 and ASTM C 1116 (Ref: ASTM C 1018) Performance Level 1 outlined in Section 21, Note 17 and Residual Strength. Use 100% virgin polypropylene (PE) manufactured to an optimum gradation for use as concrete reinforcement.

**(b) Design Basis.** Section 704.1(c), modified as follows:

- Revise the first sentence of the first paragraph as follows:
  Make trial mixtures and computations for accelerated strength Portland cement concrete including the molding and curing of test specimens.

- Revise the first sentence of the second paragraph and add a second sentence as follows:
  Design a concrete mix for having a 28-day minimum compressive strength of 26 MPa (3,750 pounds per square inch) for acceptance when tested according to PTM 604 and a 24-hour minimum compressive strength of 21 MPa (3,000 pounds per square inch). Measure concrete consistency in millimeters (inches) of slump as specified in Section 523.3(v).

- Add the following sentence to the third paragraph:
  If the overlay depth is less than 75 mm (3 inches), use No. 8 coarse aggregate instead of No. 57 coarse aggregate.

- Revise the fifth paragraph as follows:
  Use a cement factor of 385 kg (650 pounds) minimum per cubic meter (cubic yard) and a water-cement ratio of 0.42 maximum.

- Revise the sixth paragraph as follows:
  The Contractor may substitute flyash for Portland cement at a maximum rate of 10% by mass (weight) for cement. Include flyash with cement when determining the water-cement ratio. Add PE fiber at the rate of 1.78 kg (3.0 pounds) minimum per cubic meter (cubic yard).

**1. Air Content.** Section 704.1(c)3. Revise the first sentence as follows:
Design cement concrete with an air content of 7.0% in the plastic state.

**2. Class of Cement Concrete.** Section 704.1(c)2. Revise the heading and first sentence as follows:
**Accelerated Strength Portland Cement Concrete.** The concrete design submitted for review is required to comply with the specified requirements, supported by air content and compressive strength test data according to Bulletin 5. Delete the last paragraph.

**(c) Concrete Admixtures.** Section 711.3 and as follows:

- If accelerating admixtures are used, provide accelerating admixtures that do not contain chlorides.

**(d) Concrete Curing Material.** Section 711.1 and Section 711.2(a), Type 2

**523.3 CONSTRUCTION—**Section 501.3, modified as follows:

**(a) General.** Section 501.3(a), with the following additions:

Prepare a QC Plan, as specified in Section 106, detailing the timing and sequence of the work, including timing of mixing, hauling, placing, curing, monitoring of concrete temperature, joint sawing, and sampling and testing for compressive strength for opening to traffic. Indicate variations on timing in response to anticipated variations in the air temperature for the time of placement. Submit the QC Plan for review before the start of the project. Do not start work until the QC Plan has been approved.

**(e) Preparation and Protection of Base Course.** Replace Section 501.3(e) with the following:

**(e) Bituminous Surface Preparation.** Completely clean milled pavement surface. Limit cleaning to area that will be overlaid the same day. Protect the cleaned and prepared surface from oil or grease drippings from compressors, concrete trucks, spreaders, pavers, etc. by using protective covers. Remove all deleterious materials before overlaying. Sprinkle to thoroughly dampen the bituminous surface immediately before placement of cement concrete without causing pooled or puddle water.

**(h) Handling and Placing Reinforcement.** Delete Section 501.3(h).

**(i) Transverse Joint.** Replace Section 501.3(i) with the following:

**(i) Joints.** Saw joints as soon as concrete has hardened sufficiently to permit sawing without excessive raveling resulting from the sawing operation. Space joints equidistant longitudinally and transversely. Determine spacing using formula of 300 mm (1 foot) of joint spacing per 25 mm (1-inch) of depth of cement concrete overlay. Saw joints with a green cut saw to a depth of D/3 and a minimum width of 3 mm (1/8 inch). Do not seal joints. Clean joints of all deleterious material after sawing.

Saw soon enough after placement to prevent random cracking. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions. Omit sawing if a crack occurs at or within 450 mm (1.5 feet) of a joint location, before the time of the sawing or during sawing. If a crack occurs before acceptance of pavement, remove and replace one full panel width and length.

Other than white curing compound, remove curing materials from overlay, at the location where a joint is to be cut. Remove only sufficient covering to provide space necessary for sawing joints. As soon as the joint is made, replace the covering. The maximum time period allowed for pavement curing covers to be removed is 1/2 hour. If white membrane curing compound is used, cure the joint area, as specified in the first six paragraphs in Section 501.3(l)1.c.

Do not displace coarse aggregate from the joint location using a vibrating T-bar, or using a filler strip at the joint.

**(j) Longitudinal Joints.** Delete Section 501.3(j).

**(l) Curing Concrete.** Section 501.3(l), revised as follows:

**1. Normal Curing.** Revise the first sentence as follows:

Allow curing materials to remain in place and maintain as specified, for a period of 24 hours or until the concrete has reached 21 MPa (3,000 pounds per square inch) compressive strength.

Add the following paragraphs:

Provide adequate insulating blankets to prevent rapid heat loss if the air temperature is 18 °C (65F) or less. Remove any insulation when a minimum compressive strength of 21 MPa (3,000 pounds per square inch) has been attained. Remove insulation at such a rate that the temperature change in the concrete does not exceed 4 °C (40F) within any 1-hour period. If a temperature change in the concrete in excess of 4 °C (40F) occurs within any 1-hour period, whether insulation is used or not, consider the work defective.

The application or removal of insulation covers may be controlled by the use of maturity concepts, provided the minimum degree-hours of curing has been achieved at the top of the slab.

**(n) Sealing Joints and Cracks.** Delete Section 501.3(n).

**(r) Opening to Traffic.** Replace Section 501.3(q) with the following:

> **(r) Opening to Traffic.** Sample plastic concrete, for compressive strength testing (PTM No. 604) before opening to traffic, according to the approved QC Plan. The Representative will select sample locations according to PTM No. 1. The Representative will determine when pavement will be opened to traffic, but no sooner than 24 hours or when the concrete attains the minimum required compressive strength. If concrete pavement has not attained a minimum 24-hour compressive strength of 21 MPa (3,000 pounds per square inch) at the time of opening to traffic, consider the work defective.

**(t) Tests for Depth.** Section 501.3(s), with the following exception:

- For projects at intersections and less than 3500 $m^2$ (3,000 square yards), drill two cores.

**(u) Defective Work.** Section 501.3(t), except revise the first paragraph as follows:

Unless otherwise directed in writing by the District Executive, remove and replace, at no expense to the Department, pavement that is; defective in surface tolerance, as specified in Section 501.3(o); defective in compressive strength as specified in Section 523.2(b); defective in depth, as specified in Section 523.3(t); defective in air content, as specified in Section 523.2(b)1; where the temperature change in concrete in excess of 4 °C (40F) occurs within a 1-hour period; or showing surface defects resulting from the effects of rain, hail, improper final finish, excessive raveling of joints during sawing, or honeycombing which, in the Representative's opinion, cannot be repaired.

**(v) Test Slab**. Construct an off-site slab 2 weeks before placement of accelerated concrete pavement on the project as follows:

Construct the test slab one lane width wide and 3.7 m (12 feet) long. Use the concrete mix design specified in Section 523.2(a) and (b) in the test slab. Establish a target value for the consistency during placement of the test slab. The slump for production shall be the consistency of the test slab ±25 mm (±1 inch). Submit any adjustments for review.

If maturity concept is being used, correlate degree-hours of cure to compressive strength breaks at 8, 12, 16, and 24 hours following placement of the test slab. Establish the minimum number of degree-hours of cure by correlation with compressive strength tests. Verify maturity curves with first 2 days production work, regardless of quantity placed, by recording compressive strength breaks at 8, 12, 16, and 24 hours following placement.

Appropriately time joint saw cut operations as they are proposed for the actual work. The results of this test slab will be used to adjust the timing of joint sawing during construction of the actual project.

Cure the test slab as proposed for the actual work and demonstrate by compressive cylinder breaks, and maturity data if maturity concepts are used, that the mix conforms to the opening to traffic requirement within 24 hours of placement.

## 523.4 MEASUREMENT AND PAYMENT—

**(a) Surface Preparation.** Square Meter (Square Yard)

**(b) Ultra-thin Portland Cement Concrete Overlay.** Square Meter (Square Yard)

This unit price includes saw cutting of transverse and longitudinal joints and construction of test slab.

**(c) Concrete Pavement Cores.** Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled if the depth is deficient by more than 6.5 mm (1/4 inch).

# SECTION 524—THIN BONDED PORTLAND CEMENT CONCRETE OVERLAY

**524.1 DESCRIPTION**—This work is the construction of a thin bonded Portland cement concrete overlay, or inlay, including surface preparation and joint sawing and sealing.

**524.2 MATERIAL—**

**(a) Cement Concrete, Class AA.** Section 704 and as follows:

- Maximum water-cement mass (weight) ratio: 0.40
- If overlay thickness is less than 75 mm (3 inches), use No. 8 coarse aggregate instead of No. 57 coarse aggregate.

**(b) Concrete Admixtures.** Section 711.3

**(c) Concrete Covering Material.** Section 711.1(a)

**(d) Concrete Curing Materials.** Section 711.1(b) or 711.2(a), Type 2

**(e) Joint Backing Material.** Section 705.9

**(f) Joint Sealing Material.** Section 705.4(a), (b), or (c)

**(g) Tape Bond Breaker.** An acceptable self-adhesive tape the width of the sealant reservoir.

**(h) Grout.** Use the following initial mass (weight) proportions:

| Cement | Water |
|---|---|
| 2 | 1 |

Adjust as necessary.

**524.3 CONSTRUCTION**—Construct concrete overlay as specified in Section 501.3 and as follows:

**(a) Surface Preparation.** Prepare the existing concrete surface as follows:

**1. Equipment.**

**1.a Scarifying Equipment.** Provide a self-propelled mechanical scarifier capable of uniformly removing the old surface, to the depth indicated, in a satisfactory manner.

**1.b Shot Blasting, Sand Blasting, or Water Blasting Equipment.** Provide equipment capable of removing any loose concrete and rust from exposed reinforcement.

**1.c Power Tools.** Provide concrete saws, 6.6 kg (15-pound) chipping hammers, air compressors, and any other tools necessary to perform this work.

**2. Scarification of the Existing Pavement Surface.** Scarify the existing pavement surface as indicated. Cut off and remove any reinforcement that is exposed and loose.

**3. Extra-Depth Surface Preparation.** After scarifying, remove any deteriorated concrete or asphalt materials that extend below the level of the scarification, as indicated or directed. Use either 6.6 kg (15-pound) chipping hammers, operated at an angle of no more than 45 degrees measured from the pavement surface, or approved scarifying equipment.

Sound the pavement to ensure that all deteriorated and delaminated concrete has been removed.

Remove all loose material from the pavement surface before cleaning.

**4. Steel Plates.** If inlaying and the existing transverse pavement joints have steel plates, remove exposed steel plates.

**5. Cleaning the Surface.** Clean the scarified pavement surface after removing deteriorated and delaminated concrete, and before placing grout. Use shot blasting or water blasting.

Clean pavement to be overlaid the day before paving operations are planned. Do not clean more pavement than will be overlaid that day. Cover the cleaned surface with polyethylene sheeting. Keep the surface covered until ready to pave. Do not remove sheeting more than 30 m (100 feet) in front of the grouting operation.

Immediately ahead of the grouting operation, air blast the pavement surface to remove any shot, dust, or other debris. Use a compressed air stream of at least 700 kPa (100 pounds per square inch) measured at the source. Use compressed air free of oil, moisture, and other contaminants.

Keep the prepared surface free of all contaminants.

Protect the cleaned and prepared surface from oil or grease drippings from compressors, concrete trucks, spreaders, pavers, etc. by using protective covers. Remove all deleterious materials before overlay/inlay.

**(b) Overlay Transition.** Construct paving notches, as indicated.

**(c) Transverse Joint Location.** Accurately mark the location of all transverse joints so that they can be located after the overlay has been placed. Submit the proposed method of location marking for approval before the start of construction.

**(d) Grout.** Adjust the grout proportions, as directed, at no cost to the Department. Furnish grout having the consistency of latex paint. If the coarse aggregate in the prepared surface is visible through the grout, the grout is too thin.

Mix grout in an approved mobile mixer on the job site. Do not use grout mixed for more than 90 minutes.

**(e) Grout Application.** After the surface has been cleaned, spray or scrub a coating of grout into the dry, prepared surface immediately ahead of the paver. Exercise extreme care to ensure that all areas receive a thorough, even coating and that no excess grout collects in pockets.

Place new concrete before the grout begins to dry. If grout exhibits signs of drying, by a whitish appearance to the surface, remove the grout by sand blasting or shot blasting. Regrout the cleaned pavement surface before placing new concrete.

**(f) Bond Strength.** Bond strength testing will be performed at 7 days, according to PTM No. 610, on the area represented by each day's placement. Obtain three drilled cores for each test in the presence of the Inspector. The Inspector will select coring locations at random, according to PTM No. 1. When directed, supply the Department with a minimum of three additional 100 mm or 150 mm (4-inch or 6-inch) diameter cores. Provide a testing apparatus conforming to PTM No. 610. Minimum acceptable bond strength is 14 kPa (200 pounds per square inch) at 7 days.

If the average of the test results on the three cores is below minimum acceptable bond strength, the area represented will be considered defective. If this occurs, obtain additional cores at 30 m (100-foot) intervals in both directions longitudinally from the defective cores to determine the limits of defective work. Each set of three defective cores will represent the condition in the same traffic lane for a distance of 15 m (50 feet) in both directions longitudinally.

**(g) Concrete Slump.** Provide concrete with a slump within the following ranges when tested according to AASHTO T 119:

- Slipform Paving 25 mm to 50 mm (1 inch to 2 inches)

- Fixed Form Paving 50 mm to 75 mm (2 inches to 3 inches)

**(h) Curing Concrete.** Use only burlap-backed white polyethylene, white membrane forming curing compound, or burlap for normal curing.

If specified, apply curing material as specified in Section 501.3(l).

**(i) Transverse Joints.** Clean to a depth sufficient to place the new backer rod material. Place joint backing material in the existing transverse joint before overlaying. Cement this material in place so that it cannot be dislodged by the paving operation.

Saw cut all transverse joints as specified in Section 501.3(i)2.

Saw cut all transverse joints to the full depth of the overlay, including any extra depth concrete placed at the joint, directly over the existing transverse joint and the width of the existing transverse joint. Include transverse joints created by concrete pavement patching within the overlay area.

When inlaying, saw cut transverse joints to the full depth of the inlay, including any extra depth concrete placed at the joint, directly over the existing transverse joint and a minimum of 13 mm (1/2 inch) wide.

Construct a sealant reservoir as shown on the Standard Drawing for Cement Concrete Pavement Joints. The Contractor may saw cut the overlay, full depth, the width of the sealant reservoir. After sawing, immediately flush with water.

Place backing material to the proper depth.

Seal joints as specified in Section 501.3(n).

**(j) Longitudinal Joints.** Accurately reference the location of existing longitudinal joints within the overlay area and between the adjacent lane and the overlay area, so that they can be accurately located after paving. After paving, saw cut a sealant reservoir, 6 mm (1/4 inch) wide, and the full depth of the overlay, directly over the existing longitudinal joint.

Seal joints as specified in Section 501.3(n).

Provide a neat vertical edge face, free of honeycomb and segregation, longitudinally along both sides of the overlaid pavement.

**(k) Edge Slump.** Maximum edge slump permitted in the outside 150 mm (6 inches) next to the shoulder is 6 mm (1/4 inch). Maximum edge slump permitted in the outside 150 mm (6 inches) next to an adjacent lane is 3 mm (1/8 inch).

**(m) Opening to Traffic.** Before opening to traffic, sound the newly placed bonded overlay/inlay as directed by and in the presence of the Inspector. Remove and replace unbonded areas as directed.

Do not open to any traffic until the overlay/inlay develops a minimum compressive strength of 21 MPa (3,000 pounds per square inch), according to PTM No. 604, and the minimum acceptable bond strength as specified in Section 524.3(f).

**(n) Surface Tolerance.** Section 506.3(p)

**(p) Defective Work.** Unless otherwise directed in writing, remove and replace pavement overlay that is defective in depth, as specified in Table A; defective in air content, as specified in Section 704.1(c)3; defective in bond strength, as specified in Section 524.3(f); or showing surface defects resulting from the effects of rain, improper final finish, or honeycombing which, in the Representative's opinion, cannot be repaired.

Replace defective pavement overlay as specified in Section 501.3(t); except, provide a minimum pavement removal and replacement length between transverse joints of 1.8 m (6 feet).

## 524.4 MEASUREMENT AND PAYMENT—

**(a) Surface Preparation.** Square Meter (Square Yard)

**(b) Extra-Depth Surface Preparation.** Square Meter (Square Foot)

**(c) Thin-Bonded Portland Cement Concrete Overlay.** Square Meter (Square Yard)
The unit price includes saw cutting and sealing of existing and new transverse and longitudinal joints.

**1. Adjustment for Deficiencies.** If a lot, as specified in Section 506.3(v), contains depth deficiencies, the Department will determine the contract price paid for the lot as follows:

**TABLE A**
**Adjustment in Contract Price for Depth**

| Deficiency in Depth Determined by Cores mm (inches) | Payment Percent of Contract Price by Lot |
|---|---|
| 0.00 to 6.5 (0.00 to 0.25) | 100% |
| 6.6 to 7.7 (0.26 to 0.30) | 95% |
| 7.8 to 8.9 (0.31 to 0.35) | 85% |
| 9.0 to 10.1 (0.36 to 0.40) | 75% |
| 10.2 to 11.3 (0.41 to 0.45) | 50% |
| 11.4 to 12.5 (0.46 to 0.50) | 25% |
| Over 12.5 (Over 0.50) | Defective Work |

**2. Defective Pavement Left in Place.** The Department will not make any payment.

**(d) Evaluation of Concrete Pavement Ride Quality and Payment of Incentive.** Section 507.4

# SECTION 525—CONCRETE PAVEMENT SPALL REPAIR

**525.1 DESCRIPTION**—This work is the construction of one course, partial depth, cement concrete spall repair on existing concrete pavements. This work applies to both joint and surface spalls. Joint spalls are spalled areas greater than 50 mm (2 inches) in width, limited to 0.46 $m^2$ (5 square feet) at the transverse joint, and not more than 100 mm (4 inches) in depth along transverse or longitudinal joints. Surface spalls are spalled areas not more than 100 mm (4 inches) in depth occurring in the interior of concrete slabs. The total spall repair area will not exceed 0.9 $m^2$ (10 square feet) in any slab.

Repair spalled areas greater than 100 mm (4 inches) in depth as specified in Section 516.

Concrete pavement spall repair is classified into five types as follows:

**(a) Concrete Pavement Spall Repair, Type 1.** Repair spalled areas using Class AA Cement Concrete, Modified.

**(b) Concrete Pavement Spall Repair, Type 2.** Repair spalled areas using Class AA Cement Concrete, Special.

**(c) Concrete Pavement Spall Repair, Type 3.** Repair spalled areas using Rapid Set Concrete Patching Materials.

**(d) Concrete Pavement Spall Repair, Type 4.** Repair spalled areas using Latex Modified Concrete.

**(e) Concrete Pavement Spall Repair, Type 5.** Repair spalled areas using thin Bonded Portland Cement Concrete Inlay.

**525.2 MATERIAL—**

**(a) Class AA Cement Concrete, Modified.** Class AA Cement Concrete as specified in Section 704, except as follows:

- Coarse Aggregate, Type A, No. 8—Section 703.2

**(b) Class AA Cement Concrete, Special.** Class AA Cement Concrete as specified in Section 704, except as follows:

- Cement, Type III or IIIP—Section 701
- Coarse Aggregate, Type A, No. 8—Section 703.2

Submit mix design having a minimum target value of 14 MPa (2,000 pounds per square inch) compressive strength at 12 hours, when tested according to PTM No. 604.

**(c) Rapid Set Concrete Patching Material.** From a manufacturer listed in Bulletin 15. Use within the shelf life and temperature limitations set by the manufacturer. Certify as specified in Section 106.03(b)3.

**(d) Latex Modified Concrete.** Section 1042.2

**(e) Thin Bonded Portland Cement Concrete Inlay.** Section 524.2

**(f) Air Entraining Admixture.** Section 711.3(d)

**(g) Grout.** Section 524.2(h)

**(h) Epoxy Bonding Compound.** Type II, Grade 2, ASTM C 881, as specified in Section 706.1 and as follows:

Use within the shelf life and temperature limitations set by the manufacturer. Furnish material with a shelf life not exceeding 1 year after manufacture.

**(i) Concrete Curing Materials.** Section 711.1(a), (b), (c), and (d); Section 711.2(a), Type 2; and Section 711.2(b) if repair area will be overlaid before traffic.

**(j) Preformed Cellular Polystyrene.** Section 516.2(m)

**(k) Expansion Joint Filler.** Section 705.1

**(l) Joint Sealing Material.** Section 705.4(b) or (d)

**(m) Tape Bond Breaker.** An acceptable self-adhesive tape the width of the sealant reservoir.

## 525.3 CONSTRUCTION—

**(a) Surface Preparation.** Sound the pavement surface around the spalled area with a light hammer to detect delaminated areas in the presence of the Inspector. Mark the edges of the delaminated area. Layout the repair area limits approximately 75 mm (3 inches) beyond the edges of the delaminated area. Square up all repair areas. Do not use irregular and odd shaped repair areas. Construct spall repair areas a minimum of 600 mm (24 inches) apart. If spall repair areas are less than 600 mm (24 inches) apart, combine them into one spall repair area.

For Types 1, 2, and 3 spall repair, saw cut the perimeter of the repair area to a minimum depth of 38 mm (1 1/2 inches). Remove the existing concrete within the repair area to a minimum depth of 38 mm (1 1/2 inches). For Type 4 spall repair, limit the repair area depth to the depth of the delaminated concrete. For Types 1 through 4 spall repair, use a chipping hammer weighing not more than 14 kg (30 pounds). Operate the chipping hammer at an angle not exceeding 45 degrees when measured from the pavement surface.

For Type 5 spall repair, remove the delaminated concrete as specified in Section 524.3(a). Scarify to a minimum depth of 50 mm (2 inches).

Do not disturb concrete outside the limits of the repair area.

Cut and remove any reinforcement in jointed reinforced concrete pavement that is exposed after the removal of delaminated concrete. Do not cut or remove the reinforcement in continuously reinforced concrete pavement.

Resound the repair area in the presence of the Inspector to ensure that all delaminated material has been removed. Initially clean exposed surfaces of the repair area of all loose and foreign material by sandblasting or water blasting within 24 hours before concrete placement. Use air blasting as the final cleaning within 30 minutes before concrete placement. Reclean areas not repaired within 30 minutes of the final cleaning. For air blasting, use a compressed air stream, free of oil, moisture, and other contaminants, of at least 700 kPa (100 pounds per square inch) measured at the source.

If spall repair area becomes a patch due to excessive, unnecessary, removal of concrete, construct concrete pavement patching as specified in Section 516.3 at no additional cost to the Department.

**(b) Spall Repair.**

**1. Type 1 and Type 2.** Immediately after final cleaning, apply grout or epoxy bonding compound to all exposed surfaces within the repair area. Apply epoxy bonding compound in a thin even coat. Do not allow the grout or epoxy bonding compound to run or puddle in low spots.

Place concrete in the repair area before grout begins to dry or while epoxy bonding compound is still tacky. Sandblast and remove grout that has dried or epoxy bonding compound that has hardened. Reclean the repair area as specified in Section 525.3(a) and recoat the repair area with fresh grout or epoxy bonding compound.

Use a pencil size or other appropriate vibrator, as directed, to consolidate the concrete. Work concrete into saw cuts extending beyond the corners of the repair area. Strike-off and shape concrete to match the surrounding pavement, including wheel ruts. Use preformed cellular polystyrene temporary forms to keep the concrete out of existing joints. Do not patch across a joint and saw cut later.

**2. Type 3.** Use vibration or tamping to consolidate the rapid set concrete patching material. Work material into saw cuts extending beyond the corners of the repair area. Strike-off and shape the material to match the surrounding pavement, including wheel ruts. Use preformed cellular polystyrene temporary forms to keep the material out of existing joints. Do not patch across a joint and saw cut later.

**3. Type 4.** Immediately after final cleaning, remove loose aggregate from the repair area and coat all exposed surfaces within the repair area with grout. Do not allow the grout to run or puddle in low spots.

Place the latex modified concrete in the repair area before the grout begins to dry. Sandblast and remove grout that has been permitted to dry. Reclean the repair area as specified in Section 525.3(a) and recoat the repair area with fresh grout.

Use a pencil size or other appropriate vibrator, as directed, to consolidate the latex modified concrete. Strike-off and shape the concrete to match the surrounding pavement, including wheel ruts. Use preformed cellular polystyrene temporary forms to keep the concrete out of existing joints. Do not patch across a joint and saw cut later.

Do not place latex modified concrete if the ambient air temperature is below 7 °C (45F). Do not place latex modified concrete unless the predicted low temperature for the curing period of 120 hours is above 7 °C (45F).

**4. Type 5.** Construct as specified in Section 524.3.

**(c) Transverse and Longitudinal Joints.** If the spall repair is abutting an existing transverse or longitudinal joint, install preformed cellular polystyrene in the joint to a depth equal to that of repair area.

**(d) Mixing Equipment.** Furnish mixing equipment for volumetric mixed cement concrete as specified in Section 704.3 and as follows:

**1. Mixing Unit.** Power driven revolving drum tilting mixer or suitable revolving paddle mixer capable of thoroughly mixing a minimum batch of 0.11 $m^3$ (4 cubic feet).

**(e) Curing.**

**1. Type 1 and 2 Spall Repair.** Use white membrane forming curing compound or cover the repair area with saturated burlap and polyethylene sheeting.

For white membrane forming curing compound, use as specified in Section 501.3(l)1.c except as follows:

Use an atomizing type spray tank with an adjustable nozzle. Agitate the solution before each application.

When using saturated burlap, saturate the burlap with water before placement. Cover the burlap with polyethylene sheeting to completely seal the repaired surface. Secure the sheeting along the sides to maintain an airtight seal.

Cure for a minimum of 72 hours for Type 1 spall repair and 12 hours for Type 2 spall repair.

Provide cold weather curing as specified in Section 501.3(l)2.

**2. Type 3 Spall Repair.** Cure according to the manufacturer's recommendations.

**3. Type 4 Spall Repair.** Cover the repair area with saturated burlap and polyethylene sheeting. Saturate burlap with water before placement. Cover the burlap with polyethylene sheeting to completely seal the repair surface. Secure the sheeting along the sides to maintain an airtight seal.

Wet cure for a minimum of 24 hours. Remove curing materials and air cure for a minimum of 72 hours.

Provide cold weather curing as specified in Section 501.3(l)2.

**4. Type 5 Spall Repair.** Cure as specified in Section 524.3(h).

**(f) Joint Sealing.** Seal all longitudinal and transverse joints created by a spall repair abutting the joint. Only expansion joint sealing is necessary if the pavement is to be overlaid. Seal joints as specified in Section 501.3(n).

**(g) Resounding Repairs.** Resound all repairs in the presence of the Inspector. Replace any repairs that are delaminated, at no cost to the Department.

**(h) Opening to Traffic.**

**1. Type 1 and Type 2 Spall Repair.** Do not open to traffic until the concrete has cured for the period specified in Section 525.3(e)1 and has obtained a minimum compressive strength of 14 MPa (2,000 pounds per square inch) when tested according to PTM No. 604.

**2. Type 3 Spall Repair.** Do not open to traffic until all repairs are cured and accepted.

**3. Type 4 Spall Repair.** Do not open to traffic until the concrete has cured for a minimum of 96 hours, and has obtained a minimum compressive strength of 14 MPa (2,000 pounds per square inch) when tested according to PTM No. 604.

**4. Type 5 Spall Repair.** As specified in Section 524.3(m), except delete the requirement for testing for bond strength.

## 525.4 MEASUREMENT AND PAYMENT—

**(a) Concrete Pavement Spall Repair.** Square Meter (Square Foot)
For the type indicated.
The unit price includes removal of existing pavement and repairs or corrections specified in Section 525.3 that are needed as a result of spall repair operations.

**(b) Joint Sealing.** Meter (Linear Foot)
If Transverse and/or Longitudinal Joint Cleaning and Sealing are part of the contract, sealing of joints at spall repair areas are incidental to that item and will not be payable under Concrete Pavement Spall Repair.

# SECTION 526—RUBBLIZING OF CONCRETE PAVEMENTS

**526.1 DESCRIPTION**—This work is rubblizing and seating of existing concrete pavements before the placement of a pavement overlay.

Rubblizing is classified into two types as follows:

**(a) Type 1.** Rubblizing pavement into pieces having a maximum horizontal dimension of 300 mm (12 inches).

**(b) Type 2.** Rubblizing pavement into pieces having a maximum horizontal dimension of 200 mm (8 inches) and with at least 50% of the pieces per square meter (square yard) having a maximum horizontal dimension of 100 mm (4 inches).

**526.2 MATERIAL—**

**(a) Coarse Aggregate, Type A or Type B, No. 1.** Section 703.2

**(b) Subbase, No. 2A.** Section 350.2

**526.3 CONSTRUCTION—**

**(a) Equipment.** Submit a pavement rubblizing plan and list of proposed equipment for Department approval before the start of construction. If, during rubblizing operations results are not being obtained, cease all rubblizing operations and submit an alternate plan and list of equipment capable of obtaining the specified results to the Representative. Resume rubblizing operations upon acceptance of the alternate plan.

**(b) Existing Bituminous Surfaces.** Remove any existing bituminous paving materials that are overlaying the concrete pavement, as specified in Section 490.3, before beginning rubblizing operations. Do not remove any existing full depth bituminous patches.

**(c) Rubblizing.** Use mechanical or sonic vibratory equipment capable of providing concrete pieces of the specified dimensions, throughout the full depth of the pavement, on a regular and continuous basis. Provide equipment suitable to the Representative.

For Type 2 rubblizing, ensure that pieces are free of bond with reinforcement to allow adequate seating.

Excavate two, 1.0 m x 3.6 m (3-foot by 12-foot), full-depth sections of rubblized pavement, within the first 1.0 km (1/2 mile) of rubblizing operations, to ensure that the pavement is being rubblized to the specific dimensions. Excavate additional areas, as directed, to ensure that the specified dimensions are being maintained. Repeat the initial two-section, full-depth pavement removal testing procedure whenever the equipment, rubblizing pattern, or breaking force is changed.

Use coarse aggregate to backfill all excavated areas. Place backfill in maximum 150 mm (6-inch) lifts and compact by rolling until nonmovement is achieved. Do not allow any shoving or wave motion under the roller.

Cut off and remove any reinforcement steel exposed at the surface of the rubblized pavement. If the transverse joints of the original pavement contained steel plates, remove any steel plates that are exposed.

Exercise care during rubblizing operations to prevent shattering pavement edges adjacent to bituminous base repairs.

Exercise extreme care during rubblizing operations to protect and prevent damage to underground utilities, drainage facilities, bridge approach slabs, and bridge decks. Repair any damage that occurs to these areas, at no cost to the Department.

**(d) Seating.** Following the rubblizing operation, use a 45 tonne (50-ton), pneumatic-tired roller, as specified in Section 108.05(c)3.e, to seat the rubblized pavement. Establish a rolling pattern that ensures all areas of rubblized pavement surface are directly contacted by the roller in no more than four passes. Do not use vibratory rollers.

Final seating of the rubblized pavement is satisfactory when vertical deflection under the roller is less than 20 mm (3/4 inch). Undercut areas where this condition is not achieved. Remove all unsuitable or unstable material. Backfill to existing subgrade with suitable material, to the top of existing subbase with subbase material, and to the top of the rubblized pavement with coarse aggregate. Compact backfill as previously specified in Section 526.3(c).

Forty-five tonne (Fifty-ton) rollers may only cross bridges as approved by the Bridge Engineer. Repair any damage that occurs to bridge approach slabs and bridge decks during the seating operation, at no cost to the Department.

**(e) Final Surface.** After final seating, sweep and clean the surface of the rubblized and seated pavement to remove all loose material.

Prohibit traffic on the roadway after the pavement has been rubblized and seated.

Repair all rubblized and seated pavement areas disturbed by construction traffic, at no cost to the Department.

Complete all operations before construction of the leveling course. If a bituminous leveling course is indicated, apply a prime coat to the rubblized and seated surface, as specified in Section 461, before placing the leveling course.

Complete placement of the overlay within 60 calendar days after rubblizing and seating. Do not leave the rubblized and seated pavement exposed to freezing conditions.

## 526.4 MEASUREMENT AND PAYMENT—

**(a) Rubblize and Seat Concrete Pavement.** Square Meter (Square Yard)

**(b) Class 1A Excavation.** Cubic Meter (Cubic Yard)

**(c) Class 1B Excavation.** Cubic Meter (Cubic Yard)
Measured to existing subgrade level.

**(d) Coarse Aggregate.** Cubic Meter (Cubic Yard)
For the size indicated.

**(e) Removal of Existing Bituminous Surface Course.** Section 490.4

# SECTION 527 - DOWEL RETROFIT

**527.1 DESCRIPTION -** This work is the installation of epoxy-coated, smooth dowel bars into existing concrete pavement across cracks or transverse joints without dowels.

**527.2 MATERIAL -**

**(a) Force-Transfer Units.** Section 705.3 (a) and (b)

**(b) Caulking Compound.** Section 705.8(b)

**(c) Preformed Cellular Polystyrene.** ASTM C 578

**(d) Rapid Set Concrete Patching Material.** Supplied by a manufacturer listed in Bulletin 15. Use within the shelf life and temperature limitations set by the manufacturer.

**(e) Concrete Curing Materials.** Section 711.1(a) and (b)

**(f) Intermediate Curing Compound.** Section 711.2(c)

**(g) Concrete Admixtures.** Section 711.3
If accelerating admixtures are used, provide only accelerating admixtures that contain no chlorides.

**(h) Joint Sealing Material.** Section 705.4(a), (b), and (c)

**(i) Graphite Lubricant.** Section 705.6

**527.3 CONSTRUCTION –** As shown on Standard Drawing RC 26M, and as follows:

**(a) Equipment.** Provide a power driven, self propelled saw capable of making two parallel cuts per dowel bar slot for a minimum of four slots simultaneously. Do not use equipment that may cause pavement to spall or cause surface aggregates to fracture.

**(b) Slot Preparation and Cleaning.** Saw cut pavement to place center of dowel at mid-depth of pavement slab. If repair area spans different pavement thicknesses, e.g. mainline to ramp transitions, place at the mid-depth of the thinner thickness. Align saw cuts parallel to roadway centerline. Cut a minimum of four dowel slots simultaneously (eight saw cuts). Provide four dowel bar slots in each wheel path.

Use chip hammer weighing not more than 14 kg (30 pounds) to remove concrete between saw cuts. If pavement damage occurs from 14 kg (30 pounds) chip hammer, use a 6.6 kg (15 pound) chip hammer. Create a level surface at bottom of slot parallel to roadway surface.

**(c) Clean Slots.** Clean exposed surfaces of slots. Remove all loose and foreign material by sandblasting or water blasting within 24 hours before concrete placement. Use air blasting as final cleaning within 30 minutes before concrete placement. Reclean areas not repaired within 30 minutes of final cleaning or if contamination occurs before concrete placement. For air blasting, use a compressed air stream of at least 700 kPa (100 psi) measured at the source, free of oil, moisture, and other contaminates,.

**(d) Dowel Preparation and Placement.**

**1. Prepare Dowels.** Cut 6 mm (1/4 inch) thick preformed cellular polystyrene material to the cross-section dimensions of the slot at the joint. Cut an opening in the polystyrene joint material to allow the dowel to fit without stretching and without gaps. Place the material centered on the dowel to form a temporary joint. Apply graphite bond-breaker lubricant to Type B coated dowel bars, unless a bond breaker lubricant has been applied in the

shop. Stir the lubricant and apply by daubing, mopping, or with a gloved hand, to produce a thorough coating. Do not use brushes for lubricant application. Apply the lubricant, as specified, at least 1 hour before placing the concrete around the dowel assembly. Type A coated dowel bars do not require lubricant as per Section 501(i). Place 37 mm (1 1/2 inch) non-metallic expansion caps with 6 mm (1/4 inch) clearance from the end of the dowel to the bottom of the cap.

**2. Place Dowels.** Provide plastic or non-metallic chairs with a minimum 13 mm (1/2 inch) clearance between dowel bar cap and all slot surfaces, including end, both sides and bottom. Place chairs on the bottom of the slot. Place coated dowel bars parallel to roadway centerline and pavement surface, allowing no greater than 1/2 inch tolerance out of plane. Place dowels to align the temporary joint material with the existing joint or crack. Seal the temporary joint material at the sides and bottom of transverse joint or crack with caulking compound to prevent concrete patching material from entering into existing joint or crack.

**3. Epoxy Bonding Compound.** Apply according to the manufacturer's recommendations.

**4. Fill Slot.** Fill slot with concrete patching material. Vibrate to thoroughly consolidate the material in the slot and around dowel bar. Place concrete patching material. Do not allow the dowel bar to move from the specified position.

**(e) Final Finish for Pavements not being Overlaid or Diamond Ground.** Finish the surface of the slots to match the existing pavement surface profile, including any existing wheel ruts.

**(f) Curing of Concrete.** As specified in the applicable parts of Section 516.3(i).

**(g) Saw and Seal Joint.** Saw and seal transverse contraction joint sealant reservoirs for entire lane width as required

**(h) Opening to Traffic.** As specified in Section 516.3(q).

**(i) Defective Work.** Remove and replace dowel retrofits that are considered defective, at no additional cost to the Department. The 28-day minimum compressive strength testing for acceptance will not be conducted for any work that is considered defective.

**527.4 MEASUREMENT AND PAYMENT –** Each

For the existing joint or crack preparation, patching, curing and sealing operations. Includes eight dowel bars per joint or crack.

# SECTION 590—CRACK CLEANING AND SEALING

**590.1 DESCRIPTION**—This work is cleaning and sealing of cracks in existing cement concrete pavements having an opening of 1.5 mm (1/16 inch) and wider.

**590.2 MATERIAL—**

**(a) Joint Sealing Material.** Section 705.4(b) or (c)

**590.3 CONSTRUCTION**—Saw or grind cracks to a width of 20 mm (3/4 inch) wide by 25 mm (1 inch) depth. Immediately after sawing and grinding, flush with water. Do not seal the same day as sawing or grinding. If original crack is between 20 mm and 25 mm (3/4 inch and 1 inch) wide, saw or grind to a width of 25 mm (1 inch) and a depth of 30 mm (1 1/4 inches).

Immediately before placing the sealant, clean the crack by using a compressed air stream of at least 700 kPa (100 pounds per square inch) measured at the source.

Seal cracks as specified in the applicable requirements in Section 501.3(n) and as specified here.

Do not place joint sealant unless the ambient air temperature is 4 °C (40F) or greater, and the pavement temperature is 4 °C (40F) or greater.

Fill the sealant reservoir to a level of 3 mm to 6 mm (1/8 inch to 1/4 inch) below the pavement surface.

**590.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 600
# INCIDENTAL CONSTRUCTION

## SECTION 601—PIPE CULVERTS

**601.1 DESCRIPTION**—This work is construction or reconstruction and cleaning of pipe culverts, and storm drains; including the direct design, manufacturing and testing of reinforced concrete pipes.

**601.2 MATERIAL—**

**(a) Pipes.** Comply with the following:

**1. Certification.** Section 106.03(b)3

**2. Size and Type of Pipe.** As indicated.

**3. Reinforced Concrete (RC) Pipe.**

**3.a Round and Elliptical Reinforced Concrete Pipe.** Publication 280M(280). Provide RC pipe conforming to BD-636M, PENNDOT Design Manual Part 4M, Appendix H, and the Pennsylvania Installation Direct Design (PAIDD) computer program. Manufacture and test according to Publication 280M (280).

**3.b Plant Acceptance.**

**3.b.1 General.** Do not begin fabrication before the Structural Materials Engineer's inspection and acceptance of the plant. Provide a permanent building offered for the Department's acceptance.

Currently accepted plants will retain approved status, unless the acceptance is rescinded for failure to comply with the specified plant requirements, or unless ownership is changed. Reinstatement is based on owners conforming to the requirements as stated herein.

Material, equipment, test procedures, methods of fabrication, handling, storage, and transportation are subject to inspection.

**3.c QC.**

**3.c.1 General.** Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Structural Materials Engineer, MTD, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and/or organizational chart, when required, due to changes in processes, materials, or personnel.

**3.c.2 QC Manager.** Provide a QC Manager who has the overall responsibility for the adequacy of production facilities, QC, sampling, and testing, and fabrication of the product, and who will ensure that items are fabricated as designed and specified.

**3.d Testing and Inspection.**

**3.d.1 Testing.** Publication 280M (280).

**3.d.2 Inspection.** Publication 280M(280). Provide the necessary pipe inspection equipment. Before installation, pipes may have non-through wall cracks of less than 80 µm (0.003 inch) in width. Any pipe having both an unloaded surface crack width of 80 µm (0.003 inch) or greater and extending 300 mm (12 inches) or longer, will be rejected. To determine whether rejection or remediation is required, measure crack widths with leaf

gages as described in AASHTO T 280. Use gages having a thickness of 80 µm (0.003 inches) to determine pipe acceptability before installation.

**4. Metal Pipes.**

**4.a Ductile Iron Pipe.** ASTM A 716

**4.b Corrugated Steel Pipe, Metallic Coated.** AASHTO M 36/M 36M, Types I and IR; AASHTO M 218; AASHTO M 274; and AASHTO M 289

**4.c Corrugated Aluminum Alloy Pipe.** AASHTO M 196, Types I and IR

**4.d Coated Corrugated Galvanized Steel Pipe.** AASHTO M 245/M 245M, Type I; AASHTO M 246/M 246M; and AASHTO M 218. Fabricate pipes with coatings as follows:

- Grade 250/250 (Grade 10/10)—250 µm (10 mil) coating on all surfaces.

**5. Half-Circle Pipe.** Conforming to the requirements of the type indicated, except modified to meet the half-circle configuration.

**6. Thermoplastic Pipes.** Provide cell class of material (actual and minimum), minimum pipe stiffness, and the dimension ratio, when applicable, if not included in pipe markings.

**6.a Group I.** 4.5 m (15-foot) maximum fill—0.5 m (1.5-foot) minimum cover

**6.a.1 Polyethylene.**

- ASTM F 714, Type S, SDR
- ASTM F 714, Type S, SDR=26, cell class 335434C, 525 mm (21-inch) diameter—1200 mm (48-inch) diameter only
- ASTM F 894, Type S, RSC=100, cell class 335434C, 900 mm (36-inch) maximum diameter
- ASTM F 894, Type S, RSC=160, cell class 335434C, 450 mm (18-inch) diameter—1050 mm (42-inch) diameter only

**6.a.2 Polyvinyl Chloride.**

- ASTM F 794, Type S, PS=46, cell class 12454C or 12364C, 1200 mm (48-inch) diameter maximum
- AASHTO M 304, Type S, cell class 12454C, 1200 mm (48-inch) maximum diameter
- AASHTO M 304, Type S, cell class 12364C, 450 mm to 1200 mm (18-inch to 48-inch) diameter
- ASTM F 679, Types S, T1, or T2, PS=46, cell class 12364C or 12454C, 900 mm (36-inch) maximum diameter
- AASHTO M 278, Type S, cell class 12454B, 300 mm (12-inch) diameter and 375 mm (15-inch) diameter only

**6.b Group II.** 3.5 m (12-foot) maximum fill—0.5 m (1.5-foot) minimum cover. Section 601.2(a)6.a and as follows:

**6.b.1 Polyethylene.** ASTM F 894, Type S, RSC=100, cell class 335434C, 1050 mm (42-inch) diameter

**6.c Group III.** 2.5 m (8-foot) maximum fill—0.6 m (2-foot) minimum cover. Section 601.2(a)6.a and as follows:

**6.c.1 Polyethylene.**

- AASHTO M 294M, Types D and S, cell class 335400C, 750 mm (30-inch) maximum diameter; and 1998 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12.

**6.c.2 Polyvinyl Chloride.**

- AASHTO M 304, cell class 12364C, 300 mm (12-inch) diameter and 375 mm (15-inch) diameter

**6.d Group IV.** 2.0 m (7-foot) maximum fill—0.8 m (2.5-foot) minimum cover.

**6.d.1 Polyethylene.**

- AASHTO M 294M, Types D and S, cell class 335400C, 900 mm (36-inch), 1050 mm (42-inch), 1200 mm (48-inch); and 1998 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12.

- AASHTO M 294M, Type S, cell class 335400C, 1350 mm (54-inch) and 1500 mm (60-inch) diameters; and 1998 AASHTO LRFD Bridge Design Specification (with 2001 interims) Chapter 12.

**6.e Group V.** 2.0 m (7-foot) maximum fill—0.8 m (2.5-foot) minimum cover

**6.e.1 Polyethylene.**

- AASHTO M 294M, Type C, cell class 335400C, 600 mm (24-inch) maximum diameter

**6.f Group VI .** 4.5 m (15-foot) maximum fill—0.6 m (2.0-foot) minimum cover

**6.f.1 Polyethylene.**

- AASHTO M 294M, Types D and S, cell class 335400C; and 1998 AASHTO LRFD Bridge Design Specifications (with 2001 interims) Chapter 12.

**(b) Other Material.**

- Premolded Expansion Joint Filler—Section 705.1
- Mortar—Section 705.7(a)
- Caulking Compound—Section 705.8(a)
- Preformed Pipe Joint Gaskets—Section 705.5(b)

- Cement Concrete for Miscellaneous Drainage—Section 704
- Reinforcement Steel—Section 709
- Coarse Aggregate—Type C or better, Section 703.2
- Curing Compound—Section 711.2
- Curing and Protecting Covers—Section 711.1
- Bituminous Paint—Federal Specification TT-V-51F. Certify as specified in Section 106.03(b)3.
- Zinc Chromate Primer—Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.
- Flowable Backfill—Section 220.1(a)
- Geotextile, Class 4, Type A—Section 735

**(c) Grout.** Mix one part cement and two parts fine aggregate with the minimum amount of water necessary to obtain grout of the required consistency containing 3% to 7% entrained air. The Contractor may use air entraining cement in place of the plain cement and air entraining admixture. Use materials conforming to the following requirements:

- Cement—Section 701
- Fine Aggregate—Type A or C, Section 703.1
- Water—Section 720.1
- Admixtures—Section 711.3

**601.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Provide 300 mm (12-inch) minimum cover from top of finished pavement grade to top of pipe barrel. Construct the embankment to 1.2 m (4 feet) above the top of pipe elevation or to subgrade, whichever is less, before excavating for the pipe. Do not haul over pipe with less than 1.2 m (4 feet) of cover. Maintain a minimum pipe slope of 0.35% unless otherwise specified.

If running water is encountered and cannot be diverted, provide an acceptable temporary pipe or other structure before placing embankment, or as otherwise directed.

**(b) Trench and Bedding.** Excavate trench and construct bedding as shown on the Standard Drawings. Compact the bottom of the trench before placement of bedding material. If flowable backfill material is used, provide support for pipe as specified in Section 220.3(b)2.

**(c) Laying Pipe.** Lay pipe as shown on the Standard Drawings before constructing base course or pavement. Lay pipe with bells or grooves up grade in shaped recesses when required, spigot ends fully entered into the hubs. Begin placement of the pipe at the outlet end with a full length of pipe and continue towards the inlet end, unless otherwise directed. Fill lift holes with a manufactured lift hole plug that is soil-tight

Control the pipe alignment and grade with suitable string lines, with an electronic laser beam system, or by other acceptable methods.

Camber the grade line to offset anticipated settlement due to the height of embankment and bedding used, if directed.

On straight-line pipe placements, join pipe sections within 20 mm/m (1/4 inch per foot) of inside diameter or 25 mm (1 inch), whichever is less. Join pipes placed on a radius to within these tolerances as measured at a point

halfway up the pipe, springline, along the interior of the curve. For pipe runs placed on curves with a radius less than 700 m (765 yards) (greater than 2 degrees, 30 minutes) use shorter lengths of precast pipe to minimize the joint gap.

If pipes are protected by endwalls or connected with drainage structures, place exposed pipe end within cast-in-place wall or cut off flush with precast structure face and finish with mortar, as directed. Provide satisfactory connections to existing drainage structures.

Coat all aluminum surfaces that will be embedded into concrete with one coat of zinc chromate primer, or a coat of bituminous paint. Allow coating to dry completely before placement of concrete.

**(d) Joints.** Lay pipe, except interlocking style and pipe joined with bands, with pipe joint caulk or preformed pipe joint gaskets as follows:

**1. Pipe Joint Caulk.** Before placing succeeding pipe sections, place the caulk on the inside of the bell end of the pipe, such that a sufficient layer of material is placed around the entire circumference of the pipe. After the joint is assembled, remove excess caulk on the inside of the pipe, such that the flow of water is not obstructed and seal the outside circumference of the joint.

**2. Preformed Pipe Joint Gaskets.** Before placing succeeding pipe sections, place preformed pipe joint gaskets according to manufacturer's recommendation.

**(e) Elongation of Metal Pipes.** When indicated, elongate metal pipe vertically 5%, using acceptable shop methods. Elongate coated pipe by acceptable shop methods only. Satisfactorily repair coating damaged by elongation procedures.

**(f) Backfilling Trench.** After the pipe is laid, backfill the trench as shown on the Standard Drawings. Place material in 100 mm (4-inch) layers. However, 200 mm (8-inch) layers will be permitted if vibratory compaction equipment is used. Compact each layer of backfill to the density shown on the Standard Drawings to a height of 1.2 m (4 feet) above the top of the pipe, for the full trench width. Use mechanical tampers or other acceptable compaction equipment that will not damage the pipe. Do not use excavator-mounted hydraulic plate compactors. Compact backfill material to the density shown on the Standard Drawing as determined by Standard Proctor Density (SPD). Test as specified in Section 206.3(b)1. Test the coarse aggregate backfill for reinforced concrete pipe before placing remaining backfill. If flowable backfill material is used, backfill the trench as shown in the Flowable Backfill Detail on the Standard Drawings, and as specified in Section 220.3.

**(g) Shored or Trench Box Installation.** Construct shored or trench box installation where indicated and as specified in Section 107.08. Construct shored or trench box installation as required for reinforced concrete pipe.

Construct shored or trench box installations for thermoplastic or metal pipe as follows:

- Leave trench sheeting in place to prevent loss of foundation support and backfill materials unless otherwise directed. When the top of trench sheeting is to be cut off, make the cut 460 mm (18 inches) or more above the crown of the pipe. Leave rangers, whalers, and braces in place as required to support the cut off sheeting and trench wall in the vicinity of the pipe zone. Leave timber sheeting in place. Treat timber sheeting against biological degradation and decay if placed above the ground water table.

- Do not disturb the installed pipe and its embedment when using movable trench boxes and shields. Do not use movable supports below the top of the pipe backfill pay limit zone unless approved methods for maintaining the integrity and level of compaction of the backfill material are used. Before moving supports, place and compact embedment to sufficient depths to ensure protection of the pipe. Finish placing and compacting the backfill material as supports are moved.

- If the use of sheeting or other trench wall supports is permitted below the pipe backfill pay limit zone, ensure that pipe, bedding, and backfill materials are not disturbed by support removal. Fill voids left upon removal of supports and compact all material to required densities.

**(h) Jacked Pipe.** Jack pipe by means of conventional tunneling or boring methods, when indicated. Before commencement of this work, submit a complete plan and schedule for pipe installation. Include complete details of

sheeting, shoring, and bracing for the protection of facilities above the pipe, as well as materials and equipment pertinent to the jacking operation. Do not proceed with pipe installation until the plan and schedule are accepted.

Do not disturb facilities or cause settlement of the ground above the pipe. Provide free and unobstructed use of facilities above the pipe, without delay or danger to life, equipment, or property.

Install pipe immediately following the heading or tunneling excavation. After completion of the jacking operation, fill voids around the pipe with grout placed under pressure. Properly protect the grout for at least 3 days.

Place joint sealant material on concrete pipe in front of the jacking frame. Replace or repair pipe damaged during the jacking operations as directed. If steel casing pipe is used, butt-weld the joints as installation progresses. Make joints watertight.

If it is determined that the pipe installation is being conducted in an unsatisfactory manner, stop this work and place a bulkhead at the heading until an alternate procedure is proposed and accepted.

**(i) Extension of Existing Pipe.** If extensions of pipe culverts or drains are indicated or required, remove the existing endwalls as directed. Cut the existing pipe to a true edge, as required, to make a satisfactory joint. Join the new pipe to the existing pipe or endwalls, using acceptable collars constructed of Class A Concrete or acceptable metal connecting bands. Clean the existing pipe, as specified in Section 601.3(j). Repair or replace existing pipe damaged during construction.

As an alternate to removing the endwall, if permitted, extend the pipe using a concrete collar for pipe extension, as specified in Section 618.

**(j) Cleaning Existing Pipes.** Clean existing pipe culverts, as indicated and as directed, before the start of roadway paving operations. Clean inlets, bridge scuppers and piping, manholes, endwalls, and other drainage appurtenances connected to the pipes, as directed. Clean in an acceptable manner and repair damage resulting from the cleaning operation. Remove any material deposited in inlets during paving operations. Prevent material cleaned from the drainage system from entering streams or other bodies of water, and dispose of this material in a satisfactory manner.

**(k) Relaid Pipe.** Remove and clean existing pipes as indicated, and have them inspected by the Representative. Transport and relay accepted existing pipes at the indicated locations, in the same manner specified for new pipes.

**(m) Removal and Replacement.** Remove and replace pipe that is not true to alignment, shows settlement after installation, or is broken or damaged.

**(n) Final Inspection of Pipes.** Before final acceptance, inspect all of the following types of installed pipe with total load applied. Provide pipe inspection equipment and inspect all pipes over 750 mm (30 inches) in diameter from inside the pipe. Inspect 450 mm (18-inch) to 750 mm (30-inch) diameter pipes from access points. Provide written documentation of all inspections to the Representative within 72 hours following each inspection. Provide training to Contractor personnel and Department personnel and provide all safety and testing equipment required by OSHA, Section 1910.146, to both department representatives and Contractor personnel to ensure the safety of all the workers and inspectors during pipe inspections. Also, provide certification of training for the individuals doing the inspections on the proper use of the testing equipment and all safety procedures to ensure a safe operation.

**1. Concrete Pipes.** Provide pipe gages, as specified in Section 601.2(a)3.d.2. and inspect concrete pipes for signs of damage including cracks greater than 180 µm (0.007 inch) in width, spalls, damaged or cracked ends, and visible reinforcement. Submit a plan for repair or replacement as specified in Section 601.3(o) for approval.

**2. Metal Pipes.** Inspect metal pipes for damage including rust, cracking of coatings, damaged galvanization or lining, loose bolts, and areas of local buckling. Repair damaged coatings according to AASHTO M 36/M 36M and AASHTO M 245/M 245M. Develop a repair or replacement plan as specified in Section 601.3(o) for damage repairs not covered by AASHTO M 36/M 36M or AASHTO M 245/M 245M, buckling, or other major damage, and submit it for approval.

**3. Thermoplastic Pipes.** Inspect thermoplastic pipes for cracking and joint separation, and perform deflection testing at least 30 days after the embankment is completed. If the pipe run is 12 m (40 feet) or less in length, not under the roadway, and the initial visual inspection does not indicate any deflection or other deficiencies, additional testing will be waived. In all other cases, perform the deflection testing using either electronic

deflectometers, calibrated television or video cameras, properly sized "go, no-go" mandrel, direct measurement by extension rulers or tape measures in pipes that allow safe entry, or other acceptable devices. Perform deflection testing at a minimum if pipe cannot be physically inspected. Develop a remediation or replacement plan as specified in Section 601.3(o) if deflection is greater than 5% of the unloaded inside diameter of the pipe, or cracking or joint separation is found, and submit it for approval.

**(o) Remediation.** Remedial action may include but is not limited to removal and replacement or an accepted repair procedure.

## 601.4 MEASUREMENT AND PAYMENT—

**(a) Pipe Culverts and Relaid Pipe Culverts.** Meter (Linear Foot)

Measured to the point of centerline intersection of "T," "Y," and other branches. The unit price includes the pipe, the bedding material, and the backfill as shown on the Standard Drawings. Furnishing personnel and equipment for dewatering operations, inspection of pipes, and all remedial measures are incidental to the pipe items.

If the pipe item for shore/trench box is indicated or required; the unit price includes placement and removal or keeping in place of shoring, supports, shield systems and trench boxes as specified in Section 601.3(g).

**(b) Half-Circle Pipe.** Meter (Linear Foot)

**(c) Cement Concrete for Miscellaneous Drainage.** Cubic Meter (Cubic Yard)

As indicated, for the class specified, for the item indicated.

The unit price includes reinforcement when required.

**(d) Class 1 Excavation.** Cubic Meter (Cubic Yard)

Pay limits as shown on the Standard Drawings.

**(e) Class 2 Excavation.** Cubic Meter (Cubic Yard)

For Half-Circle Pipe including bedding and anchors.

**(f) Class 4 Excavation.** Cubic Meter (Cubic Yard)

Pay limits as shown on the Standard Drawing for pipe culverts and relaid pipe culverts. Where inlets are installed, measurement terminates 300 mm (1 foot) from the outside face of the inlet wall.

**(g) Cleaning Existing Pipe Culverts.** Meter (Linear Foot)

Measured from inlets, manholes, endwalls, and other drainage appurtenances along the pipe centerline.

Pay items will establish a break point based on the sizes of pipes to be cleaned. The Department will pay for cleaning of pipe culverts having diameters up to and including 900 mm (36 inches) under one pay item, and cleaning of pipe culverts having diameters over 900 mm (36 inches) under a separate pay item.

**(h) Jacked Pipe.** Meter (Linear Foot)

The unit price includes excavation.

**(i) Flowable Backfill Material.** As indicated, for all pipe installations, flowable backfill and geotextile are incidental to meter (linear foot) of pipe payment.

# SECTION 602—CORRUGATED METAL PIPE-ARCH CULVERTS

**602.1 DESCRIPTION**—This work is construction or reconstruction of pipe-arch culverts.

**602.2 MATERIAL**—Sections 601.2(a)1 and 2; 601.2(b) and (c); and as follows:

**(a) Corrugated Steel Pipe-Arch, Metallic Coated.** AASHTO M 36/M 36M, Types II and IIR; AASHTO M 218; AASHTO M 274; and AASHTO M 289.

**(b) Corrugated Aluminum Alloy Pipe-Arch.** AASHTO M 196/M 196M, Types II and IIR.

**(c) Coated Corrugated Galvanized Steel Pipe-Arch.** AASHTO M 245/M 245M, Type II; AASHTO M 218; and AASHTO M 246/M 246M. Fabricate pipe-arch with coating as follows:

- Grade 250/250 (Grade 10/10)—250 µm (10 mil) coating on all surfaces.

**602.3 CONSTRUCTION**—As specified in Section 601.3, according to the requirements applicable to metal pipes.

**602.4 MEASUREMENT AND PAYMENT**—As specified in Sections 601.4(a), (c), (d), and (h).

# SECTION 603—METAL PLATE CULVERTS

**603.1 DESCRIPTION**—This work is construction of metal plate pipes, metal plate pipe-arches, and metal plate arch culverts.

**603.2 MATERIAL—**

**(a) Metal Plate Pipes, Metal Plate Pipe-Arches, and Metal Plate Arches.** Certify as specified in Section 106.03(b)3. Comply with the requirements of AASHTO M 167/M 167M (Steel) and AASHTO M 219/M 219M (Aluminum Alloy), except modify as follows:

**1. AASHTO M 167/M 167M.** Modified as follows:

**1.a Section 11, Fabrication.** Except:

- Space bolt holes 235 mm (9.4 inches) apart along plate edges that are to form circumferential seams.
- For bolt hole diameters, do not exceed the bolt diameter by more than 3 mm (1/8 inch) for longitudinal bolt holes or 6 mm (1/4 inch) for circumferential bolt holes.
- Form corrugations at right angles to the structure's longitudinal axis, having a depth of not less than 48 mm (1 7/8 inches) but not greater than 54 mm (2 1/8 inches), unless otherwise accepted.
- Where necessary, to secure additional seam strength for pipe assembled with lap joints, increase the number of bolts per meter (foot) of longitudinal seam to 20 (six) or 28 (eight).

In addition:

- Furnish plates in sizes that will allow length increments of 600 mm (2 feet) for square-ended structures.
- Provide a lap joint capable of transmitting the design thrust through the joint.
- Fabricate plates so not more than three plates come together at a point.
- In the two bottom segments of an arch, plates may be punched with one row of holes adjacent to the longitudinal plate edge that is to rest on the pier or abutment.

**1.b Section 14, Dimensions and Tolerances.** Determine the thickness of plates by mass (weight) of flat plates before corrugating. Comply with the following theoretical masses (weights) and tolerances.

**THEORETICAL MASS AND TOLERANCES (Metric)**

| Galvanized Plate Thickness (mm) | Theoretical Mass Before Galvanizing ($kg/m^2$) | Theoretical Mass After Galvanizing ($kg/m^2$) | Permissible Variation of Average Mass of Lots* (percent) | |
|---|---|---|---|---|
| | | | Over | Under |
| 7.11 | 54.92 | 55.678 | 5.5 | 3 |
| 6.32 | 48.81 | 49.576 | 5.5 | 3 |
| 5.54 | 42.71 | 43.474 | 5.5 | 5 |
| 4.78 | 36.61 | 37.372 | 5.5 | 5 |
| 4.32 | 33.560 | 34.321 | 5 | 5 |
| 3.56 | 27.458 | 28.220 | 5 | 5 |
| 2.82 | 21.356 | 22.118 | 5 | 5 |

**THEORETICAL WEIGHTS AND TOLERANCES (English)**

| Gage | Theoretical Weight Before Galvanizing (lbs. per sq. ft.) | Theoretical Weight After Galvanizing (lbs. per sq. ft.) | Permissible Variation of Average Weight of Lots* (percent) | |
|---|---|---|---|---|
| | | | Over | Under |
| 1 | 11.25 | 11.406 | 5.5 | 3 |
| 3 | 10.00 | 10.156 | 5.5 | 3 |
| 5 | 8.75 | 8.906 | 5.5 | 5 |
| 7 | 7.50 | 7.656 | 5.5 | 5 |
| 8 | 6.875 | 7.031 | 5 | 5 |
| 10 | 5.625 | 5.781 | 5 | 5 |
| 12 | 4.375 | 4.531 | 5 | 5 |

* The term "lot" means all the plates of one thickness (gage) in the shipment, for thicknesses 4.78 mm (gage 7) and heavier and not less than 2700 kg (6,000 pounds), for thicknesses 4.32 mm (gage 8) and lighter, with all individual plates not below the theoretical mass (weights) by more than 10%.

**1.c Section 17.1, Inspection.** Inspect mill and factory base metal when required, according to AASHTO M 36/M 36M. Test the mass (weight) of the spelter coating, according to AASHTO T 65.

**2. AASHTO M 219/M 219M.** Include fabrication details on the shop drawings.

**3. Field Inspection and Acceptance of Plates.** A field inspection will be made at the job site. Furnish an itemized statement showing the number, size, and certified chemical analysis of the plates in each shipment.

A plate will be rejected if it:

- fails to meet specifications,
- shows defective workmanship, or
- has a bruised or broken spelter coat.

**(b) Other Materials.**

- Class A Cement Concrete—Section 704

- Cement Concrete for Miscellaneous Drainage—Section 704
- Reinforcement—Section 709.3
- Coarse Aggregate—Section 703.2
- Selected Borrow Excavation—Structure Backfill. As shown on the Standard Drawings.
- Structural Steel—Section 1105.02(a)2
- Emulsified Asphalt Class RS-1(E-1A) or CRS-1(E-1C) (Mop Coat on Concrete Paving)—Section 702
- Bituminous Coating—AASHTO M 243. Certify as specified in Section 106.03(b)3.
- Bituminous Material—(For sealing the groove, metal bearing channel or angle or arches, as required.) Class BF-1 Asphalt Cement, Section 702.
- Hook Bolts—Section 1105.02(d). Certify as specified in Section 106.03(b)3.
- Metal Bearing Materials—AASHTO M 183/M 183M, galvanized as specified in Section 1105.02(s) (AASHTO M 232). Certify as specified in Section 106.03(b)3.
- Curing and Protective Covers—Section 711.1

**603.3 CONSTRUCTION—**

**(a) General.** Provide shop drawings for review and acceptance. Show physical properties of plates and the proposed joint design on the drawings.

Inspect metal plate culverts as specified in Section 601.3(n) and provide remediation as specified in Section 601.3(o).

**(b) Placing and Erecting.** Excavate, as shown on the Standard Drawings. Place and erect as follows, unless an alternate method from the manufacturer is accepted:

**1. Metal Plate Pipes and Pipe-Arches.** Form the bed and trench, as shown on the Standard Drawings. Place plates "shingle-wise" to allow water to flow over, not against, the edges of plates, except for haunch plates for pipe-arches. Haunch plates may require placement inside or outside of adjacent haunch plates. When indicated, place washers under nuts. Use sufficient bolts to hold plates of the pipe or pipe-arch in position until the structure is completed. Place the bottom two rows of bolts with the threaded end inside the structure to facilitate tightening. Place bolts on other seams alternately, so nuts are always on the crests of corrugations, first inside, then outside, the culvert. Do not draw bolts and nuts tight until the structure is finished. Draw bolts and nuts tight before backfilling.

**1.a Elongation.** Elongate round pipes vertically 5%, using acceptable shop methods, or 3%, using timber strutting in the field, unless otherwise indicated.

Submit a plan for review before placing timber strutting, showing strut sizes, spacing, and jacking methods. A tolerance of ±25% of the specified amount of elongation will be permitted. Complete the field strut before backfilling around the pipe.

Place struts for pipe-arches when directed, to retain the size.

Uniformly strut from end to end of pipes and pipe-arches without endwalls. If endwalls are used, do not elongate the ends of pipes or pipe-arches. Leave struts in place until the roadway embankment is complete and compacted, unless otherwise directed.

**1.b Bituminous Coating.** Clean and dry plates and field apply a bituminous coating, if indicated, at the proper temperature. Provide a coating with a minimum thickness of 1.3 mm (0.05 inch), measured on the crest of corrugations, to the lower inside one-half of the pipe or pipe-arch.

**1.c Concrete Paving.** If indicated, pave inverts of pipes and pipe arches with Class A cement concrete, reinforced with 152 mm x 152 mm, 3.4 mm diameter (6 inches by 6 inches, 10 gage), steel wire fabric (WWR 152 x 152 - MW9 x MW9 and/or WWF 6 x 6 - W 1.4 x W 1.4). Anchor reinforcement to the structure. Cover 25% of the periphery of pipes and 40% of the periphery of pipe-arches to a thickness of 50 mm (2 inches) above the crests of corrugations. If bituminous coating and concrete paving are both indicated, pave with concrete first. Do not apply bituminous coating on the paved portion. Tamp the concrete to the required thickness and contour. After initial set, cover concrete with a heavy spray or mop coat of emulsified asphalt, Class E-1.

**2. Metal Plate Arches.** Construct the concrete foundation, as indicated and as specified in the applicable parts of Section 1001.3. Place the metal channels or angles in the concrete foundation, as indicated.

Erect metal plates one course at a time and hold in place temporarily, beginning at the sides, with lower plates fitted into their channels. Progress to the top or center of the arch. Portions of the arch may be assembled and lifted into place, if directed.

Place downstream plates outside adjoining upstream plates, with each rise plate outside the adjoining lower plate and all placed "shingle-wise", or as recommended by the manufacturer. When indicated, place washers under each nut. Use enough bolts to hold arch plates in position until the structure is formed. Then, place and tighten the remaining bolts. Place nuts on the crests of corrugations, alternately inside and outside of the arch. Draw all bolts tight before backfilling.

After the arch has been completely placed, but before backfilling, fill the groove or channel used for the bearing area of the arch with bituminous material. If an angle is used for the bearing area, seal the intersection of the arch and angle with bituminous material.

**(c) Backfilling.**

**1. Metal Plate Pipes and Pipe-Arches.** After plates are satisfactorily erected, place fill material around the pipe or pipe-arch, as specified in Section 601.3(f).

**2. Metal Plate Arches.** Carefully place selected borrow excavation-structure backfill, as shown on the Standard Drawings and as specified in Section 1001.3(q)2.b when the substructure concrete has attained the required strength and plates have been erected, unless otherwise directed.

Place backfill in layers not exceeding 100 mm (4 inches) in depth, alternately on each side of the arch, or on each side of each arch in the case of a multiple installation. Compact with mechanical tampers until a power roller may be used, then place the remainder of the embankment, as specified in Section 206.3.

When filling around and over arches, before endwalls are constructed, place the first fill material midway between the arch ends, forming as narrow a ramp as possible until the top is reached. Build the ramp evenly from both sides, compacting fill material while placing it. After the ramps have been built to the arch top, deposit the remainder of fill material from the top, in both directions, from the center to the ends, as evenly as possible on both sides.

If endwalls are built before any fill material is placed around and over the arch, place fill material adjacent to one endwall until the arch top is reached, then dump fill material from the top toward the other endwall, using care to deposit material evenly on both sides of the arch.

For a multiple installation, follow the procedure specified above, but bring material up evenly on each side of each arch, avoiding unequal pressure.

Tamp the fill material thoroughly, but not excessively. Do not puddle the material with water.

Remove fill material causing excessive distortion of plates. Brace plates into correct position, then replace fill material. Remove bracing, as directed.

Conform to additional requirements from the manufacturers.

**603.4 MEASUREMENT AND PAYMENT—**

**(a) Metal Plate Pipes and Pipe Arches.** Meter (Linear Foot)

Measured along the centerline of culverts with square or skewed vertical ends; the average length along the centerline of culvert with square or skewed beveled ends.

Bedding, backfill, concrete paving, if indicated, and inspection of culverts, including personnel and equipment, is incidental.

**(b) Metal Plate Arches.** Meter (Linear Foot)

Measured along the centerline of culverts with square or skewed vertical end; the average length along the centerline of culverts with square or skewed beveled ends.

**(c) Excavation.** Cubic Meter (Cubic Yard)

For the class indicated.

**(d) Cement Concrete for Miscellaneous Drainage.** Section 601.4(c)

The unit price does not include concrete paving, if indicated.

**(e) Selected Borrow Excavation-Structure Backfill.** Section 1001.4(g)

# SECTION 604—COMBINATION STORM SEWER AND UNDERDRAIN

**604.1 DESCRIPTION**—This work is construction of combination storm sewer and underdrain.

**604.2 MATERIAL—**

**(a) Pipes.** Section 601.2(a)1 and (a)2 and as follows:

**1. Nonmetal Pipes.**

**1.a General.** When indicated provide a minimum water inlet area of 3000 $mm^2/m$ (1.4 square inches per linear foot) of pipe.

**1.b Reinforced Concrete (RC) Pipe.** Section 601.2(a)3. Where specified, provide RC pipe with specified water inlet area according to Pennsylvania Installation Direct Design (PAIDD) computer program and Publication 280M (280).

**1.c Group IP.** Section 601.2(a)6.a

**1.d Group IIP.** Section 601.2(a)6.b

**1.e Group IIIP.** Section 601.2(a)6.c, and as follows:

**1.e.1 Polyethylene.** Add the following:

- AASHTO M 294/M 294M, Type S, Class 1 perforations, provide specified water inlet area.

**1.f Group IVP.** Section 601.2(a)6.d, and as follows:

**1.f.1 Polyethylene.** Add the following:

- AASHTO M 294/M 294M, Type S, Class 1 perforations, provide specified water inlet area.

**1.g Group VP.** Section 601.2(a)6.e, and as follows:

**1.g.1 Polyethylene.** Add the following:

- AASHTO M 294/M 294M, Class 1 perforations, provide specified water inlet area.

**1.h Group VIP.** Section 601.2(a)6.f, and as follows:

**1.h.1 Polyethylene.** Add the following:

- AASHTO M 294/M 294M, Class 1 perforations, provide specified water inlet area.

**2. Metal Pipes.**

**2.a General.** Perforate pipe with Class 1 perforations, according to AASHTO M 36/M 36M, M 196/M 196M, or M 245/M 245M, except provide a minimum water inlet area of 3000 $mm^2/m$ (1.4 square inches per linear foot) of pipe.

**2.b Corrugated Steel Pipe, Metallic Coated.** AASHTO M 36/M 36M, Types I and IR; AASHTO M 218; AASHTO M 274; and AASHTO M 289

**2.c Corrugated Steel Pipe-Arch, Metallic Coated.** Section 602.2(a)

**2.d Corrugated Aluminum Alloy Pipe.** AASHTO M 196/M 196M, Types I and IR

**2.e Corrugated Aluminum Alloy Pipe-Arch.** AASHTO M 196/M 196M, Types II and IIR

**2.f Coated Corrugated Galvanized Steel Pipe.** Section 601.2(a)4.d

**2.g Coated Corrugated Galvanized Steel Pipe-Arch.** Section 602.2(c)

**(b) Other Material.**

- Coarse Aggregate—Type C or better, No. 57, Section 703.2.
- Geotextiles—Class 1, Section 735.

**604.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Laying Pipe.** Section 601.3(c), except as follows:
Lay pipe with perforations facing upwards. Place rigid non-metal pipe, keeping the portions of the joints in contact with the coarse aggregate clean, and providing a minimum water inlet area of 3000 $mm^2/m$ (1.4 square inches per linear foot) by either blocking open, furnishing pipe manufactured with the required water inlet area provided, or by other acceptable means. Fill the remainder of the joint, as specified in Section 601.3(d).

**(b) Geotextiles, Class 1.** Section 212.3(b)

**(c) Backfilling Trench.** After the pipe is satisfactorily laid, backfill, as specified in Section 601.3(f). Obtain suitable impervious material, as required.

**(d) Pipe Inspections.** Inspect pipes as specified in Section 601.3(n)

**604.4 MEASUREMENT AND PAYMENT**—

**(a) Pipe.** Meter (Linear Foot)
Measured to the point of centerline intersection of "T," "Y," and other branches.

**(b) Geotextiles, Class 1.** Section 212.4(a)

**(c) No. 57 Coarse Aggregate.** Cubic Meter (Cubic Yard)

**(d) Class 1 Excavation.** Section 601.4(d)

**(e) Class 4 Excavation.** Section 601.4(f)

# SECTION 605—ENDWALLS, INLETS, MANHOLES, AND SPRING BOXES

**605.1 DESCRIPTION**—This work is construction of endwall, inlet, manhole, and spring box structures of the type indicated.

**605.2 MATERIAL—**

**(a) Inlet Grates and Frames.** As shown on the Standard Drawings RC 34M, either structural steel, Section 1105.02(a)3.c, or gray, malleable, or ductile iron as specified in Section 1105.02(h). Certify as specified in Section 106.03(b)3.

Coat structural steel grates with bituminous paint in the shop or in the field, before placement. Coat structural steel frames with bituminous paint when placing in the concrete inlet top. Cover frames and grates completely with no pin holes or voids. As an alternative to bituminous paint, hot dip galvanize structural steel grates and frames as specified in Section 1105.02(s).

**(b) Manhole Frames and Covers.** As shown on the Standard Drawings, either gray malleable or ductile iron, as specified in Section 1105.02(h). Machine-grind the metal-bearing contact areas to fit in pairs. Matchmark each pair with notches to ensure satisfactory seating.

**(c) Manhole Steps.** Certify as specified in Section 106.03(b)3. As shown on the Standard Drawings, conforming to the vertical design load and the horizontal pull out design load requirements of ASTM C 478M; and made of one of the following materials:

- Corrosion-resistant steel alloy bars containing 1.65% to 1.85% nickel and 0.8% to 0.9% copper, having a minimum tensile strength of 345 MPa (50,000 pounds per square inch) and a minimum yield strength of 255 MPa (37,000 pounds per square inch), with a minimum elongation of 30% over a 50 mm (2-inch) gage length.

- Deformed Wire, ASTM A 496, Epoxy-Coated according to ASTM A 934/A 934M-95, encased in a co-polymer polypropylene shell that conforms to ASTM D 4101, Table PP, Group 03, Class 4, Table B Designation B44744.

- Deformed reinforcement bars, AASHTO M 31/M 31M, Grade 300 (Grade 40), galvanized after bending, according to ASTM A 787/A 787M.

- Deformed reinforcement bars, ASTM A 615/A 615M, Grade 400 (Grade 60), coated with copolymer polypropylene plastic that conforms to ASTM D 4101; Table PP; Group 03 Copolymer or Impact Modified; Class 2, 3, or 4; any of grades 1 through 9.

- Gray, malleable or ductile cast iron, as specified in Section 1105.02(h).

- Aluminum alloy ASTM B 221M, 6061-T6, 6005-T5, or 6351-T6, with a protective coat applied to the portion to be embedded in the concrete.

- Fiberglass-reinforced polyester, ASTM D 2444 and D 635.

- Fabricate manhole steps free from sharp edges, burrs, and hazardous projections.

**(d) Other Material.**

- Class A Cement Concrete—Section 704

- Brick—Section 713.1

- Reinforcement—Section 709
- Mortar—Section 705.7
- Precast Concrete Units—Section 714
- Concrete Curing Compounds—Section 711.2(a)
- Curing and Protecting Covers—Section 711.1
- Bituminous Paint—AASHTO M140 (emulsified asphalt) meeting the requirements listed in Bulletin 25 and from a supplier listed in Bulletin 15, Section 702-EM. Certify as specified in Section 106.03(b)3.
- Zinc Chromate Primer—Federal Specification TT-P-645. Certify as specified in Section 106.03(b)3.

**605.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

- Cement Concrete Structures—As specified in the applicable parts of Section 1001.3.
- Brick Masonry—Section 663.3

Excavate for the structure as required.

Place concrete foundations and walls monolithically, except if otherwise allowed.

Carefully remove existing castings that are to be reused. Clean and transport to the new location.

Construct new inlet or manhole walls and bottoms to accommodate the dimensions of the existing castings.

Set frames, concrete top units, and grade adjustment rings (if required for inlets and manholes) in full mortar beds.

Set pipes in inlets and manholes, flush with the inside structure face. For pipes protected by endwalls, set flush with the exposed structure face.

If constructing structures in conjunction with existing pipe culverts and drains, provide for satisfactory connections, as specified for new construction of a similar type.

Backfill excavated spaces around the structure, with acceptable embankment material, as specified in Section 206.3(b)4. Satisfactorily dispose of unsuitable and surplus materials.

Coat all aluminum surfaces to be embedded in concrete with one coat of zinc chromate primer, or a coat of bituminous paint. Allow to dry completely before placing concrete.

**605.4 MEASUREMENT AND PAYMENT—**

**(a) Inlets and Manholes.** Each

The price for the inlet includes Inlet Box and Inlet Top Unit. The price for the manhole includes manhole cover, frame, and steps.

**(b) Inlets and Manholes Using Existing Frames and Grates or Covers.** Each

**(c) Concrete for Miscellaneous Drainage.** Section 601.4(c)

**(d) Inlet Boxes.** Each

**(e) Inlet Top Units.** Set

The price includes frames, grates, and grade adjustment rings, if required.

**(f) Spring Boxes.** Each

The price includes reinforcement, if required.

**(g) Endwall Excavation.** Cubic Meter (Cubic Yard)
For the Class of excavation, as indicated.

**(h) Manhole Covers and Frames.** Set includes grade adjustment rings, if required.

**(i) Endwalls.** Each
For the type indicated.

# SECTION 606—GRADE ADJUSTMENT OF EXISTING MISCELLANEOUS STRUCTURES

**606.1 DESCRIPTION**—This work is the grade adjustment of existing inlets, manholes, or utility boxes for a vertical height of 100 mm (4 inches) or less.

**606.2 MATERIAL—**

**(a) Manhole and Inlet Extensions.** From a manufacturer listed in Bulletin 15 or have the type of extension accepted by the MTD before use.

Use extensions composed of gray, malleable, or ductile iron conforming to the requirements of Section 1105.02(h); structural steel, Section 1105.02(a)2; or merchant quality steel conforming to ASTM A 575.

Fabricate the extensions to conform to the shape of the original manhole or inlet castings. They may be either welded in place or secured by a swedge fit. Weld according to the manufacturer's recommendations. Provide a locking device to ensure the swedge fit is permanent. Coat steel extensions with a bituminous paint, as specified in Section 605.2(a).

**(b) Additional Material.** Conforming to the requirements specified for new structures.

**(c) Certification.** Section 106.03(b)3

**606.3 CONSTRUCTION—**

**(a) General.** Excavate as necessary. Carefully remove and clean existing castings. Construct the structure walls to the required elevation, as specified in Section 605.3, conforming to the type of construction and dimensions of the existing structure.

Replace castings on a full mortar bed, as required.

Remove existing walls if the existing structure elevation is higher than the proposed elevation or if directed because the walls are in an unsatisfactory condition. Rebuild as specified.

Backfill as required. Repair or replace existing pavement, curb, and sidewalk damaged due to rebuilding. Satisfactorily dispose of unsuitable and surplus materials.

Upon completion, clean each structure of accumulations of debris, mortar, or foreign matter, including existing material, and keep clean until final acceptance.

**(b) Adjustable Extensions.** Before placing pavement material, set the adjustable extension unit in the existing inlet or manhole frame with the section resting on the flange. Secure the unit in place, according to the manufacturer's recommendations. Set the manhole cover or inlet grate in the flange formed by the adjustable extension unit.

**606.4 MEASUREMENT AND PAYMENT**—Set

# SECTION 607—REBUILT MISCELLANEOUS STRUCTURES

**607.1 DESCRIPTION**—This work is rebuilding of existing inlets, manholes, or utility boxes of the types indicated for vertical heights in excess of 100 mm (4 inches).

**607.2 MATERIAL**—Section 605.2

**607.3 CONSTRUCTION**—Section 606.3(a). Install necessary additional manhole steps as required.

**607.4 MEASUREMENT AND PAYMENT**—Vertical Meter (Vertical Foot)

The Department will measure and pay to the nearest 0.01 m (0.1 foot), except that heights less than 0.3 m (1 foot) will be paid for as 0.3 m (1 foot) vertical.

# SECTION 608—MOBILIZATION

**608.1 DESCRIPTION**—This work is the assembly and set-up of the general plant required to comply with the contract and with local and State laws and regulations. General plant includes Contractor's offices, shops, plants, storage areas, and sanitary or other facilities. This work includes obtaining the required permits, insurance, bonds, and any other initial items required for the start of the work.

**608.2 MATERIAL**—Furnish adequate material and furnishings required. These material and furnishings will not be considered a part of the other completed contract items.

**608.3 CONSTRUCTION**—Construct the required facilities.

**608.4 MEASUREMENT AND PAYMENT**—Lump Sum

The Department will pay for mobilization, as specified in Section 110.05, and according to the following schedule:

**(a)** If work is performed equal to 10% of the total contract price, excluding the bid price for this item, the amount bid for mobilization, or 3% of the total contract price, excluding the bid price for this item, whichever is less, will be paid.

**(b)** If work is performed equal to 25% of the total contract price, excluding the bid price for this item, any remaining amount bid for mobilization or an additional 2% of the total contract price, excluding the bid price for this item, whichever is less, will be paid.

**(c)** Upon completion of the project, any remaining amount bid for mobilization will be paid.

# SECTION 609—INSPECTOR'S FIELD OFFICE AND INSPECTION FACILITIES

**609.1 DESCRIPTION**—This work is furnishing, setting up, maintaining, and removing a field office of the type indicated and, if indicated, a field laboratory, proportioning plant office, and/or equipment package for the exclusive use of Department personnel.

**609.2 MATERIAL—**

**(a) General.** Provide offices and laboratories having the minimum floor space specified, along with all required furnishings, equipment, and materials. Furnish office and laboratory facilities that conform to applicable occupational safety and health regulations, including, but not limited to, those governing sanitation, illumination, ventilation, means of egress, medical services and first aid, and fire protection. Ensure that offices and laboratories have at least 2 m (7-foot) ceilings, locking windows, adequate electric lighting, an adequate number of storage cupboards and closets, a mail slot or drop box, and a private entrance secured with lock and key. Ensure that stairway systems installed for access to offices and laboratories include a handrail and non-skid treads. Provide systems to heat and cool interior spaces, as necessary, to maintain an ambient temperature between 18 ºC (65F) and 24 ºC (75F). Maintain acceptable sanitary toilet facilities, for exclusive use by Department personnel, near or within offices and laboratories. Ensure that the number of sanitary toilet facilities furnished is sufficient based on the size of the Department inspection staff that will likely be stationed in the indicated office or laboratory. Maintain acceptable lavatory (wash-up) facilities near or within sanitary toilet facilities. Ensure that lavatory facilities are equipped with hot and cold (or tepid) running water: hand soap or similar cleansing agents; and clean, sanitary, cloth or paper hand towels or warm air blowers. Ensure that the electric supply service is of sufficient capacity to allow unrestricted operation of all indicated electronic systems, appliances, and equipment. Furnish documentation certifying that indicated equipment requiring calibration has been calibrated within the last 12 months, and continue to have such equipment recalibrated annually for the duration of the project. If required furnishings and/or equipment being provided have been previously used, ensure that such items are in satisfactory condition and fully functional as of the scheduled start of work. Whenever practical, obtain maintenance agreements for communications, electronic, and/or specialized equipment that provide for on site repair service. If malfunctioning equipment cannot be repaired on site, provide a replacement within a reasonable amount of time, as determined by the Representative, based on the relative importance of the piece to the timely performance of required project management functions.

**1. Inspector's Field Office.** Set up the indicated field office in an acceptable weatherproof building or trailer. Situate the field office in an acceptable location on or in the immediate vicinity of the project, separate from other construction offices. For field offices where multiple individual partitioned rooms are indicated, submit a floor plan showing the layout of the interior space for approval. Equip the field office as specified in Table A.

**2. Proportioning Plant Office.** If indicated, provide an office at the proportioning plant. Set up the indicated plant office in an acceptable weatherproof building or trailer. Equip the office as specified in Table A.

**3. Field Laboratory.** If indicated, provide a laboratory for materials and soils testing. Set up the indicated field laboratory in an acceptable weatherproof building or trailer situated in an acceptable location. Supply a gravity or pressure water system having at least a 400 L (100-gallon) capacity and connected to a service sink with a faucet and acceptable outside drain. Equip the field laboratory as specified in Table A.

**(b) Testing Equipment.** On projects where a Field Laboratory is indicated, furnish and maintain the following equipment for required testing of soil or aggregates:

| Number of Each | Equipment |
|---|---|
| 1 | C.A. Mechanical Sieve Shaker with Timer |
| 1 | F.A. Mechanical Sieve Shaker with Timer |
| 1 | Set Standard Sieves for C.A. |
| 1 | Set Standard Sieves for F.A. and Soils |
| 1 | Unit Mass (Weight) Metal Container 28 L (1 cubic foot ) |
| 1 | Unit Mass (Weight) Metal Container 14 L (1/2 cubic foot) |
| 1 | Platform Scale, 90 kg (200-pound) capacity, sensitive to 0.005 kg (0.01 pound) |
| 1 | Balance, 2 000 g (70.5-ounce) capacity, sensitive to 0.1 g ($3.5x10^3$ ounce), with one complete set of Masses (Weights). |
| 1 | Exhaust Fan (for venting Mechanical Shakers) |
| 1 | Density Sample Extruder |
| 1 | Proctor Mold and Rammer |
| 1 | 300 mm (12-inch) Steel Straightedge |
| 2 | Mixing/Drying Pans |
| 1 | Mixing Spoon |
| 1 | Broom & Dust Pan |

In addition, on projects where a Field Laboratory is indicated and cement concrete, bituminous concrete, and/or construction aggregates are to be used; furnish and maintain the equipment specified in Section 704.2(a), in the plant requirements of Bulletin 27, and/or in Sections 703.1(b) and 703.2(b), respectively.

**(c) Communications Equipment.** When indicated, provide the communications equipment specified in the proposal. Furnish communications equipment in the quantity indicated and meeting the following requirements:

**1. Copier.** A digital laser copier having reduction/enlargement functions and capable of accepting maximum 216 mm x 356 mm (8 1/2-inch by 14-inch) size originals and producing 216 mm x 356 mm (8 1/2–inch by 14-inch) size copies at a minimum rate of 10 letter size copies per minute. Include sufficient imaging cartridges (toner/drum/developer) to yield a minimum of 5,000 copied pages.

**2. Fax Machine.** A high speed desktop facsimile machine capable of transmitting and receiving copies of standard, 216 mm x 279 mm (8 1/2–inch by 11–inch) printed material, pictures, etc. over a standard telephone line.

**3. Cellular Phone.** A portable, handheld unit capable of providing wireless communications within a 80.5 km (50-mile) radius of the project. Include a carrying case with belt loop/clip, cigarette lighter adapter, spare battery, and desk charger. Arrange for a cellular service plan that includes a voice mail option, call waiting, and 400 peak minutes of unrestricted use per month, for each device supplied, for the duration of the project.

**(d) Electronic Equipment.** When indicated, provide the electronic equipment specified in the proposal. Furnish electronic equipment in the quantity indicated and meeting the following requirements:

**1. Digital Camera.** A minimum 3.1-megapixel image resolution digital camera having 6X combined zoom (2X optical, 3X digital) and capable of producing pictures in JPG/JPEG file format. Image quality best up to 127 mm x 178 mm (5 inches by 7 inches). Include two sets of NiMH rechargeable batteries and a compatible battery charger capable of recharging one set of batteries in 2 hours or less. Furnish a 128-MB (minimum) internal memory card having the appropriate format for use with the camera; an external, USB-connected adapter capable of reading the memory card regardless of format (i.e. SmartMedia, Compact Flash, xD, SD, etc.); and any other operating essentials. Must be compatible with the Microcomputer System specified in Section 688.2.

**2. Document Scanner.** A flatbed, color scanner with automatic document feeder capable of scanning a minimum of 5 pages per minute in black and white mode and having, at a minimum, an optical resolution of 600 x 1200 dpi, a 42-bit color rate, a USB interface, and text scanning and image editing software. Software provided must support TIFF Group 4-2D and JPEG file formats. Must be compatible with the Microcomputer System specified in Section 688.2.

**3. Laser Printer.** An HP compatible, laser printer having USB connectivity; capable of delivering 216 mm x 279 mm (8 1/2-inch by 11-inch) and 216 mm x 356 mm (8 1/2-inch by 14-inch) prints at a minimum speed of 6 pages per minute. Include all necessary cords and cables. Provide compatible toner cartridges, as required. Must be compatible with the Microcomputer System specified in Section 688.2.

**4. Color Printer.** A color inkjet printer having, at a minimum, a black and white print resolution of 600 x 600 dpi, a color print resolution of 4800 x 1200 dpi, parallel port or USB connectivity, and 32KB of standard memory; capable of delivering black and white prints at a minimum speed of 17 pages per minute and color prints at 11 pages per minute. Include all necessary cords and cables. Provide compatible inkjet cartridges, as required. Must be compatible with the Microcomputer System specified in Section 688.2.

**(e) Specialized Equipment.** When indicated, provide the specialized equipment specified in the proposal. Furnish specialized equipment in the quantity indicated and meeting the following requirements:

**1. Surveyor's Level and Measuring Rod.** A standard, waterproof, surveyor's leveling instrument having, as a minimum, 20x magnification and a sighting range of up to 61 mm (200 feet); with a job accuracy range within 6.4 mm (1/4 inch) at 23.0 m (75 feet). Include a 7.6 m (25-foot) minimum, fiberglass measuring rod, folding leg tripod, rain cover, and carrying case.

**2. Electronic Digitizer.** A stationary or portable, high performance digitizer system capable of electronically measuring the exact, net area and perimeter of linear shapes on plan drawings at any scale, in both English and Metric units, and converting those measurements to areas and volumes. Furnish electronic digitizer having a tablet with a minimum 559 mm x 914 mm (22-inch by 36-inch) active area. Include necessary cabling, carrying case, and all other operating essentials.

**3. Digital Display Level.** A durable level, a minimum of 1.2 m (4 feet) in length with automatic calibration function, that reads angles with precision and digitally displays readings in degrees, percent slope, and pitch to within 1/10 degree accuracy. Include battery(ies).

**4. Infrared Thermometer.** A hand-held, portable, non-contact thermometer capable of measuring temperatures between –20 °C and 250 °C (–4F and 482F) and with a field of view (i.e., spot ratio) of at least 6:1. Include protective case, battery(ies) and all other operating essentials.

**5. Laser Range Finder.** A self-contained, light-weight, hand-held instrument that measures and records distances in feet, yards, or meters; having a maximum range of 229 m (750 feet) to an uncooperative, non-reflective target; LCD display; and shock/water resistant housing. Include battery(ies), cabling, carrying case, and all other operating essentials.

**(f) Internet Service.** For each type Field Office indicated, purchase a subscription to an Internet service, for exclusive use by Department personnel, for the duration of the project. Purchase a separate Internet service subscription for the Proportioning Plant Office, if indicated. Choose a proprietary or mid-market service that provides for high-speed access to the account by means of a Digital Subscriber Line (DSL), Cable, or other Broadband connection. Based on the specific type of high-speed connection provided, furnish a compatible modem with built-in hardware firewall protection. If such high-speed access is not available within the area where the project is located, choose an Internet service that provides for dial-up access to the account by means of a local access telephone number. Ensure that the subscription package allows for the exchange of electronic mail and includes some means of securing access to the account (e.g. password protection) by at least four different users.

If a high-speed Internet service is provided for the Field Office, and the proposal indicates that more than one microcomputer system will be used on the project, provide a compatible, wired router with built-in hardware firewall protection and Ethernet switch, and the cabling needed to interconnect the router with the modem and all microcomputers. A wireless router will not be acceptable.

If a dial-up Internet service is provided for the Field Office and the proposal indicates that more than one microcomputer system will be used on the project, provide a dial-up Internet service with sub-accounts that allow at least two separate users to be online at the same time, or, if the service provider does not support sub-accounts, provide two separate dial-up internet services.

Demonstrate connectivity with the Internet Service Provider at the time of or immediately following microcomputer system installation.

**(g) Miscellaneous Materials.** For each microcomputer system that will be used on the project, as indicated in the proposal, provide the following:

- Thirty, 90 mm (3 1/2-inch), high density (1.44-Mbyte) diskettes and a separate carrying case,
- Fifty, recordable CD-R 700 MB (minimum) compact disks (CD's) with individual protective cases,
- Ten, rewritable CD-RW 700 MB (minimum) compact disks (CD's) with individual protective cases,
- Ten, Zip Disks of a capacity that is compatible with the Zip Drive specified in Section 688.2, Table A (Type A Microcomputer Systems only),
- One, 90 mm (3 1/2-inch) diskette drive cleaning kit, and
- One, CD-ROM drive cleaning kit.

All diskettes, compact disks, and Zip Disks become Department property.

In addition, provide the following miscellaneous materials:

- Ten, 216 mm x 279 mm (8 1/2-inch by 11-inch); ten, 279 mm x 216 mm (11-inch by 8 1/2-inch); and ten, 216 mm x 356 mm (8 1/2-inch by 14-inch) pressboard or plastic computer paper binders with plastic locking strips as required, and
- Twelve, 75 mm (3-inch), three D-ring binders, with vinyl covers, having dimensions of 216 mm x 279 mm (8 ½ inches by 11 inches).
- 216 mm x 279 mm (8 1/2 -inch by 11-inch) and 216 mm x 356 mm (8 1/2-inch by 14-inch), 20# white bond paper for copiers and printers, as specified, sufficient for the life of the project.

All binders and paper become Department property.

**609.3 CONSTRUCTION—**Install the indicated facilities no later than 5 working days after the Notice to Proceed Date or 5 days before the scheduled start of work. Anchor the facilities to withstand high winds. Maintain the facilities from installation until 30 days after physical work has been satisfactorily completed, unless released earlier by the Representative. Satisfactorily clean or arrange for the indicated facilities to be cleaned at least once per week. Provide an adequate number of accessible parking spaces immediately adjacent or in close proximity to the offices or laboratory for exclusive use by Department personnel. Provide proper maintenance of parking areas. Ensure that there is sufficient lighting to illuminate the exterior of offices or laboratory and all parking areas. Designate a specific individual to serve as the contact person for service-related problems. After physical work has been completed, but before release by the Representative, arrange to meet with the Inspector-in-Charge to examine and determine the condition of all specialized equipment that is contractor-owned. Report any unresolved disputes over the condition of such equipment to the Representative. Failure to meet with the Inspector-in-Charge or to report problems with the condition of specialized equipment will create a presumption that, except for expected wear

resulting from normal usage, the equipment is in good condition and remains fully functional. Specialized equipment that is lost or determined to be damaged beyond repair will be replaced or reimbursement will be made as specified in Section 110.03, provided such loss or damage is not the result of carelessness or negligence on the part of the Contractor or any other responsible third party. The Representative may direct that the facilities be maintained for more than 30 days after physical work has been satisfactorily completed, as necessary, to allow time for Department personnel to process outstanding project records. Remove and dispose of furnishings, equipment, and materials upon release by the Representative.

**609.4 MEASUREMENT AND PAYMENT**—Lump Sum

The proposal will include separate pay items for the Inspector's Field Office and Inspection Facilities, Field Laboratory, Proportioning Plant Office, and Equipment Package, as applicable.

Each contract item will be paid, as specified in Section 110.05, in two equal payments, according to the following schedule:

- When work is completed in an amount equivalent to at least 10% of the original contract amount, excluding the bid price for the applicable item, the first payment will be made.

- When work is completed in an amount equivalent to at least 60% of the original contract amount, excluding the bid price for the applicable item, the second payment will be made.

**(a) Price Adjustments.** Adjustments to the lump sum prices bid for the indicated office or laboratory facilities and equipment package, as applicable, will be made as follows:

**1. Time Extensions and Reductions.** In the event the time for completion of all work on the project is extended or reduced, as specified in Section 108.06, an appropriate adjustment (payment to the Contractor or rebate to the Department) will be made to the lump sum prices bid for the indicated office or laboratory facilities and equipment package, as applicable, for the days in excess of (payment) or less than (rebate) the original contract time, at the following daily rate:

$$\text{Daily Price Adjustment Rate} = \frac{75\% \text{ x Contract Lump Sum Price}}{\text{Original Contract Time in Days}}$$

**2. Facilities Maintained for More than 30 Days After Physical Work Completion.** In the event the Representative directs that the office or laboratory facilities and equipment package be maintained for more than 30 days after the date of physical work completion, as specified in Section 609.3, an appropriate adjustment (payment to the Contractor) will be made to the lump sum prices bid for the indicated office or laboratory facilities and equipment package, as applicable, for the days in excess of 30 until released by the Representative, at the Daily Price Adjustment Rate specified in Section 609.4(a)1.

No adjustment will be made if the Representative directs that the office or laboratory facilities and equipment package be maintained for more than 30 days after the date of physical work completion due to the Contractor's failure to submit, complete, and/or correct required certificates or documents, as established during the final inspection.

**TABLE A**

| Office/Laboratory and Standard Equipment | | | | | |
|---|---|---|---|---|---|
| | Type A Field Office | Type B Field Office | Type C Field Office | Proportioning Plant Office | Field Laboratory |
| Floor Space $m^2$ (square foot), out to out | 121 (1,300) | 60 (650) | 22 (240) | 14 (150) | 14 150) |
| Individual Partitioned Rooms | 6 | 3 | 2 | 1 | 1 |
| Conference Table & Chairs | 1 | | | | |
| Desk(s) & Chair(s) | 6 | 3 | 2 | 1 | 1 |
| Office Chairs | 15 | 9 | 6 | | |
| Plan Rack(s) | 2 | 2 | 2 | | 1 |
| Work Table(s) (1) | 5 | 3 | 2 | 1 | 1 |
| Printer Stand(s) (2) | 5 | 3 | 1 | | |
| 4-Drawer File Cabinet(3) | 4 | 3 | 2 | 1 | 1 |
| 2-Drawer File Cabinet(3) | 2 | 1 | 1 | | |
| Sample Splitter (4) | | | | | 1 |
| Range (5) | | | | | 1 |
| Sanitary Electric Water Cooler | 1 | 1 | 1 | 1 | 1 |
| Individual Access Phone Line(s) (6) | 6 | 5 | 4 | 3 | |
| Telephone(s) w/ Answering Machine(s) or Voice Mail | 2 | 1 | 1 | 1 | |

(1) Work Table. Minimum size: 760 mm x 2100 mm x 760 mm high (2 1/2 feet by 7 feet by 2 1/2 feet high).
(2) Printer Stand. Specifically designed to accommodate laser and color printers, with paper storage/feeder tray. Minimum size: 457 mm x 457 mm x 760 mm high (18 inches by 18 inches by 2 1/2 feet high).
(3) File Cabinets. Fire resistant (D-Label), lockable, metal file cabinet.
(4) Sample Splitter. For coarse and fine aggregate, with adjustable chute opening.
(5) Range. Standard, 914 mm (36-inch) range, gas or electric, new or used, with oven capable of operating at 110 °C ± 5 °C (230°F ± 9°F).
(6) Individual Access Phone Line(s). The number indicated includes the phone line(s) needed for microcomputer system operation and Internet service.

# Appendix

## TABLE A

| EQUIPMENT PACKAGE | |
|---|---|
| **Equipment** | **Quantity*** |
| **Communications Equipment** | |
| Copier (1) | |
| Fax Machine (1) | |
| Cellular Phone(s) | |
| **Electronic Equipment** | |
| Digital Camera | |
| Document Scanner (2) | |
| Laser Printer (2) | |
| Color Printer (2) | |
| **Specialized Equipment** | |
| Surveyor's Level & Measuring Rod | |
| Electronic Digitizer | |
| Digital Display Level | |
| Infrared Thermometer | |
| Laser Range Finder | |

* The special provision will be included in the proposal indicating the quantity of each type of communications, electronic, and/or specialized equipment to be furnished.

(1) Unless otherwise approved, a multifunction machine may not be furnished in lieu of a separate copier and fax.

(2) Unless otherwise approved, a multifunction machine may not be furnished in lieu of a separate scanner, laser printer, and color printer.

**Microcomputer Systems**. To assist Bidders in meeting the requirements of Section 609.2(f), Internet Service, and Section 609.2(g), Miscellaneous Materials, the special provision in the proposal will indicate the total number of microcomputer systems that will be used on the project.

Microcomputer systems may be furnished by the Department. If microcomputer systems are to be furnished by the Contractor, as part of the construction Contract, the bid will include applicable, 0688-XXXX bid items. When indicated, furnish microcomputer systems meeting the requirements of Section 688.

# SECTION 610—PIPE UNDERDRAIN AND PAVEMENT BASE DRAIN

**610.1 DESCRIPTION**—This work is construction of pipe underdrains, of the type indicated, and pavement base drains.

**610.2 MATERIAL—**

**(a) Pipes**. Section 601.2(a)1 and as follows:

**1. General.**

**1.a Type.** Use the type indicated. If not indicated, use any one of the types listed below.

**1.b Size.** For circular pipe, unless otherwise indicated, use pipe with a minimum inside diameter of 100 mm (4 inches) and sized in not less than 25 mm (1-inch) increments. For semi-circular pipe, unless otherwise indicated, use pipe with a smooth-walled bottom section and an average inside diameter of 117 mm (4 5/8 inches).

**1.c Perforations.** Perforate a pipe to provide a minimum water inlet area of 3000 $mm^2$/m (1.4 square inches per linear foot) of pipe and, unless otherwise specified, as follows:

- Cut perforations cleanly so as not to restrict the flow of water.
- Provide either circular or slotted perforations, except do not use slotted perforations in smooth walled pipe.
- For circular perforations, provide holes with a nominal diameter not less than 5 mm (3/16 inch) or greater than 10 mm (3/8 inch). Also, provide similar rows of perforations on both sides of the pipe's vertical centerline, with the lower most rows separated by an arc of 60 degrees minimum.
- For slotted perforations, provide slots not exceeding 3 mm (1/8 inch) wide and a length not more than 10% of the average inside circumference for 100 mm to 200 mm (4-inch to 8-inch) diameter pipe and not exceeding 64 mm (2 1/2 inches) for pipes larger than 200 mm (8 inches). Additionally, center the slots in the corrugation valleys and at maximum 120 degree intervals about the pipe circumference.

**1.d Strength Test.** As specified, except for plastic pipe test using the parallel plate load test, according to ASTM D 2412.

**1.e Infiltration Rate.** For perforated or porous pipe, provide a minimum infiltration rate of 2 (L/s)/m (10 (gallons per minute) per linear feet) of pipe, as determined according to AASHTO M 176M.

**1.f Pipe Length.** Flexible plastic pipe, 150 mm (6 inches) or less in diameter, may be supplied in specified coiled lengths or standard increments agreeable to the Department. The use of long coils, 900 m to 1200 m (3,000 feet to 4,000 feet) in length, is allowed, provided placement is by equipment recommended by the manufacturer and the pipe is not stretched or damaged during handling or placement. Furnish flexible plastic pipe, larger than 150 mm (6 inches) in diameter, and all sizes of rigid pipe in maximum lengths of 6 m (20 feet). Furnish lengths not less than 99% of the stated quantity. Measure with any suitable device accurate to 6 mm (1/4 inch) in 3 m (10 feet) (0.2%) while the pipe is stress-free and at rest on a flat surface in a straight line.

**1.g Plastic Pipe.** Extrude or mold plastic pipe using high density, flexible plastic.

Permanently mark, stencil, or label pipe with manufacturer's name, pipe trade name, or type, average size the specification designates, the plant designation code, and the date of manufacture all at intervals of no more than 3 m (10 feet).

**2. Porous Concrete Pipe.** AASHTO M 176M

**3. Corrugated Polyethylene (PE) Pipe.** AASHTO M 252 (pipes 100 mm through 250 mm (4 inches through 10 inches)) and AASHTO M 294 (pipes 300 mm through 375 mm (12 inches through 15 inches)), modified as follows:

- The Department will determine the lot size for acceptance.
- Minimum pipe stiffness for pipes 100 mm through 250 mm (4 inches through 10 inches) to be 210 kPa (30 pounds per square inch) at 10% deflection, when tested according to ASTM D 2412. Minimum pipe stiffness for pipes 300 mm through 375 mm (12 inches through 15 inches) to be 310 kPa (45 pounds per square inch) at 5% deflection and 280 kPa (40 pounds per square inch) at 10% deflection, when tested according to ASTM D 2412.

**4. Polyvinyl Chloride (PVC) Pipe.** ASTM D 3034, ASTM F 758, Type PS46 or ASTM F 949 modified as follows:

- Minimum pipe stiffness for pipes 100 mm through 250 mm (4 inches through 10 inches), 241 kPa (35 pounds per square inch) at 5% deflection, when tested according to ASTM D 2412. Minimum pipe stiffness for pipes 300 mm through 375 mm (12 inches through 15 inches), 310 kPa (45 pounds per square inch) at 5% deflection, when tested according to ASTM D 2412.
- Capable of being flattened to 40% of the original pipe O.D. without splitting, cracking, or breaking.

**5. Acrylonitrile-Butadiene Styrene (ABS) Pipe.** ASTM D 2751, modified as follows:

- Minimum pipe stiffness for pipes 100 mm through 250 mm (4 inches through 10 inches), 241 kPa (35 pounds per square inch) at 5% deflection, when tested according to ASTM D 2412. Minimum pipe stiffness for 300 mm pipe (12 inches), 310 kPa (45 pounds per square inch) at 5% deflection, when tested according to ASTM D 2412.
- Capable of being flattened to 60% of the original pipe O.D. without splitting, cracking, or breaking.

**6. Perforated Plastic Semicircular Pipe.** AASHTO M 278 or AASHTO M 264, modified as follows:

- Smooth or corrugated top and a smooth semicircular bottom.
- Minimum pipe stiffness (PS), 241 kPa (35 pounds per square inch) at 5% deflection, when tested according to ASTM D 2412.
- Capable of being flattened to 40% of the original pipe outside-to-outside height for PVC or 60% for ABS without splitting, cracking, or breaking.

**7. Corrugated Steel Pipe, Metallic Coated.** AASHTO M 36/M 36M, Type III with Class 1 perforations or Type IIIA; AASHTO M 218; AASHTO M 274; and AASHTO M 289.

**8. Corrugated Aluminum Alloy Pipe.** AASHTO M 196/M 196M, Type III with Class 1 perforations or Type IIIA.

**9. Prefabricated Pavement Base Drains.**

**9.a General.** Use prefabricated pavement base drains consisting of an inert, plastic core, designed to carry water flow, wrapped in geotextile fabric for filtering purposes. Select from a manufacturer listed in Bulletin 15.

**9.b Backfill.** As indicated, fine aggregate, Type A, except limestone sand, Section 703.1.

**9.c Core Materials.** An inert, plastic material resistant to commonly encountered chemicals and substances, having the following properties:

- Tensile strength, ASTM D 638/D 638M—8300 kPa (1,200 pounds per square inch), minimum
- Water absorption, ASTM D 570—0.01% after 24 hours
- Fungus resistance, ASTM G 21—no growth
- Crush strength, *GRI-GC4—280 kPa (40 pounds per square inch), minimum
- Flow rate, ASTM D 4716—0.0031 $m^3/s \cdot m$ (15 gallons per minute feet) minimum
- Provide a minimum of 6% open core area on the pavement side face of the base drain and a minimum of 3% on the shoulder side face.
- Provide unobstructed inflow through a minimum of 50% of the geotextile area on the pavement side face of the base drain and 12% of the geotextile area on the shoulder side face, when stretched across the face of the core.

* Geosynthetic Research Institute, Drexel University.

**9.d Geotextile Fabric.** Provide Class 1 geotextile, except slit film and heat bonded materials, conforming to the requirements of Section 735, modified as follows:

- Apparent Opening Size (AOS), ASTM D 4751—U. S. Standard Sieve 212 mm (No. 70), minimum
- Permeability, k, ASTM D 4491—0.01 mm/s (0.001 cm/sec), minimum

Resins are to be virgin materials, unless otherwise approved, and identified as such in the certification statement.

**9.e Approval.** Approval will be based on certified test data submitted by the manufacturer or testing by MTD, or both, before being listed in Bulletin 15.

**9.f Certification and Shipment to Project.** Certify each shipment as specified in Section 106.03(b)3.

Clearly identify each roll of pavement base drain by affixing a tag or sticker containing the following information:

- Lot number
- Manufacturer's name and address
- Product type and designation
- Product identification including thickness, height, roll length, and roll mass (weight)
- Geotextile type and designation

**9.g Wrapping of the Core.** Wrap the geotextile completely around the drainage core with the seam along the length of the drain, on the shoulder side face, and preferably near the midpoint. Fabricate the seam using a non water-soluble adhesive, if adhesive is used. Firmly attach geotextile to the protrusions on the pavement side face of the drainage core and spot-bond on the shoulder side face, or submit results of flow tests on the drain under loading with the geotextile unattached, to ensure that the geotextile will not deform under continuous loading to the point where flow capacity is diminished and the specified minimum flow rate is not achieved.

**9.h Splice Connections and Fittings.** Provide standard fittings and splice connections along the pavement base drain, as indicated or as directed, of sufficient strength to withstand construction handling and permanent loading. Obtain approval for any nonstandard fittings and connections.

**9.i Outlets.** Section 615.2

**(b) Aggregates.**

**1. Fine Aggregate.** Type II backfill, natural or manufactured Type A sand, Section 703.1; rock, gravel, or blast furnace slag sand prepared from Type C, or better, coarse aggregate as specified in Section 703.2; except conform to the size and grading requirements for Type A sand, Section 703.1, with a maximum loss in soundness test not exceeding 20%.

**2. Coarse Aggregate.** Type C or better, Section 703.2, except that the percentage of crushed fragments for gravel is not required. Use No. 57 for Type I backfill and No. 8 for Type II backfill.

**(c) Mortar.** Section 705.7(a)

**(d) Geotextiles, Class 1.** Section 735

**(e) Open Graded Subbase.** Section 350

**610.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Pipe, Trench, and Backfill.** Place pipe underdrain after fine grading is completed.

Place pavement base drain after the adjacent roadway pavement is constructed, except when it is placed under curb sections or other special locations. Excavate pavement base drain trench without disturbing subbase under the roadway pavement.

Join underdrain or base drain to new or existing drainage structures with satisfactory connections. Use fittings with deflection angles of 45 degrees or less.

After completing the trench and the lower 50 mm (2 inches) of compacted backfill, lay the pipe and make the joints according to the manufacturer's recommendations.

For perforated pipe, place the perforations down, unless otherwise directed. Lay semicircular pipe with the smooth, circular portion at the bottom.

Do not leave trenches open during periods of precipitation or overnight.

Seal the upgrade end of pipe underdrain or base drain to prevent entry of foreign material.

Complete backfilling after having the pipe inspected by the Inspector-in-Charge.

**(b) Geotextiles, Class 1.** Use Class 1 geotextile, as specified in Section 212.3(b), for all pavement base drain construction and if indicated for pipe underdrain construction.

**(c) Prefabricated Pavement Base Drains.**

**1. General.** At least 2 weeks before beginning installation, submit the proposed installation method to the Representative, in writing, and note any deviation from the plans or from the manufacturer's approved drawings. Upon request by the Representative, have a technical representative from the manufacturer present during installation.

**2. Shipping and Storage.** Ship drainage materials with protective covering and store in a manner so as not to damage or contaminate them. Visually inspect all materials, before placement, to ensure they are free from damage. Damaged drainage material will not be accepted. Store drainage material on an elevated platform and protect from weather and ultraviolet exposure. Do not remove material from the manufacturer's protective covering until ready to be installed. If material is rerolled and stored, use an approved protective covering equivalent to the manufacturer's original wrapping.

**3. Excavation.** Place prefabricated pavement base drain in a trench constructed adjacent to the roadway pavement edge as shown on the Standard Drawings. Construct trench without disturbing the pavement structure or subbase. Unless otherwise indicated or directed, provide trench having a width as shown on the Standard Drawings and a depth extending at least 50 mm (2 inches) into the subgrade.

**4. Placement and Backfilling.** Place prefabricated pavement base drain vertically in the trench as shown on the Standard Drawings. Place the first lift of backfill material simultaneously with drain install to ensure complete contact with the geotextile and the trench wall. Repair any tears in the geotextile according to the manufacturer's recommendation. If raised core projections protrude from only one side of the drain, place the projections toward the pavement side of the trench.

Backfill the trench with fine aggregrate, Type A using 230 mm (9-inch) (maximum) hydraulically compacted lifts. Spray each lift with water at 12.4 L/m (1.0 gallon per linear foot).

Ensure that excavation, drain placement, and backfill operations are performed in sequence, with a minimum amount of trench open at all times. Do not leave trenches greater than 50 mm (2 inches) in depth open overnight. Barricade trenches at all times according to the requirements of 67 PA Code, Chapter 203.

**5. Connections, Fittings, and Outlets.** Fit splice connectors into the drainage core so that they do not restrict flow. Follow the manufacturer's approved connection details. Do not allow backfill material to enter the connector at any point. For drainage cores that splice using male-to-female overlapping, roll back the geotextile onto the in-place drainage core, make the splice, and rewrap the geotextile over the completed joint. Provide a minimum of 150 mm (6 inches) of geotextile overlap from one section to the next.

Install subsurface drain outlet pipe and fittings as specified in Section 615.3, concurrently with the pavement base drain, to establish positive drainage within 24 hours of the beginning of trenching for the installation of a given section of base drain. The Representative may restrict installation of additional sections of base drain until acceptable outlet installations are completed. Ensure transitions are smooth and nonrestricting to flow. Do not use "home-made" connections.

Install all fittings and connections to preclude soil intrusion into the drainage core or outlet piping and to provide continuity of drainage flow. Install fittings for positive, gravity flow, and outlet the drainage system as indicated or as directed. Furnish outlet pipes with galvanized wire mesh shields as shown on the Standard Drawings. If the drain is terminated without an outlet, provide a fitting to prevent soil intrusion into the end of the drainage core. Protect all joints and fittings from damage during construction.

## 610.4 MEASUREMENT AND PAYMENT—

**(a) Pipe Underdrain, Types I and II Backfill.** Meter (Linear Foot)

**(b) Pavement Base Drain.** Meter (Linear Foot)

**(c) Class 4 Excavation.** Cubic Meter (Cubic Yard)

For extra-depth pipe underdrain and extra-depth pavement base drain excavation in excess of that shown on the Standard Drawings.

**(d) Fine Aggregate for Extra-Depth Pipe Underdrain.** Cubic Meter (Cubic Yard)

**(e) Additional Coarse Aggregate for Extra-Depth Pipe Underdrain.** Cubic Meter (Cubic Yard)

**(f) Additional Coarse Aggregate for Extra-Depth Pavement Base Drain.** Cubic Meter (Cubic Yard)

**(g) Geotextiles, Class 1.** Section 212.4(a)

**(h) Prefabricated Pavement Base Drains.** Meter (Linear Foot)

**(i) Subsurface Drain Outlets.** Section 615.4

# SECTION 612—SUBGRADE DRAINS

**612.1 DESCRIPTION**—This work is construction of subgrade drains.

**612.2 MATERIAL—**

- Bituminous Paper—Section 727
- Coarse Aggregate, Type C or better (no steel slag), No. 57—Section 703.2, except that the soundness test is not required and the percentage of crushed fragments for gravel does not apply.
- Geotextiles, Class 1—Section 735

**612.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Trench and Backfill.** Excavate the trench, backfill, and adequately tamp the backfill.

Keep outlet ends of subgrade drains open during construction and until final acceptance of shoulders.

Extend subgrade drains a length sufficient to adequately drain the wet area. Construct subgrade drains under subbase after the subgrade has been completed but before the subbase is placed. Construct subgrade drains at right angles to the roadway centerline, or skew, as directed. Extend subgrade drains along the roadway, if necessary, to achieve a suitable outlet. Maintain a minimum slope of 1:50 (1/4 inch per foot) on the trench bottom through pavement and shoulder areas.

**(b) Geotextiles, Class 1.** Section 212.3(b), if indicated.

**612.4 MEASUREMENT AND PAYMENT—**

**(a) Subgrade Drains.** Meter (Linear Foot)

**(b) Geotextiles, Class 1.** Section 212.4(a)

# SECTION 613—STONE BACKFILL FOR MISCELLANEOUS DRAINAGE

**613.1 DESCRIPTION**—This work is the furnishing and placing of stone backfill for miscellaneous drainage.

**613.2 MATERIAL—**

- Coarse Aggregate, Type C or better (no steel slag), No. 1 and No. 57—Section 703.2
- Local Stone—If allowed, acceptable, clean, sound, hard, and durable slabs of stone, sharply broken, if required, and not more than 150 mm (6 inches) in any dimension.
- Geotextiles, Class 1—Section 735

**613.3 CONSTRUCTION**—Place No. 1 Coarse Aggregate or local stone backfill for miscellaneous drainage in sumps, springs, wells, sink holes, and other places, where indicated or directed. Place geotextiles, Class 1, as specified in Section 212.3(b).

If local stone is used, place a 150 mm (6-inch) layer of No. 57 coarse aggregate as the stone backfill top layer.

**613.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

# SECTION 615—SUBSURFACE DRAIN OUTLETS

**615.1 DESCRIPTION**—This work is construction of subsurface drain outlets.

**615.2 MATERIAL—**

- Pipe—Section 610.2(a); except, without perforations. Unless otherwise directed, use outlet pipe of the same materials as the underdrain or pavement base drain. Provide smooth walled PE or PVC outlet pipe, for use with PE, PVC, or ABS underdrain or pavement base drain, conforming to the above requirements and having a minimum stiffness of 483 kPa (70 pounds per square inch) at 5% deflection at all pipe diameters.

- Class A Cement Concrete—Section 704

- Red Subsurface Drain Outlet Marker—From a manufacturer listed in Bulletin 15. Reflective sheeting material is not required.

**615.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Excavate the trench, leaving the bottom uniformly firm and smooth, ensuring positive gravity flow in outlet. Lay pipe on top of 50 mm (2 inches) of satisfactorily tamped embankment material. Join pipe with connecting bands or with split couplings. After the outlet pipe has been laid and accepted, backfill the trench in 100 mm (4-inch) layers, using satisfactory embankment material, then thoroughly tamp. Compact the portion of the outlet under pavement or shoulder, as specified in Section 601.3(f). Provide outlet opening protection as shown on the Standard Drawings.

Connect to the pipe underdrain or pavement base drain using suitable couplings and fittings or special connectors; connect with a maximum 45-degree bend or series of 45-degree bends. If indicated or directed, provide satisfactory connections to join outlets to existing drainage structures.

If indicated, construct concrete endwalls to protect outlets not connected to new or existing drainage structures. If plastic pipe is used, protect ends from exposure to the deteriorating effects of sunlight, using satisfactory endwalls and trench backfill material.

Mark subsurface drain outlet using a red subsurface drain outlet marker on the side of opening facing approaching traffic. Embed the markers a minimum of 450 mm (18 inches) or as recommended by the manufacturer.

**615.4 MEASUREMENT AND PAYMENT—**

**(a) Subsurface Drain Outlets.** Meter (Linear Foot)

**(b) Class 4 Excavation.** Cubic Meter (Cubic Yard)
For subsurface drain outlet excavation in excess of that shown on the Standard Drawings.

**(c) Subsurface Drain Outlet Endwall.** Each

**(d) Red Subsurface Drain Outlet Marker.** Each

# SECTION 616—END SECTIONS AND SLOPE PIPE FITTINGS

**616.1 DESCRIPTION**—This work is construction of end sections and slope pipe fittings.

**616.2 MATERIAL**—Manufactured or fabricated as specified in applicable portions of Section 601, as shown on the Standard Drawings, and as follows:

**(a) Concrete End Sections.** Section 601.2(a)3 except as follows:
Provide reinforcement per meter (linear foot) of end section, equal to the minimum steel requirements for circular reinforcement in a Type A Standard Installation Concrete Pipe having the internal diameter of the end section portion, withstanding a fill height greater than or equal to 900 mm (36 inches) and less than 2100 mm (82 inches).

**(b) Steel End Sections, Metallic Coated.** Section 601.2(a)4.b

**(c) Aluminum Alloy End Sections.** Section 601.2(a)4.c

**(d) Steel Slope Pipe Fittings.** Fabricated from sheet steel of the thickness indicated, as specified in Section 601.2(a)4.b for steel sheets, except that minor variations may be acceptable to allow use of the manufacturer's standard methods of fabrication.

**(e) Coarse Aggregate.** Section 703.2

**616.3 CONSTRUCTION**—Install end sections as specified in the applicable requirements of Section 601.3 and as indicated.
Install slope pipe fittings as shown on the Standard Drawings.

**616.4 MEASUREMENT AND PAYMENT**—

**(a) End Sections.** Each
The price includes excavation and all backfill as indicated.

**(b) Slope Pipe Fittings.** Each
The price includes excavation and all backfill as indicated.

# SECTION 617—SLOTTED DRAINS

**617.1 DESCRIPTION**—This work is construction of drains with continuous slotted openings.

**617.2 MATERIAL**—

- Slotted Drain—Fabricated from metallic-coated steel pipes specified in Section 601.2(a)4.b and structural steel conforming to the requirements specified in Section 1105.02(a)2 or precast polymer concrete troughs as listed in Bulletin 15 and certified as specified in Section 106.03(b)3.

- Coarse Aggregate—Section 350.2

**617.3 CONSTRUCTION**—Excavate the trench, as shown on the Standard Drawings for pipe and for precast polymer concrete sections according to the manufacturer's recommendations.

Install the drains according to the manufacturer's instructions or by another accepted method.

Place the drain to the line and grade indicated, adequately supported until adjacent construction is completed.

Provide temporary covers, as required, to prevent foreign material from entering the drain during construction. Before placing cement concrete or bituminous concrete adjacent to the drain, place adequate covers in or over the slot or grate to prevent entry of the paving material. If directed, remove and dispose of the temporary covers.

Backfill metal pipe as specified in Section 601.3(f) and precast polymer concrete sections according to the manufacturer's recommendations.

**617.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 618—CONCRETE COLLAR FOR PIPE EXTENSION

**618.1 DESCRIPTION**—This work is construction of a concrete pipe collar for extending existing pipe(s) from an endwall or other structure.

**618.2 MATERIAL—**

- Class A Cement Concrete—Section 704
- Mortar—Section 1001.2(e)
- Reinforcement Bars—Section 709.1(a)1

**618.3 CONSTRUCTION**—As shown on the Standard Drawings for pipe diameters up to 825 mm (33 inches), as indicated for larger diameter pipe, and as follows:

**(a) General.** Remove a portion of the endwall footer, if required to obtain proper pipe alignment, using acceptable equipment and methods.

Obtain acceptance for drilling equipment and methods before drilling. Drill 25 mm (1-inch) holes in the existing structure with equipment and so that does not damage the existing structure. Clean material from the full depth of the holes before placing the reinforcement and grout. Grout the reinforcement in place, using non-shrinking mortar placed to ensure complete bonding of the reinforcement to the grout and the existing structure. Completely fill all holes with mortar, and after placing the reinforcement remove excess mortar protruding from the structure. Obtain acceptance for adjustments required to obtain final horizontal and concentric alignment.

**(b) Cement Concrete.** Construct the collar, as specified in the applicable parts of Section 1001.3, after placing the pipe extension, as specified in Section 601.3(i).

**(c) Excavation and Backfill.** Excavate as required. Backfill excavated spaces around the collar, using acceptable embankment material, as specified in Section 206.3(b)4. Satisfactorily dispose of unsuitable and surplus material.

**618.4 MEASUREMENT AND PAYMENT**—Lump Sum

# SECTION 619—PERMANENT IMPACT ATTENUATING DEVICES

**619.1 DESCRIPTION**—This work is furnishing and installing of permanent impact attenuating devices, including all appurtenances and hardware, as indicated.

**619.2 MATERIAL—**

- Permanent impact attenuating devices from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

**619.3 CONSTRUCTION—**

**(a) General.** Submit shop drawings as specified in Section 105.02(d).

**(b) Installation.** Install according to the manufacturer's specifications and installation instructions for full depth embedment only, and as follows:

Drive posts mechanically, unless otherwise directed by the Representative. Do not cut, batter, burr, separate galvanizing from steel, or distort the post. Driven post must be plumb. As directed, remove and replace posts bent or otherwise damaged.

In areas where random boulders, hardpan, or bedrock are encountered and the specified post cannot be driven to full depth embedment, remove the post, then drill a 300 mm (12-inch) minimum diameter hole to the required depth, as per manufacturer's recommendation for full depth embedment. Reset the post in the hole to the proper elevation and backfill to the ground line, using an acceptable embankment material thoroughly compacted in maximum 150 mm (6-inch) layers. If the placed material around the post cannot be satisfactorily compacted, backfill the hole in maximum 150 mm (6-inch) layers thoroughly compacted to ground line, and then redrive the post to proper elevation.

Type A or B flowable backfill as specified in Section 220 Table A can be used to backfill the hole after resetting the post in place.

**619.4 MEASUREMENT AND PAYMENT**—Each
The price includes tail end treatment when required.

# SECTION 620—GUIDE RAIL

**620.1 DESCRIPTION**—This work is construction of new guide rail of the type indicated, re-setting of existing guide rail, and removal of existing guide rail, including all appurtenances and hardware.

**620.2 MATERIAL—**

**(a) Guide Rail.** Section 1109 and Section 1119

**(b) Other Material.**

- Class A Cement Concrete—Section 704
- Reinforcement Bars—Section 709.1

**(c) Certification.** Section 106.03(b)3

**620.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) New Guide Rail.**

**1. General.** Set posts plumb at the spacing shown. Minor adjustments in spacing may be allowed to clear objects or to fit between fixed ends.

Use bolts that are long enough to extend at least 6 mm (1/4 inch) beyond the nuts. Draw bolts tight, except if required for expansion.

Before installation, apply acceptable galvanizing paint to repair portions of posts to be placed underground. After installation, apply two coats of the galvanizing paint to guide rail or related appurtenances, including threaded portions of fittings, fasteners, and the cut end of bolts, that have been abraded or cut, exposing the base metal.

If guide rail is installed under traffic conditions, conform to the following requirements:

- Perform work only within those areas protected by temporary traffic control devices.
- Attach guide rail on posts driven during the day, before the end of that day.
- Provide satisfactory protection at exposed, unfinished ends of guide rail.

Join new and existing guide rail, if required, as indicated or directed.

Construct concrete parts of guide rail, if required, as specified in the applicable parts of Section 1001.3.

**2. Posts and Offset Brackets.** Drill or punch holes suitable to the type of guide rail indicated. Drive posts mechanically, unless otherwise directed. Do not batter, burr, separate galvanizing from steel, or distort the post. As directed, remove and replace posts bent or otherwise damaged. Install offset brackets, if required.

In areas where random boulders are encountered and the post cannot be driven to grade, remove the post, then drill or excavate a hole of suitable dimensions and depth to place the post at grade. Reset the post and backfill to the ground line, using an acceptable embankment material, thoroughly compacted in 150 mm (6-inch) layers.

In areas where bedrock is encountered, and the post cannot be driven to grade, remove the post, then drill or excavate a hole of suitable dimensions to the required depth. Reset the post and backfill to the ground line, using an acceptable embankment material, thoroughly compacted in 150 mm (6-inch) layers. In isolated locations where only one or two posts are affected, the Nested W-Beam (Type 2-S) Guide rail treatment may be used, as per RC-52M.

**3. Rail Elements.** Do not allow the free end of Types 2-W and 2-WC rail elements to swing free and cantilever from the M8 x 1.25 (5/16-inch) mounting bolt. Rest the free end on temporary M14 x 2 (1/2-inch) support bolts and nuts or temporary drift pins until the M8 x 1.25 (5/16-inch) mounting bolts are torqued.

Splice by lapping in the direction of traffic. Provide full contact between the rail elements in the overlap, between the center and both edges of the element, and between the bracket or post, as the case may be.

Use suitable shop-formed guide rail or rubbing rails on curves having a radius of less than 46 m (150 feet).

**4. Terminal Sections, Post Anchorages, and End Treatments.** Install, where indicated.

**5. Over Underground Structures.** Install, where indicated, using Class A Cement Concrete, reinforcement bars, anchor bolts, nuts, and washers.

**(b) Guide Rail to Bridge Barrier Transition.**

**1. Typical and Alternate Concrete Bridge Barrier Transition.** Install approach end guide rail transition at structure barrier, with or without inlet placement as indicated, as shown on the Standard Drawings.

**2. Thrie-Beam to PA Type 10M Bridge Barrier Transition.** Install approach end guide rail transition at structure barrier, with or without inlet placement as indicated, as shown on the Standard Drawings.

**3. Thrie-Beam to Vertical Wall Bridge Barrier Transition.** Install approach end guide rail transition at structure barrier as shown on the Standard Drawings.

**4. Thrie-Beam to PA Bridge Barrier Transition.** Install approach end guide rail transition at structure barrier as shown on the Standard Drawings.

**(c) Reset Guide Rail.** Carefully remove existing guide rail and reset at locations indicated, as shown on the Standard Drawings.

Repair or replace rail element, posts, hardware, or other materials damaged during this operation.

**(d) Remove Existing Guide Rail.** Remove existing guide rail from locations indicated, then dispose of the material outside the right of way, or stockpile inside the right of way for removal by the Department, as specified or indicated.

**(e) Structure-Mounted Guide Rail.** Install as indicated and as shown on the Standard Drawings.

## 620.4 MEASUREMENT AND PAYMENT—

**(a) Guide Rail.** Meter (Linear Foot)
For the type indicated.

**(b) Terminal Section.** Each
For the type indicated.

**(c) Type 2-S Post Anchorage.** Each

**(d) Type 2-S End Treatment.** Each

**(e) Type 2-W End Treatment.** Each

**(f) Type 2-W End Treatment, Driveways and Openings.** Each

**(g) Reset Guide Rail.** Meter (Linear Foot)

**(h) Structure Mounted Guide Rail.** Meter (Linear Foot)

**(i) Remove Guide Rail.** Meter (Linear Foot)

**(j) Guide Rail to Bridge Barrier Transition.** Each
For the type indicated.

**(k) Inlet.** Section 605.4

# SECTION 621—METAL MEDIAN BARRIER

**621.1 DESCRIPTION**—This work is construction of new metal median barrier of the type indicated, resetting of existing metal median barrier, and removal of existing metal median barrier.

**621.2 MATERIAL**—

**(a) Metal Median Barrier.** Section 1109

**(b) Other Material.**

- Class A Cement Concrete—Section 704
- Joint Sealing Material—Section 705.4(b) or (c)
- Bituminous Wearing Course—Section 420.2 (Not RPS)
- Reinforcement Bars—Section 709.1
- Asphalt Cement—Class PG 64-22 or PG 58-28

**(c) Certification.** Section 106.03(b)3.

**621.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Metal Median Barrier.**

**1. General.** Section 620.3(a)1, except substitute median barrier for guide rail.

**2. Posts.** Drill or punch holes.
Drive posts, as specified in Section 620.3(a)2, or set manually.
As directed, either form holes before placing concrete, or cut or drill holes in existing or newly placed concrete to accommodate the installation. Do not make holes any larger than necessary to install the post. Drive the post to grade after the hole is cut or drilled; backfill the hole with either hot or cold bituminous wearing course material and fill the void around the post with Asphalt Cement, Class PG 64-22 or PG 58-28.
In areas where random boulders are encountered and the post cannot be driven to grade, remove the post, then drill or excavate a hole of suitable dimensions and depth to place the post at grade. Reset the post and backfill to the ground line, using an acceptable material, thoroughly compacted in 100 mm (4-inch) layers. If a hole has been cut or drilled in paved areas, backfill the hole for the full paved depth, using hot or cold bituminous wearing course material, finish to a flush elevation, then seal the top with joint sealing material.
In areas where bedrock is encountered and the post cannot be driven to grade, remove the post, then drill or excavate a hole of sufficient dimensions to the required depth. Fill the hole with Class A Cement Concrete, set the post to grade, then plumb and secure until the concrete has set.

**3. Rail Elements.** Support rail elements and splice, as specified in Section 620.3(a)3. Use suitable shop-formed rail on curves having a radius of less than 46 m (150 feet). Do not punch, drill, cut, or weld in the field, except if directed for special conditions.

**4. Cement Concrete Anchor Blocks.** Section 620.3(a)4

**(b) Reset Metal Median Barrier.** Section 620.3(c), except substitute median barrier for guide rail.

**(c) Remove Existing Median Barrier.** Section 620.3(d), except substitute median barrier for guide rail.

**621.4 MEASUREMENT AND PAYMENT—**

**(a) Metal Median Barrier.** Meter (Linear Foot)

**(b) Metal Median Barrier End Treatment.** Each

**(c) Metal Median Barrier End Treatment, Driveways and Openings.** Each

**(d) Metal Median Barrier, Structure Mounted.** Meter (Linear Foot)

**(e) Reset Metal Median Barrier.** Meter (Linear Foot)

**(f) Remove Existing Metal Median Barrier.** Lump Sum or Meter (Linear Foot)

# SECTION 622—CONCRETE GLARE SCREEN

**622.1 DESCRIPTION**—This work is construction of cement concrete glare screen of the type indicated.

**622.2 MATERIAL—**

- Class AA Cement Concrete—Section 704, except use Class AAA Cement Concrete as specified in Section 704, for pre-cast barrier.
- Class AA Cement Concrete (Slip-Forming)— Section 704, except:
  The slump criteria for acceptance specified in Table A, Section 704.1 does not apply. Establish a target slump value to control the consistency of the concrete and action points and rejection points and include in the QC Plan. Perform slump testing at the frequency established in the QC Plan.
- Premolded Expansion Joint Filler—Section 705.1
- Reinforcement—Section 709.1, 709.3, or 709.4
- Curing and Protecting Covers—Sections 711.1 and 711.2(a)
- Joint Sealing Material (Longitudinal Joints)—Section 705.4(b) or (c)
- Mortar—Section 1001.2(d)
- Coarse Aggregate—Section 703.2
- Precast Concrete Barrier—Section 714
- Protective Coating for Concrete—Section 503.2
- Dowel Holes—Section 1003
- Nonshrink Mortar—Section 1001.2(e)
- Subbase Material—Section 350.2
- Structural Steel (Plates for Joints)—Section 1105.02(a)2. Galvanized as specified in Section 1105.02(s) or coated as specified in Section 605.2(a).
- Intermediate Curing Compound—Section 711.2(c)
- Caulking Compound (Vertical Joints)—Section 705.8(b)

**622.3 CONSTRUCTION**—As shown on the Standard Drawings and as specified in the applicable parts of Sections 623.3 and 1001.3.

**622.4 MEASUREMENT AND PAYMENT—**

**(a) Concrete Glare Screen.** Meter (Linear Foot)

**(b) End Transition.** Each

**(c) Concrete Glare Screen, Structure Mounted.** Meter (Linear Foot)

# SECTION 623—CONCRETE MEDIAN BARRIER

**623.1 DESCRIPTION**—This work is construction of cement concrete median barrier.

**623.2 MATERIAL—**

**(a) Preformed Fabric Filter Drain.**

**1. General.** Use prefabricated pavement base drains consisting of an inert, plastic core, designed to carry water flow, wrapped in geotextile fabric for filtering purposes.

**2. Geotextile Fabric.** Non-woven, clog resistant, geotextile that does not reduce core flow capacity by creeping or deforming. Has the equivalent life of the core material.

**3. Approval.** Approval will be based on certified test data submitted by the manufacturer, or testing by MTD, or both.

**4. Certification and Shipment to Project.** Certify each shipment as specified in Section 106.03(b)3.

**(b) Other Material.**

- Class AA Cement Concrete—Section 704, except use Class AAA Cement Concrete, as specified in Section 704, for pre-cast barrier.
- Class AA Cement Concrete (Slip-Forming)—Section 704, except:
  The slump criteria for acceptance specified in Table A, Section 704.1 does not apply. Establish a target slump value to control the consistency of the concrete and action points and rejection points and include in the QC Plan. Perform slump testing at the frequency established in the QC Plan.
- Premolded Expansion Joint Filler—Section 705.1
- Reinforcement, Epoxy Coated or Galvanized—Section 709.1, 709.3, or 709.4
- Curing and Protecting Covers—Sections 711.1 and 711.2(a)
- Joint Sealing Material (Longitudinal Joints)—Section 705.4(b) or (c)
- Mortar—Section 1001.2(d)
- Coarse Aggregate—Section 703.2
- Subbase Material—Section 350.2
- Precast Concrete Barrier—Section 714
- Structural Steel (Plates for Joints)—Section 1105.02(a)2. Galvanized as specified in Section 1105.02(s).
- Protective Coating for Concrete—Section 503.2
- Intermediate Curing Compound—Section 711.2(c)
- Caulking Compound (Vertical Joints)—Section 705.8(b)

**623.3 CONSTRUCTION**—As shown on the Standard Drawings, as specified in the applicable parts of Section 1001.3, as follows:

**(a) General.** Submit proposed standard design modifications to the District Executive for review and acceptance before starting work.

Fill surface blemishes larger than 13 mm (1/2 inch) with mortar, as directed.

Install barrier mount delineation devices, as directed or according to the manufacturer's recommendations.

For sections of barrier indicated as removable sections, install a bond breaker, such as bituminous paper or polyethylene, to facilitate removal. Provide suitable lifting methods for handling, installing, and removing the barrier units. If not in use, plug lifting devices with removable plastic or other acceptable plugs.

Join new concrete median barrier and existing barrier, where indicated and as directed.

If required, construct structure mounted median barrier, as indicated.

Precast concrete median barrier used in temporary installations, as specified in Section 627, may later be placed in a permanent installation, as specified here, provided barrier sections are not identified as being for temporary use only, are free from damage, and are otherwise acceptable.

Construct cast-in-place barrier and slip-form barrier according to the weather restrictions specified in Section 501.3(b).

Cure cast-in-place barrier and slip-form barrier as specified in Section 1001.3(p)3.a or Section 501.3(l) except white membrane curing compound may be used to cure barrier subject to the application of protective coatings and the first paragraph specified in Section 501.3(l)1.c does not apply.

Apply a protective coating to barriers, a minimum of 28 days after concrete placement, as specified in Section 503.3(b). Before application, thoroughly dry and clean concrete surfaces of dirt, debris, oil, grease, and foreign matter that would prevent protective coating penetration, adhesion, or drying.

Do not apply protective coating to precast barrier units produced specified in Section 714.

**(b) Slip-Form Method.** If the barrier is cured by a method other than a liquid membrane curing compound, apply an intermediate monomolecular film curing agent as specified in Section 516.3(j) immediately after the extruded concrete surface leaves the slip form machine or immediately after necessary offsets and fins are removed by light troweling.

Do not touch the barrier extruded concrete surface as it leaves the slip-form machine, except to immediately remove offsets and fins by light troweling.

Make adjustments in the operation to correct any condition causing surface blemishes larger than 13 mm (1/2 inch). If the adjustments do not correct the condition within 9 m (30 linear feet), halt the operation until the condition is corrected, either by adjustments to the operation or by adjustments to the concrete mix.

Do not use an intermediate curing compound or water on the completed barrier to correct imperfections.

**(c) Joints.** Form contraction joints, by hand or saw, 5 mm (3/16 inch) wide and 50 mm (2 inches) deep, at 6 m (20-foot) intervals. Saw as soon as possible after the concrete sets sufficiently to preclude raveling during the sawing, before any shrinkage cracking occurs in the concrete. The depth of saw cut may be decreased at the edge adjacent to the pavement to obtain a maximum depth without pavement damage.

Tool the construction joint edges.

Place 19 mm (3/4-inch) premolded, expansion-joint material, cut to conform to the cross sectional area, at structures and at the end of the workday.

Construct longitudinal joints a maximum of 6 mm (1/4 inch) wide on both sides of the barrier, as indicated. For precast units on curved sections, the Representative will allow a maximum 12 mm (1/2-inch) longitudinal joint. For curves with radii less than 700 m (765.5 yards) (For curves greater than 2 degrees 30 minutes), use shorter precast barrier lengths to maintain longitudinal joint tolerances.

Seal the longitudinal joint as specified in Section 501.3(n). Seal all vertical contraction and construction joints with an approved caulking compound. Trim 19 mm (3/4-inch) premolded expansion-joint material at construction joints to create a notch for caulking compound. Do not seal the joints between precast barrier sections. Place precast barrier sections so that transverse joints are reasonably tight, but do not result in damage to barrier edges during placement.

**(d) Removal of Forms.** Do not remove forms until at least 12 hours after placing the concrete. Do not rub to correct irregularities until the full curing period has elapsed. Correct any irregular surface by rubbing with a carborundum stone. Do not brush finish or plaster. After removing the forms, fill minor defects with mortar. Promptly remove and replace rejected barrier.

**(e) Testing and Acceptance.** Have the finished barrier conform to the dimensions of the design template within 6 mm (1/4 inch) in all directions and across the joints. Test the top and side surfaces using a 3 m (10-foot) straightedge. Hold the straightedge in successive positions for the entire length of the barrier and advance in stages of not more than 1.5 m (5 feet). Remove and replace barrier with deviations in excess of 6 mm (1/4 inch) as measured from the testing edge of the straightedge.

**(f) Single Face Concrete Barrier.** If single face concrete barrier is specified for use as a retaining wall, and drainage treatment is necessary, construct a preformed fabric filter drain as indicated.

## 623.4 MEASUREMENT AND PAYMENT—

**(a) Concrete Median Barrier.** Meter (Linear Foot)

**(b) End Transition.** Each

**(c) Concrete Median Barrier, Structure Mounted.** Meter (Linear Foot)

**(d) Single Face Concrete Barrier.** Meter (Linear Foot)

**(e) Flared End Transition.** Each

# SECTION 624—RIGHT-OF-WAY FENCE

**624.1 DESCRIPTION**—This work is construction of right-of-way fence of the type indicated.

**624.2 MATERIAL**—

**(a) Right-of-Way Fence.** Section 1110

**(b) Packaged Dry Concrete.** ASTM C 387, normal strength concrete; Type IA, IIA, or IIIA cement; 28-day compressive strength of 21 MPa (3,000 pounds per square inch).

**(c) Other Material.**

- Class A Cement Concrete—Section 704
- Mortar—Section 1001.2(e)
- Ground Rod—Acceptable 25 mm x 3 m (1-inch by 10-foot) copper clad rod with suitable clamps
- Ground Wire—21.15 $mm^2$ (No. 4 AWG) solid copper

**(d) Certification.** Section 106.03(b)3

**624.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Clear and grub to construct the right-of-way fence and to provide a reasonably smooth ground profile at the fence line, unless otherwise directed. Cut, trim, and remove vegetation, as specified in Section 810, as required for right-of-way fence installation.

Excavate or construct compacted embankment a maximum depth of 150 mm (6 inches) and a minimum width of 450 mm (18 inches), with 1:2 (2:1) side slopes, unless otherwise directed to obtain the desired elevations. Fill minor ground depressions that are not water courses.

Restore areas disturbed by grading operations as specified in Section 105.14.

Join new and existing right-of-way fence as indicated or directed.

Complete the fence true to line, plumb, taut, rigid, and erected in conformance with established practices for the type specified.

**(b) Posts.** Orient posts with sections that have a major and a minor bending axis, with the major axis parallel to the fence line. Place corner posts with the major axis parallel to one of the lines of the fence.

Drive line posts, except when concrete footings are required. Obtain acceptance for the method of driving and of protecting the post. Remove and replace posts with battered heads, bent, or otherwise damaged posts as directed.

Furnish and place longer line posts where indicated to suit field conditions.

If rock is encountered, drill a hole with a diameter that is 15 mm (1/2 inch) larger than the post's maximum dimension, at least 300 mm (12 inches) into the rock, and then grout the post in place with mortar.

**(c) Anchorages.** Construct concrete footings or install acceptable drive anchors. Construct concrete footings, using Class A Concrete or packaged dry concrete. Concrete footings do not require forming. Finish the footing tops to drain water away from the posts. Do not place the fabric until the concrete has cured for a minimum of 72 hours.

**(d) Fabric.** Firmly fasten wire fabric to the posts using aluminum or galvanized bands or clamps, or by other acceptable methods.

Splice fabric using an acceptable method that develops the full fabric strength.

Place fabric on the side of the fence toward the highway unless otherwise indicated or directed. At corner posts and on curves, place the fabric so it pulls against the post.

If supplied with both knuckled and barbed selvages, install fabric with the barbed selvage on the fence top edge.

**(e) Gates.** Install gates where indicated or directed.

**(f) Electrical Grounds.** Install an electrical ground directly under areas where electrical transmission, distribution, or secondary lines cross over the right-of-way fence. Drive a 3 m (10-foot) copper clad rod, a minimum of 25 mm (1 inch) in diameter, vertically until the top is approximately 150 mm (6 inches) below the ground elevation. Bronze clamp a 21.15 $mm^2$ (No. 4 AWG) solid-copper conductor to the rod and to the fence so each fence element is grounded.

## 624.4 MEASUREMENT AND PAYMENT—

**(a) Right-of-Way Fence.** Meter (Linear Foot)

**(b) End Post, Corner Post, and Pull Post.** Each

**(c) Gate.** Each

**(d) Class 2 Excavation.** Cubic Meter (Cubic Yard)

Excavation and embankment within the specified depth of 150 mm (6 inches) is incidental to this work. If the Representative directs additional excavation and/or embankment beyond the 150 mm (6-inch) depth indicated, the Department will pay for additional quantities as Class 2 Excavation.

# SECTION 626—GABIONS

**626.1 DESCRIPTION**—This work is the furnishing, assembling, and filling of open mesh wire baskets with aggregate, forming gabions of the type indicated.

**626.2 MATERIAL—**

**(a) Aggregate.**

**1. Physical Requirements.** Use acceptable quality aggregate, sound, free from structural defects and foreign substances. Submit samples to the MTD for petrographic examination for durability before use, unless the aggregate comes from material providing an approved Type A aggregate.

**2. Size.** Use aggregate in the following sizes, measured in the greatest dimension:

| Gabion Height | Minimum Aggregate Size | Maximum Aggregate Size |
|---|---|---|
| Less than 300 mm | 75 mm | 130 mm |
| or over 300 mm | 100 mm | 200 mm |

| Gabion Height | Minimum Aggregate Size | Maximum Aggregate Size |
|---|---|---|
| Less than 1 foot | 3 inches | 5 inches |
| 1 foot or over | 4 inches | 8 inches |

**(b) Geotextiles, Class 2, Type B.** Section 735

**(c) Gabion Baskets.** As shown on the Standard Drawings and as follows:

**1. Types A and B.**

**1.a Wire Mesh.**

- Galvanized steel wire, minimum 3.07 mm thick (No. 11 gage) for heights 300 mm (12 inches) and over; 2.36 mm thick (No. 13 gage) for the 230 mm (9-inch) height.
- Tensile strength from 410 MPa to 586 MPa (60,000 pounds per square inch to 85,000 pounds per square inch), determined according to ASTM A 392.
- Zinc coated with a minimum coating mass of 250 g/m$^2$ (0.80 ounces per square foot), determined according to ASTM A 90.
- Maximum linear dimension of the mesh opening not exceeding 114 mm (4 1/2 inches) and mesh opening area not exceeding 5100 mm$^2$ (8 square inches) for baskets 300 mm (12 inches) in height and over; maximum linear dimension not exceeding 83 mm (3 1/4 inches) and mesh opening area not exceeding 3900 mm$^2$ (6 square inches) for baskets 230 mm (9 inches) in height. Dimensions may vary, subject to a tolerance limit of 3% of the manufacturer's stated sizes.

**1.b Fabrication.**

- Fabricate so the sides, ends, lid, and diaphragms can be assembled at the construction site into the required rectangular basket.

- Use baskets of single-unit construction.
- Weave base, lid ends, and sides either into a single unit, or with one edge of those members connected to the base section of the basket, so the strength and flexibility at the point of connection is at least equal to the mesh.
- Assemble with the necessary diaphragms secured in position on the base so no additional tying is necessary now.
- Join the mesh perimeter forming the basket so the joints formed have at least the same strength as the mesh body.
- Provide four internal connecting wires in each cell (two across the width and two across the length) at a level of one-third the cell height and at a level of two-thirds the cell height.
- Use the same type connecting wire as the wire in the mesh, except do not exceed the wire mesh diameter by more than 20%.
- Fabricate the wire mesh to be nonraveling, which is the ability to resist pulling apart at the twists or connections forming the mesh if a single wire in a mesh section is cut, and the mesh section is then subjected to the load test, as specified in Section 626.2(c)1.c.2.

**1.c Wire Mesh Tests.**

**1.c.1 Elongation.** The diameter or tensile strength of individual wires is not reduced to values less than those of wire 10% smaller when elongated equivalent to 10% of the section length.

**1.c.2 Strength.** Wire does not rupture, or mesh fasteners open when a load of 27 kN (6,000 pounds) is applied as follows:

**Step 1.** Clamp a section 1.8 m (6 feet) long, not less than 0.9 m (3 feet) wide including selvage bindings, for 0.9 m (3 feet) along the width, or in the middle of widths greater than 0.9 m (3 feet), with the excess falling free on each side.

**Step 2.** Apply tension to elongate the section 10%.

**Step 3.** Apply the force (load) to 0.09 $m^2$ (1 square foot) located approximately in the center of the sample between clamps and in a direction perpendicular to the tension force direction using a circular ram head with edges beveled or rounded to prevent cutting the wires.

**2. Corrosion Resistant-Types A and B.** Section 626.2(c)1 and as follows:

**2.a Wire Mesh.** Polyvinyl chloride coated, galvanized steel wire; minimum 2.71 mm (No. 12 gage) wire core for heights 300 mm (12 inches) and over; 2.05 mm (No. 14 gage) for 230 mm (9-inch) height; coated with polyvinyl chloride 0.549 mm (0.0216 inch) thick, minimum.

**2.b Coated Mesh Test.** Section 626.2(c)1.c and as follows to determine the resistance of the coating to corrosive effects of air and water.

**2.b.1** Immerse for 20 hours in hydrochloric acid (solution composed of 50% water and 50% hydrochloric acid concentration 21 Baume-Test temperature 15 °C (59F)); or immerse for 60 hours in a saturated solution of salt water at 15 °C (59F). Unprotected ends not immersed and mesh showing noticeable loss of mass (weight) due to sheathing material corrosion or wire's diameter reduction will not be acceptable.

**2.b.2** Immerse for 50 hours in a 3.5% solution of potassium permanganate at ambient temperature; the maximum allowable penetration between the coating and the core wire from a square cut end is 11.99 mm (0.472 inch).

**2.b.3** Subject wire to temperatures ranging between 70 °C and -40 °C (158F and -40F); mesh is acceptable if the coating is not altered or deformed.

**3. Certification.** Section 106.03(b)3. Certify each shipment delivered to the job site. A shipment consists of material arriving at the job site at approximately the same time.

**626.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Excavation.** Excavate as required to place the baskets. Remove unsuitable material below the bottom of baskets and replace with acceptable material. Thoroughly compact the entire foundation and finish to a firm, even surface, one free of vegetation, large stones, and other debris, with depressions filled. Dispose of unsuitable or excess material.

**(b) Geotextiles, Class 2, Type B.** Place as specified in Section 212.3(c).

**(c) Gabions.** Assemble each basket by binding vertical edges together with a continuous piece of connecting wire, looped twice around the vertical edges with a coil, approximately every 100 mm (4 inches); on 230 mm (9-inch) high baskets, loop the coils every 80 mm (3 inches). Set empty baskets to line and grade, as indicated. Join the units together with connecting wire, in the same manner as described above. Space uniformly, then securely fasten the internal tie wires in each outside cell of the structure, or as directed. If gabions are placed as slope protection or channel lining, the internal tie wires may be deleted, if directed.

Fill Type A gabions by hand placement of the aggregate, at least along the exposed faces, for a uniform appearance. Fill Type B gabions with small power equipment or by hand.

When filling baskets, use a standard fence stretcher, chain fall, or iron rod to stretch the baskets and to maintain alignment. Carefully place aggregates in corrosion-resistant baskets, making sure the sheathing is not broken or damaged. After filling a basket, bend the lid over until it meets the sides and edges. Secure the lid to the sides, ends, and diaphragms, using connecting wire in the manner specified for assembling.

**626.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

# SECTION 627—TEMPORARY CONCRETE BARRIER

**627.1 DESCRIPTION**—This work is the furnishing, placing, maintaining, and removing of temporary precast concrete barrier or glare screen, as indicated, for maintenance and protection of traffic during construction.

**627.2 MATERIAL**—

- Precast Concrete Median Barrier or Glare Screen—Section 714
- Mortar—Section 1001.2(d)
- Structural Steel—Section 1105.02(a)2
- Warning Lights—67 PA Code, Chapter 203 and from a manufacturer listed in Bulletin 15.
- Barrier Mount Delineation Devices – Section 937.2

**627.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Place clean, precast barriers on a stable base, then properly join and align the barriers at the required locations. Install a bond breaker when placing barrier on bituminous pavement to prevent damage to the pavement when removing the barrier. Install delineators and warning lights as directed and according to the manufacturer's recommendations. Maintain alignment, delineation, warning lights, and condition of the barriers as necessary, for the duration of the project. Remove the barriers from the project upon project completion, or when directed.

Immediately replace or repair barriers showing the following signs of damage:

- fractures or cracks, that, as determined by the Representative, hinder the barrier performance.
- broken or cracked ends that, as determined by the Representative, prevent making a satisfactory joint.

**627.4 MEASUREMENT AND PAYMENT**—

**(a) Temporary Concrete Barrier.** Meter (Linear Foot)

**(b) Temporary End Transition.** Each

**(c) Incidental Work.** The following work is incidental to the temporary concrete barrier item: burying blunt ends of the temporary concrete barrier; cleaning and removal of conflicting markings; and bond breaker.

# SECTION 628—RESET TEMPORARY CONCRETE BARRIER

**628.1 DESCRIPTION**—This work is the resetting of a temporary concrete barrier from one construction area to another within the project limits.

**628.2 MATERIAL**—Section 627.2

**628.3 CONSTRUCTION**—Section 627.3

Reset barrier if construction operations require a change in protection or traffic or as directed. Store or transport the barrier, as required.

**628.4 MEASUREMENT AND PAYMENT—**

**(a) Reset Temporary Concrete Barrier.** Meter (Linear Foot)

**(b) Reset Temporary End Transition.** Each

**(c) Reset Temporary Concrete Barrier, Structure Mounted.** Meter (Linear Foot)

# SECTION 630—PLAIN CEMENT CONCRETE CURB

**630.1 DESCRIPTION**—This work is construction of plain cement concrete curb.

**630.2 MATERIAL—**

- Class A Cement Concrete—Section 704
- Class A Cement Concrete (Slip-Forming)— Section 704, except with a maximum slump of 38 mm (1 1/2 inches).
- Premolded Expansion Joint Filler—Section 705.1
- Covers for Curing and Protection—Section 711.1
- Curing Compound—Section 711.2(a)
- Mortar—Section 1001.2(d)
- Caulking Compound—Section 705.8
- Reinforcement Bars—Section 709.1(a)

**630.3 CONSTRUCTION**—As shown on the Standard Drawing RC 64M, as specified in Section 501.3, and as follows:

**(a) Excavation.** Excavate as required. Remove existing curb, pavement, and sidewalk to neat lines when indicated., then compact the material, upon which the curb is to be constructed, to a firm even surface.

**(b) Forms.** Use acceptable metal forms specified in Section 501.3(d), use wood forms on sharp curves and short tangent sections. Use forms that will not discolor the concrete.

**(c) Placing, Finishing, and Curing Concrete.** Conform to weather restrictions for concrete placement specified in Section 501.3(b). Place the concrete in the forms in layers not exceeding 130 mm (5 inches) in depth when spading, or layers not exceeding 380 mm (15 inches) in depth when using a vibrator to eliminate voids. Provide drainage openings through the curb, at the elevation and of the size required, where indicated or directed. Smoothly and evenly finish the top surface of the curb using a wood float. While the concrete is still plastic, round the edges of the face and back of the curb. Place depressed curbs for drives or curb ramps, where indicated or directed. Place bars as indicated for depressed curb at drives as specified in Section 1002.3. Cure concrete as specified in Section 501.3(l)

**(d) Curb Machine.** The concrete curb may be placed with an acceptable, self-propelled machine.

Uniformly feed the concrete to the machine so that it maintains the shape of the section without slumping after extrusion.

The Representative will not allow voids or honeycomb on the surface of the finished curb. Immediately after extrusion, perform any additional surface finishing.

**(e) Joints.** Form or saw contraction joints to dimensions shown on Standard Drawing RC 64M and as specified in Section 501.3(i)2. Place 19 mm (3/4-inch) premolded expansion joint material conforming to the cross-sectional area of the curb where indicated and at the end of the workday. Do not place expansion joint material at Type C precast inlet tops.

Prepare and caulk joints according to caulking manufacturer's recommendations.

**(f) Removal of Forms.** Do not remove forms until such time that it will not be detrimental to the concrete. Correct irregular surfaces by rubbing with a carborundum stone. Do not brush finish or plaster. Fill minor defects with mortar.

**(g) Backfilling and Embankment.** As soon as possible after the removal of forms, backfill the voids in front and back of the curb, using acceptable embankment material, as specified in Section 206.3(b)4.

Complete embankments in back of raised curbs, as indicated, and as specified in Section 206.3, except carefully compact the embankment by means of mechanical tampers, or rollers, if permitted, not exceeding 7.3 tonnes (8 tons).

Replace existing pavement and sidewalk damaged or removed during construction.

Dispose of unsuitable and surplus material.

**(h) Curb Modification.** Modify curb construction within existing pavement limits and existing structures, where indicated or directed. Drill holes and insert dowel bars with nonshrink mortar, as required.

**630.4 MEASUREMENT AND PAYMENT**—Depressed curb will be measured and paid for as full depth curb of the type indicated.

**(a) Plain Cement Concrete Curb.** Meter (Linear Foot)

**(b) Plain Cement Concrete Curb, Including Removal of Existing Curb.** Meter (Linear Foot)

**(c) Class I Excavation.** Section 203.4

# SECTION 633—PLAIN CONCRETE MOUNTABLE CURB

**633.1 DESCRIPTION**—This work is construction of plain concrete mountable curb of the type indicated.

**633.2 MATERIAL**—As specified in Section 630.2 and as follows:

- Subbase—Section 350

**633.3 CONSTRUCTION**—As shown on the Standard Drawing RC 65M, as specified in Section 501.3, and as follows:

**(a) Excavation.** Excavate, if necessary, as specified in Section 630.3(a).

**(b) Forms.** Use forms as specified in Section 630.3(b).

**(c) Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete as specified in Section 630.3(c).

**(d) Curb Machine.** Use a curb machine as specified in Section 630.3(d).

**(e) Joints.** Form or saw contraction joints as specified in Section 630.3(e).

**(f) Removal of Forms.** As specified in Section 630.3(f).

**(g) Backfilling and Embankment.** As specified in Section 630.3(g).

**(h) Curb Modification.** Modify curb construction within existing pavement limits and existing structures, where indicated or directed. Drill holes and insert dowel bars with nonshrink mortar, as required.

**633.4 MEASUREMENT AND PAYMENT—**

**(a) Plain Concrete Mountable Curb.** Meter (Linear Foot)

**(b) Class 1 Excavation.** Section 203.4

# SECTION 636—BITUMINOUS CONCRETE CURB

**636.1 DESCRIPTION**—This work is construction of a hot-mixed, hot-laid, bituminous concrete curb on a completed bituminous surface.

**636.2 MATERIAL**—Section 401.2, except that the Marshall method controls do not apply.

**(a) Bituminous Material.** Asphalt Cement, Class PG 64-22 or 58-28.

**(b) Aggregate.** Fine Aggregate, Section 703.1.

**(c) Filler (Drawn Polyester Fibers).** Provide a supplier certification with each shipment as specified in Section 106.03(b)3. The supplier shall certify that the filler conforms to the following requirements:

| | |
|---|---|
| Average Length | 6.5 mm ± 1.5 mm (0.25 inch ± 0.06 inch) |
| Average Diameter | 0.010 mm (0.0004 inch) minimum |
| Specific Gravity | 1.34 to 1.40 |
| Melting Temperature | 249 °C (480F) minimum |
| Tensile Strength | 480 MPa (70,000 pounds per square inch) minimum |

**(d) Composition of Mixture.** Combine fine aggregate, bitumen, and fiber in proportions that produce a mixture conforming to composition by mass (weight) percentages within the limits of Table A and as directed. Add approximately 0.3% asphalt cement per 0.12% by mass (weight) of polyester fibers.

**TABLE A**
**Bituminous Concrete Curb**
**(Percentages by Mass (Weight) Passing Square Opening Sieves)**

| Passing Sieve | Required Composition of Mixture |
|---|---|
| 9.5 mm (3/8-inch) | 100 |
| 4.75 mm (No. 4) | 90 - 100 |
| 2.36 mm (No. 8) | 70 - 100 |
| 1.18 mm (No. 16) | 50 - 80 |
| 600 µm (No. 30) | 35 - 60 |
| 300 µm (No. 50) | 20 - 45 |
| 150 µm (No. 100) | 10 - 30 |
| 75 µm (No. 200) | 5 - 20 |
| Asphalt Cement, % by Mass (Weight) | 6 - 13 |
| Drawn Polyester Fiber, % by Mass (Weight) of Total Mix | 0.12 - 0.38 |

**(e) Bituminous Tack Coat.** Section 460.2

**636.3 CONSTRUCTION—**

**(a) Bituminous Mixing Plant.** Obtain the bituminous mixture from a plant conforming to Chapter 1, Bulletin 27, except that three bins are not required.

**(b) Hauling Equipment.** Section 401.3(d)

**(c) Bituminous Paver.** Use an acceptable, self-propelled, extruding curb-paver.

**(d) Preparation of Surface.** Before placing curb, clean the bituminous surface and apply a tack coat, as specified in Section 460.3.

**(e) Placing and Compacting.** Place the curb in a continuous operation. The Representative will determine the mixture temperature from within the range of 143 °C to 157 °C (290F to 315F) based on weather conditions and workability requirements at the time of placement. Maintain the mixture temperature within a tolerance of 8 °C (15F) of the mixture temperature.

Place the hot bituminous mixture in the hopper of the curb-paver without segregation and then extrude the mixture through the mold to provide the proper compaction and surface texture.

Properly support and mass-load the curb-paver during operation along the edge of pavement. Guide the paver along string or chalk lines to maintain proper alignment and grade of the completed curb.

Where indicated or directed, make drainage openings through the curb.

Remove and replace completed curbs that show signs of sagging, cracking, or distortion; do not conform to lines, grades, or cross sections; and that cannot be satisfactorily repaired.

**(f) Joints.** If placing of curb is interrupted and the mixture cools below 135 °C (275F) cut a vertical joint in the curb. Just before placing the curb resumes, paint the joint with a thin, uniform coat of hot Asphalt Cement, Class PG 64-22 or PG 58-28.

**(g) Curing.** Protect newly completed curb from traffic or any other disturbance for at least 12 hours.

**(h) Backfilling.** Immediately after the curing period and where necessary, backfill and compact acceptable material behind the curb up to the required elevation and cross section.

**636.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 640—PLAIN CEMENT CONCRETE GUTTER

**640.1 DESCRIPTION**—This work is construction of plain cement concrete gutter.

**640.2 MATERIAL—**

- Class AA Cement Concrete—Section 704
- Asphalt Cement—Class PG 64-22 or PG 58-28
- Joint Sealing Material—Sections 705.4(b) or (c)
- Caulking Compound—Section 705.8
- Covers for Curing and Protection—Section 711.1
- Curing Compound—Section 711.2(a)

**640.3 CONSTRUCTION**—As shown on the Standard Drawing RC 64M, as specified in the applicable parts of Section 501.3, and as follows:

**(a) Foundation.** Form the foundation for the gutter bottom at the required depth below the finished surface as indicated. Remove unsuitable materials, replace with acceptable embankment material, as specified in Section 206.2(a), and then compact thoroughly to a firm, even surface.

**(b) Forms.** Use acceptable forms of wood or metal.

**(c) Placing and Finishing Concrete.** Place the concrete on a moist foundation between the forms, consolidate, and then strike off to the required shape. Finish smoothly and evenly with a wood float. Where the gutter joins other structures, seal the adjacent edges with an approved Asphalt Cement. Tool the gutter edge to the radius indicated.

**(d) Joints.** Form or saw contraction joints to dimensions shown on the Standard Drawing RC 64M and as specified in Section 501.3(i).

Place 19 mm (3/4-inch) premolded expansion joint material that is cut to the cross section of the gutter at structures and where gutter placement ends each work day.

Prepare and seal or caulk joints, according to manufacturer's recommendations.

**(e) Backfilling.** After the concrete has hardened sufficiently, backfill the spaces adjacent to the gutter with acceptable embankment material, as specified in Section 206.3(b)4.

**640.4 MEASUREMENT AND PAYMENT—**

**(a) Plain Cement Concrete Gutter.** Square Meter (Square Yard)

**(b) Class 1 Excavation.** Cubic Meter (Cubic Yard)

# SECTION 641—PLAIN CEMENT CONCRETE CURB GUTTER

**641.1 DESCRIPTION**—This work is construction of plain cement concrete curb gutter.

**641.2 MATERIAL—**

- Mortar—Section 1001.2(d)
- Class AA Cement Concrete—Section 704
- Asphalt Cement—Class PG 64-22 or PG 58-28
- Joint Sealing Material—Sections 705.4(b) or (c)
- Caulking Compound—Section 705.8
- Covers for Curing and Protection—Section 711.1
- Curing Compound—Section 711.2(a)

**641.3 CONSTRUCTION**—As specified in Section 640.3 and as follows:

Do not rub forms to correct irregularities until they have been removed and the full curing period has elapsed. Correct irregular surfaces by rubbing with a carborundum stone. Do not brush finish or plaster. Fill minor defects with mortar. Place depressed curb gutter where indicated or directed.

Prepare and seal or caulk joints according to manufacturer's recommendations.

**641.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

The Department will not adjust the area for depressing the curb portion.

# SECTION 651—PAVED SHOULDERS, TYPE 1, TYPE 1-F, TYPE 1-I, TYPE 1-S, AND TYPE 1-SP

**651.1 DESCRIPTION**—This work is construction of paved shoulders, of the type indicated, on a prepared surface.

**651.2 MATERIAL**—

- Aggregate Base—Section 350.2
- Bituminous Concrete Base Course—Section 305.2
- Bituminous Surface Treatment—Section 480.2
- Bituminous Wearing Course, FJ-1, SRL-L—Section 422.2
- Bituminous Wearing Course, ID-2, SRL-L—Section 420.2
- Slurry Seal—Section 480.2
- Superpave Asphalt Mixture Design, HMA Base Course—Section 309.2 and as follows: PG 64-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, HMA Wearing Course, SRL-L—Section 409.2 and as follows: PG 64-22, <0.3 million ESALs, or as indicated or directed.

**651.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Combination Base Course.**

1. **Aggregate Base.** Section 350.3
2. **Bituminous Concrete Base Course.** Section 305.3
3. **Superpave Asphalt Mixture Design, HMA Base Course (for Type 1-SP).** Section 309.3

**(b) Bituminous Surface Treatment (for Type 1).** Section 480.3

**(c) Bituminous Wearing Course, FJ-1 (for Type 1-F).** Section 422.3

**(d) Bituminous Wearing Course, ID-2 (for Type 1-I).** Section 401.3

**(e) Double Slurry Seal (for Type 1-S).** Apply a seal, as specified in Section 482.3.

**(f) Superpave Asphalt Mixture Design, HMA Wearing Course (for Type 1-SP).** Section 409.3

**651.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 653—PAVED SHOULDERS, TYPE 3

**653.1 DESCRIPTION**—This work is construction of paved shoulders on a prepared surface.

**653.2 MATERIAL—**

- Aggregate Base—Section 350.2
- Bituminous Prime Coat—Section 461.2
- Bituminous Surface Treatment—Section 480.2

**653.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Aggregate Base.** Section 350.3; except, if granulated steel slag is used as a base material, construct the top 75 mm (3 inches) of the aggregate base using either stone, gravel, or air-cooled blast furnace slag aggregate.

**(b) Prime Coat.** Section 461.3

**(c) Bituminous Surface Treatment.** Section 480.3

**653.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 654—PAVED SHOULDERS, TYPE 4

**654.1 DESCRIPTION**—This work is construction of paved shoulders, Type 4, and preparation of the underlying surface.

**654.2 MATERIAL**—

- Aggregate Base—Section 350.2
- Bituminous Prime Coat—Section 461.2
- Bituminous Surface Treatment—Section 480.2
- Shoulder Backfill Material—Section 350.2

**654.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Remove surplus material on existing shoulders to the bottom of the proposed base course or to a directed depth. If the existing guide rail is to remain in place, excavate the shoulder without disturbing the existing guide rail. Remove and shape material under and in back of existing guide rail to the elevation and slopes indicated or as directed. The Contractor is not required to compact behind the existing rail.

Satisfactorily repair existing guide rail damaged or destroyed by the construction operations, as directed.

Satisfactorily dispose of excess or unsuitable material, as directed.

**(b) Scarifying.** After removing surplus material and at directed locations, scarify existing shoulder areas to a maximum depth of 100 mm (4 inches) below existing grade or to the directed depth.

**(c) Shaping and Compacting.** Shape and compact existing shoulder areas and low areas filled with graded material from the shaping operation to the bottom elevation of the proposed base course. If there is insufficient graded material, provide aggregate base course material to fill low areas to the bottom elevation of the proposed base course. Compact graded material or aggregate base course material as specified in Section 654.3(f).

**(d) Aggregate Base.** Construct, as specified in Section 350.3, to the depth indicated.

**(e) Excavation.** Where indicated, excavate the shoulder area below the bottom of the proposed base course to the depth indicated or directed.

**(f) Shoulder Backfill.** Where the shoulder area was excavated below the bottom elevation of the proposed base course, backfill, shape, and compact aggregate base course material to the bottom elevation of the proposed base course. Compact using rollers conforming to Section 108.05(c)3.a, 3.b, 3.e, or 4. The material is satisfactorily compacted when it does not move under the compaction equipment.

**(g) Prime Coat.** Section 461.3

**(h) Bituminous Surface Treatment.** Section 480.3

**654.4 MEASUREMENT AND PAYMENT—**

**(a) Paved Shoulders, Type 4.** Square Meter (Square Yard)

**(b) Shoulder Backfill.** Cubic Meter (Cubic Yard) or Tonne (Ton)
The unit price includes excavation below the bottom of the proposed base course.

# SECTION 656—PAVED SHOULDERS, TYPE 6, TYPE 6-F, TYPE 6-I, TYPE 60-S, AND TYPE 6-SP

**656.1 DESCRIPTION**—This work is construction of paved shoulders, of the type indicated, and preparation of the underlying surface.

**656.2 MATERIAL—**

- Bituminous Concrete Base Course—Section 305.2
- Bituminous Surface Treatment—Section 480.2
- Shoulder Backfill (if required)—Section 350.2
- Bituminous Wearing Course, FJ-1, SRL-L—Section 422.2
- Bituminous Wearing Course, ID-2, SRL-L—Section 420.2
- Slurry Seal—Section 482.2
- Superpave Asphalt Mixture Design, HMA Base Course—Section 309.2 and as follows: PG 64-22, <0.3 million ESALs, or as indicated or directed.
- Superpave Asphalt Mixture Design, HMA Wearing Course, SRL-L—Section 409.2 and as follows: PG 64-22, <0.3 million ESALs, or as indicated or directed.

**656.3 CONSTRUCTION**—As shown on the Standard Drawings; as specified in Sections 654.3(a), (b), (c), (e), and (f); and as follows:

**(a) Bituminous Concrete Base Course.** Section 305.3

**(b) Bituminous Surface Treatment (for Type 6).** Section 480.3

**(c) Bituminous Wearing Course, FJ-1 (for Type 6-F).** Section 422.3

**(d) Bituminous Wearing Course, ID-2 (for Type 6-I).** Section 401.3

**(e) Double Slurry Seal (for Type 6-S).** Apply a seal, as specified in Section 482.3.

**(f) Superpave Asphalt Mixture Design, HMA Base Course (for Type 6-SP).** Section 309.3

**(g) Superpave Asphalt Mixture Design, HMA Wearing Course (for Type 6-SP).** Section 409.3

**656.4 MEASUREMENT AND PAYMENT—**

**(a) Paved Shoulders.** Square Meter (Square Yard)

**(b) Shoulder Backfill.** Cubic Meter (Cubic Yard) or Tonne (Ton)
The unit price includes excavation below the bottom of the proposed base course.

# SECTION 657—PAVED SHOULDERS, TYPE 7

**657.1 DESCRIPTION**—This work is construction of paved shoulders.

**657.2 MATERIAL**—Same type as the material used to resurface the roadway, except use SRL-L.

**657.3 CONSTRUCTION**—As shown on the Standard Drawings.

**657.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 658—CONCRETE SHOULDERS

**658.1 DESCRIPTION**—This work is construction of plain cement concrete shoulders, of the type indicated, on a prepared surface.

**658.2 MATERIAL—**

- Class AA Cement Concrete—Section 704
- Joint Sealing Material—Section 705.4(a), (b), or (d)
- Covers for Curing and Protection—Section 711.1
- Concrete Curing Compound—Section 711.2(a)
- Concrete Admixtures—Section 711.3
- Base Courses—Sections 303.2, 350.2, and 360.2
- Deformed and Plain Bar Dowels—Section 709.1(a)
- Premolded Expansion Joint Filler—Section 705.1
- Longitudinal Joint Material—Section 705.2

**658.3 CONSTRUCTION—**

**(a) General.** Construct concrete shoulders as shown on the Standard Drawing RC 25M and as specified in Section 501.3, except as follows:

**(f) Placement and Initial Strike-Off of Concrete**. Revise the third paragraph of Section 501.3(f) as follows:
Do not damage the prepared surface while transporting or depositing concrete ahead of the paver. If the prepared surface is an asphaltic leveling course on rubblized concrete, treated base course of cement or asphalt, or a No. OGS subbase, travel on the prepared surface only in the immediate area of the paving operation for the purpose of depositing concrete ahead of the paver. Do not use the prepared surface for hauling. Repair or replace any damaged areas to the satisfaction of the Engineer, at no additional cost to the Department.

**(g) Slip-Form Paving Method.** Revise Section 501.3(g)4 as follows:
**4. Joints.** Saw, cure, and protect transverse and longitudinal contraction joints, as specified in Sections 501.3(i) and (j).

**(i) Transverse Joints.** Revise Sections 501.3(i) as follows:
Delete the second paragraph.
Revise Section 501.3(i)2, first paragraph as follows:
**2. Contraction Joints.** Accurately mark, using tacks or other approved methods, the location for the center of the sawed transverse contraction joints. Saw joints with equipment having guides, a blade guard, watercooling system, and cut-depth control. Provide adequate, extra equipment and parts at the site, before placing concrete and during sawing operations.

**658.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

# SECTION 660—SHOULDER RUMBLE STRIPS

**660.1 DESCRIPTION**—This work is the construction of rumble strips on the shoulder.

**660.3 CONSTRUCTION**—As shown on the Standard Drawing RC 25M and as follows:

**(a) Equipment.** Use a machine capable of providing a smooth cut without tearing or snagging, and producing rumble strips as shown on the Standard Drawing RC 25M. Equip machine with guides to provide uniformity and consistency in alignment of each cut with respect to the roadway.

**(b) Milling Operation.** Construct shoulder rumble strips to have finished dimensions and tolerances as shown on the Standard Drawing RC-25M. Check and verify the alignment of pattern edge during the milling operation. Construct shoulder rumble strips on new concrete shoulders only after curing as specified in Section 501.3(l). Discontinue milling operations if satisfactory results are not being obtained, and submit an alternate construction plan for approval. At the end of each working day, move all equipment to a location designated by the Representative.

When constructing for ramps, extend the mainline shoulder rumble strip pattern to the nose of the gore. Provide shoulder rumble strips on the right and left sides of the ramps to tie into the mainline shoulder rumble strip pattern at the nose of the gore.

**(c) Disposal of Removed Material.** Remove and dispose of removed material in compliance with the DEP Residual Waste Regulations. Remove debris from areas disturbed by the milling operation before opening roadway to traffic.

**660.4 MEASUREMENT AND PAYMENT**—Measured longitudinally along edge of pavement. The unit prices include removal and disposal of removed material.

**(a) Concrete Shoulder Rumble Strips.** Meter (Linear Foot)

**(b) Bituminous Shoulder Rumble Strips.** Meter (Linear Foot)

# SECTION 663—BRICK MASONRY

**663.1 DESCRIPTION**—This work is construction of brick masonry.

**663.2 MATERIAL**—

- Brick—Section 713.1
- Mortar—Section 705.7(b)

**663.3 CONSTRUCTION**—

**(a) Excavation.** Excavate for masonry structure footer, as required, to form a compacted, firm, even foundation surface as specified in Section 204 for Class 3 excavation. Remove unsuitable material as specified in Section 203.1(b).

**(b) Footing.** Construct masonry structure footer as detailed and as specified in Section 1001 using Class A cement concrete as specified in Section 704.

**(c) Sample Panel.** Construct an on-site, sample, masonry panel approximately 1.2 m (4 feet) square, indicating the color range, texture, bonding pattern, mortar color, tooling, and workmanship of the proposed brick masonry structure. Obtain approval of the sample panel before erecting the brick masonry.

**(d) Placing Brick.** Lay brick with exposed surfaces true to line, in courses, in a full bed and head of mortar, and with joints not exceeding 10 mm (3/8 inch) in width. Do not furrow beds. Stagger head joints on adjoining courses one-half brick, as nearly as practicable. Make courses level, except as otherwise indicated or directed. Construct at least one course in every six entirely of headers, common bond, unless otherwise directed. Saturate bricks with water and ensure that bricks are surface dry before placement. Do not use broken or chipped brick in exposed faces. When making closures, do not use less than the width of a brick and lay whole brick, with the long side at right angle to the face.

**(e) Pointing.** Finish mortar joints with a concave pointing tool to a depth not exceeding 3 mm (1/8 inch) and to an approved appearance.

**(f) Curing and Protection.** Do not place mortar and bricks or point, in freezing weather, unless otherwise authorized in writing. Protect brickwork and other masonry from freezing until cured. Provide adequate protection from frost, and remove and replace work damaged by frost. Protect completed brickwork from the elements. Cure brickwork with water moisture for at least 3 days. Wet and clean the exposed brick faces with a 10% (by volume) solution of muriatic acid, applied with stiff fiber brushes.

**(g) Select Borrow Excavation (Structural Backfill).** Backfill as specified in Section 205.

**663.4 MEASUREMENT AND PAYMENT**—

**(a) Brick Masonry.** Cubic Meter (Cubic Yard)

**(b) Class A Cement Concrete.** Cubic Meter (Cubic Yard)

**(c) Excavation.** Cubic Meter (Cubic Yard)
For the class indicated.

# SECTION 664—MODULAR ARCHITECTURAL BLOCK SYSTEM

**664.1 DESCRIPTION**—This work is construction of a modular architectural block system. Modular architectural block systems may be used for nonstructural landscape architecture applications according to the manufacturer drawings and recommendations. An acceptable landscape architectural site cannot have structures with foundations above the aggregate base within 2.4 m (8 feet) of the back of the block system. System construction is restricted to a height of 1.2 m (4 feet) above grade.

**664.2 MATERIAL—**

**(a) Modular Architectural Blocks.** Certify as specified in Section 106.03(b)3, Section 713.2, and as follows:

Machine-made blocks uniform in color with a minimum compressive strength of 31 MPa (4,500 pounds per square inch) and an absorption of 6% or less, when tested according to ASTM C 140, and a minimum durability factor of 80 when tested according to ASTM C 666, Procedure A.

**(b) Geotextile.** Class 2, Type A, non-woven-heat-bonded as specified in Section 735.

**(c) Coarse Aggregate.** AASHTO 8 and Section 703.2(c)2.

**(d) Mortar.** Section 705.7(b)

**(e) Topsoil.** Section 802

**(f) Seeding and Soil Supplements.** Section 804

**(g) Rejection.** Blocks exhibiting any of the following conditions are not accepted:

- Defects that indicate imperfect proportioning, mixing, and molding;
- Non-uniform or contrasting coloration as determined by the Representative; or
- Surface defects, such as honeycombing or open texture, or areas damaged beyond satisfactory repair.

**664.3 CONSTRUCTION**—As indicated on the shop drawings and as follows:

Excavate and place geotextile, Class 2, Type A, non-woven-heat bonded, to the limits specified in Section 212.3(a) and (c). After placing the geotextile, construct a level 200 mm (8 inches) thick aggregate base according to the shop drawings. Ensure that each block course placed is level and aligned correctly with uniform staggered butt joints. Provide a block layout so as not to use any block smaller than half of a block in size. Clean the foreign material from the lower block course to ensure alignment and stability of the subsequent block course. Place the coarse aggregate backfill in 150 mm (6-inch) maximum lifts behind each block course against the geotextile before placing subsequent block courses. Use a vibratory plate to compact the course aggregate backfill before placing subsequent block courses. Wrap the geotextile material over the top of the coarse aggregate as indicated. Place the cap block course on a bed of mortar. Ensure butt joints in cap block course do not align with butt joints in preceding block course. Place topsoil and apply seeding and mulching using material and formula, at rates typical for the project. The contractor must be familiar with the placement of these block systems and certified by the block manufacturer. If not familiar with the block systems and certified by the manufacturer, provide an on-site trained technician from the block manufacturer, at no expense to the Department, during installation until the Representative is satisfied with workmanship.

**664.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot)

Measured to equal the area of the vertical face of the blocks, including vertical face concealed by finished grade. Excavation is incidental to this item.

# SECTION 667—CEMENT CONCRETE PAVING FOR STREAM BEDS

**667.1 DESCRIPTION**—This work is construction of reinforced cement concrete paving for stream beds.

**667.2 MATERIAL—**

- Class A Cement Concrete—Section 704
- Joint Sealing Material—Section 705.4(b) or (c)
- Premolded Expansion Joint Filler—Section 705.1
- Reinforcement—Sections 709.3 and 709.4
- Curing and Protecting Covers—Section 711.1
- Concrete Curing Compound—Section 711.2(a)

**667.3 CONSTRUCTION**—As shown on the Standard Drawings, as specified in the applicable parts of Section 1001.3, and as follows:

**(a) General.** Excavate the streambed to the required dimensions. Remove unsuitable material below the paving bottom and replace with acceptable material. Compact the entire foundation and finish to a firm, even surface. Protect paving portions under construction from the elements, flowing water, or other disturbances until curing is completed.

**(b) Reinforcement.** Place reinforcement, as indicated, and then hold firmly in position during the placing of concrete.

**(c) Joints.** Form or saw contraction joints 5 mm (3/16 inch) wide and 50 mm (2 inches) deep. Saw as soon as possible after the concrete sets sufficiently to preclude raveling during sawing and before any shrinkage cracking occurs in the concrete. The depth of the saw cut may be decreased at the edge adjacent to the pavement if required to obtain a maximum depth without pavement damage.

Tool the edges of construction joints to a 6 mm (1/4-inch) radius.

Place 13 mm (1/2-inch) premolded expansion joint filler, cut to conform to the cross-sectional area at not more than 30 m (100-foot) intervals, at the end of curve sections, at structures, and at the end of a day's work. Make the filler 13 mm (1/2 inch) less than the pavement depth.

Seal joints as specified in Section 501.3(n).

**667.4 MEASUREMENT AND PAYMENT—**

**(a) Cement Concrete Paving for Stream Beds.** Cubic Meter (Cubic Yard)

**(b) Excavation.** Cubic Meter (Cubic Yard)

For removal of unsuitable material of the same class of excavation for the ditch or channel above the paving.

# SECTION 673—PRECAST CEMENT CONCRETE BLOCK SLOPE WALL CAST-IN-PLACE CEMENT CONCRETE SLAB SLOPE WALL

**673.1 DESCRIPTION**—This work is construction of precast cement concrete block or cast-in-place cement concrete slab slope walls.

**673.2 MATERIAL—**

- Class A Cement Concrete—Section 704
- Reinforcement—Sections 709.1 and 709.3
- Precast Cement Concrete Blocks—Section 713.2(a)
- Fine Aggregate, Type A—Section 703.1
- Premolded Expansion Joint Filler—Section 705.1
- Joint Sealing Material—Section 705.4(b) or (c)
- Caulking Compound—Section 705.8
- Waterstops—Section 705.5(c)
- Water—Section 720.2
- Mortar—Section 705.7(b)
- Concrete Curing Compound—Section 711.2(a)
- Curing and Protecting Covers—Section 711.1
- Geotextiles, Class 2, Type B—Section 735

**673.3 CONSTRUCTION**—As indicated, as shown on the Standard Drawings, and as follows:

**(a) Precast Cement Concrete Block.** Place Geotextiles, Class 2, Type B, as specified in Section 212.3(c). After placing the geotextiles, carefully spread and shape the sand on the graded area.

Except for cutoff walls, lay the concrete blocks with long dimensions parallel to the toe wall, bedded with 10 mm (3/8-inch) joints, staggered, and spaced as indicated. Straighten the courses by striking lightly with a sledgehammer against a suitable wood block placed against every fourth row. Maintain the specified gap between the blocks. Do not use cracked or defective blocks.

Roll or tamp the blocks to a firm, uniform elevation. Wet the joints with as much water as will be readily absorbed. Fill joints with mortar. Use mortar of as dry a consistency as practical and fill joints flush with the top surface of adjacent blocks. Strike off the mortar to form a smooth joint between the blocks. Pointing is not required. If the bond has breaks around a block, remove the block, along with the mortar from the joint, then clean and reset with fresh mortar as specified.

**(b) Cast-In-Place Cement Concrete Slab.** Place the concrete directly on the prepared graded area, without placing a sand bed. Construct the slabs of Class A Cement Concrete, 100 mm (4 inches) in depth, and of uniform dimension not over 5.0 m (16 feet) in length or width, unless otherwise directed for closures.

Place indicated reinforcement midway between the top and bottom of the slabs. Score the slabs to a minimum depth of 15 mm (1/2 inch) in 1.2 m (4-foot) squares, or as directed. Place 13 mm (1/2-inch) thick, premolded expansion joint filler, for the full depth, between adjacent slabs and at contact points between slabs and structures.

Construct a cutoff wall 150 mm (6 inches) wide and 400 mm (16 inches) deep, monolithically with the slabs, at each end of the slope paving. Construct toe walls to the dimensions indicated. Use Class A Cement Concrete for toe and cutoff walls. Finish and cure the concrete as specified in the applicable requirements of Sections 501.3(j) and (k). Seal the joints as specified in Section 501.3(n).

**673.4 MEASUREMENT AND PAYMENT—**

**(a) Precast Cement Concrete Block Slope Wall.** Square Meter (Square Yard)

**(b) Cast-In-Place Cement Concrete Slab Slope Wall.** Square Meter (Square Yard)

# SECTION 674—STONE SLOPE WALLS

**674.1 DESCRIPTION**—This work is construction of plain or mortared stone slope walls.

**674.2 MATERIAL**—

**(a) Stone.** Use stones of acceptable quality, sound and free from structural defects and foreign substances. Submit samples to the MTD for petrographic examination before use, unless the rock comes from material providing an approved Type A aggregate. Use stones at least 80 mm (3 inches) thick, of a length at least three times the thickness, and of a width at least equal to the depth of the slope wall from the exposed surface of the slope wall to the subgrade, except for spalls for packing voids. For stones in excess of 150 mm (6 inches) thick, use stones at least twice as long as their thickness.

**(b) Other Material.**

- Class A Cement Concrete—Section 704
- Premolded Expansion Joint Filler—Section 705.1
- Mortar—Section 705.7(b), except use Type C, fine aggregate.
- Filler—Acceptable coarse sand, gravel, or other material.
- Geotextiles, Class 2, Type B—Section 735

**674.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Plain Stone Slope Wall.** Place geotextiles, Class 2, Type B, as specified in Section 212.3(c). After placing geotextiles, set stones by hand and firmly bed on the prepared graded area, with the length dimension approximately parallel to the toe wall foundation. Bed stones one against the other with ends and sides in contact, then break joints. Lay the stones flat in toe wall and cutoff wall areas. Set the stones on edge in anchor wall areas and on sloped areas.

Pack spaces between the larger stones with spalls, then ram into place. Tamp the whole area of the wall to a tight, even surface. Fill voids by sweeping filler over the surface.

**(b) Mortared Stone Slope Wall.** Set the stones as specified in Section 674.3(a). Fill the voids with mortar and spalls, as required, to within 15 mm (1/2 inch) of the surface of the adjacent stone. Use mortar with a stiff but workable consistency. Pointing is not required. Do not hammer, roll, or ram the stones after mortaring. If the bond around stones becomes broken, remove stones and mortar, reset the stones, and fill the voids with mortar, as specified.

Do not place mortar in freezing weather, unless permitted in writing, and then only with adequate protection.

Remove and replace work damaged by frost. Protect completed wall from the elements and cure with water for a period of at least 3 days.

**(c) Toe Walls, Cutoff Walls, and Anchor Walls.** Construct concrete toe, anchor, and cutoff walls as indicated and as specified in the applicable parts of Section 1001.3. Obtain approval.

**674.4 MEASUREMENT AND PAYMENT—**

**(a) Plain Stone Slope Wall.** Cubic Meter (Cubic Yard)

**(b) Mortared Stone Slope Wall.** Cubic Meter (Cubic Yard)

# SECTION 675—RANDOM STONE SLOPE WALL

**675.1 DESCRIPTION**—This work is construction of random stone slope walls.

**675.2 MATERIAL**—

- Coarse Aggregate, Type A, No. 1 Stone—Section 703.2
- Class A Cement Concrete—Section 704
- Premolded Expansion Joint Filler—Section 705.1
- Joint Sealing Material—Section 705.4(b) or (c)
- Geotextiles, Class 2, Type B—Section 735

**675.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Construct concrete toe, anchor, and cutoff walls as specified in Section 1001.3. Where the wall butts another rigid concrete structure, place a 13 mm (1/2-inch) premolded, expansion joint filler. Seal the top 15 mm (1/2 inch) of the joint with joint sealing material.

Place rock and geotextiles as specified in Section 850.3.

Spot-check the finished surface with a string line. Fill depressions and cut high areas greater than 50 mm (2 inches) as required.

**675.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

The Department will measure to include toe, anchor, and cutoff walls.

# SECTION 676—CEMENT CONCRETE SIDEWALKS

**676.1 DESCRIPTION**—This work is construction of cement concrete sidewalks on an aggregate bed.

**676.2 MATERIAL—**

- Class A Cement Concrete—Section 704
- Aggregate—Section 350.2
- Premolded Expansion Joint Filler—Section 705.1
- Concrete Curing Compound—Section 711.2(a)
- Curing and Protecting Covers—Section 711.1
- Mortar—Section 1001.2(d)
- Joint Sealing Material—Section 705.4 (a), (b), or (c)

**676.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Preparation of Foundation.** Excavate, as required, and form the foundation at a depth 250 mm (10 inches) parallel with the finished surface of the sidewalk. If directed, remove unsuitable material as specified in Section 203.1(b). Thoroughly compact the foundation, finish to a firm, even surface; moisten if required.

**(b) Placing Aggregate for Bed.** Spread aggregate on the prepared foundation to form a thoroughly compacted bed 150 mm (6 inches) deep.

**(c) Forms.** Use acceptable wood or metal forms that extend the full depth of the concrete.

**(d) Concrete.** As specified in Section 1001.3.

Place concrete 100 mm (4 inches) deep. Strike off, finish, and test, as specified in Sections 501.3(k) and (p), except that manual operations are allowed and a light broom finish applied.

Form outside edges and joints with a 6 mm (1/4-inch) radius-edging tool.

Form transverse dummy joints at 1.5 m (5-foot) intervals, approximately 3 mm (1/8 inch) wide, and at least 25 mm (1 inch) deep.

If required, construct cement concrete sidewalk as indicated for curb ramp. Finish cement concrete sidewalk with a coarse broomed texture transverse to the slope of the curb ramp. Transverse dummy joints are not required for curb ramps.

**(e) Expansion Joints.** Place 13 mm (1/2-inch) premolded, expansion joint material for the full depth of the sidewalk, opposite expansion joints in adjacent curb, between the sidewalk and curb, and between the sidewalk and rigid structures.

**1. Seal Joints.** Clean joints of all scale, dirt, curing compound, and other foreign material with a mechanized wire brush.

Do not place poured joint-sealing material if the air temperature is less than 5 °C (40F), unless permitted. Use heating equipment of an indirect heating type, constructed as a double boiler. Provide positive temperature control and mechanical agitation. Obtain the safe heating temperature and recommended pouring temperature from the manufacturer's shipping container. Place the material within this temperature range, but as close as possible to the recommended pouring temperature. Maintain a safe heating temperature. Maintain a single material batch at the pouring temperature for no more than 4 hours. Heat the material only once.

Fill the joint reservoir, created by the cleaning operation, with sealing material to a depth 4 mm (1/8 inch) below the top of sidewalk. Do not allow sealing material to spread over concrete surfaces.

**(f) Removal of Forms.** Do not remove side forms until at least 12 hours after placing concrete. After removal of forms, fill minor honeycombed areas with mortar. As directed, remove and replace defective major honeycombed areas.

**(g) Backfilling.** After the concrete has cured for at least 72 hours, backfill spaces adjacent to the sidewalk, using acceptable embankment material, as specified in Section 206.3(b)4.

Repair or replace existing pavement, curb, and sidewalk damaged due to construction. Satisfactorily dispose of unsuitable and surplus materials.

## 676.4 MEASUREMENT AND PAYMENT—

**(a) Cement Concrete Sidewalks.** Square Meter (Square Yard)

**(b) Class 1A Excavation.** Cubic Meter (Cubic Yard)

# SECTION 677—SELECTED MATERIAL SURFACING

**677.1 DESCRIPTION**—This work is the furnishing and placing of selected material on a prepared area.

**677.2 MATERIAL**—Section 703.3

**677.3 CONSTRUCTION**—Uniformly spread aggregate upon the prepared areas, in loose layers not exceeding 130 mm (5 inches) in depth, without segregation of coarse and fine material. Compact with a roller as specified in Section 108.05(c)3.a or 3.b.

Satisfactory compaction will be determined by the stability of the material under the specified compaction equipment. If material used does not contain sufficient fines to properly lock under the roller, add additional fines of the same material, or limestone fines, as necessary, to obtain the compaction and stability.

**677.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard) or Tonne (Ton)

# SECTION 678—PERMANENT BARRICADES

**678.1 DESCRIPTION**—This work is construction of permanent barricades.

**678.2 MATERIAL**—As shown on the Standard Drawings and as follows:

**(a) Posts.**

**1. Wood Posts.** No. 1 stress-rated Southern Pine; No. 1 Douglas Fir; Larch; select, structural Hem-Fir; Mountain Hemlock; Western Hemlock; or sound square edge Red Oaks; seasoned before treatment as required by AWPA or AWPB Standards; and pressure treated according to AWPA and AWPB Standards and as follows:

| Treatment | Retention |
|---|---|
| **(Species except Red Oaks)** | **(kg/m$^3$)** |
| Ammoniacal Copper Arsenite (ACA) | 10 |
| Pentachlorophenol | 10 |
| Chromated Copper Arsenate (CCA) Types A, B, or C | 10 |
| **(Red Oaks)** | |
| Pentachlorophenol | 5 |

| Treatment | Retention |
|---|---|
| **(Species except Red Oaks)** | **(pounds per cubic foot)** |
| Ammoniacal Copper Arsenite (ACA) | 0.60 |
| Pentachlorophenol | 0.60 |
| Chromated Copper Arsenate (CCA) Types A, B, or C | 0.60 |
| **(Red Oaks)** | |
| Pentachlorophenol | 0.30 |

Certify as specified in Section 106.03(b)3.

A tolerance of 15 mm (1/2 inch) scant from nominal dimensions is required for the size of posts.

Do not use posts that, for any reason, prevent attachment of guide rail fittings or alignment with other posts.

Throughout the project, use posts treated with the same type of preservative.

**2. Steel Posts.** Section 1109

**(b) Wood Planks.** Seasoned No. 1, structural grade, Long Leaf Yellow Pine; or select, structural grade, Douglas Fir; pressure treated as specified. Certify as specified in Section 106.03(b)3.

**(c) Class A Cement Concrete.** Section 704

**(d) Extruded Aluminum Channel.** Section 1103.02(a). The Contractor may use an alternate channel section, of equal or greater section modulus, with suitable dimensions to utilize the mounting hardware. Certify as specified in Section 106.03(b)3.

**(e) Aluminum Blanks (for Wood Barricade Panels).** Section 1103.04(a), Alloy 6061-T6. Certify as specified in Section 106.03(b)3.

**(f) Reflective Sheeting.** Section 1103.04(c), Type III or Type IV. Certify as specified in Section 106.03(b)3.

**(g) Miscellaneous Material.**

- Aluminum Hardware Items—Section 1103.11
- Aluminum Round Head Wood or Lag Screws—Section 1103.11
- Other Hardware Items—Section 1109.05

**(h) Extruded Aluminum Channel and Aluminum Blank Preparation.** Section 1103.02(b)

**678.3 CONSTRUCTION**—As shown on the Standard Drawings, using either aluminum channels or wood planks with wood or steel posts.

Apply the reflective sheeting to the aluminum channels as specified in Section 1103.02(c) or to the aluminum blank as specified in Section 1103.03(b).

The post spacing may vary to a maximum of 3 m (10 feet) center-to-center. Mechanically drive posts or erect in concrete footings.

Cut and peen bolts against the faces of nuts.

After erection, treat galvanized components, including the cut ends of bolts, that are abraded or damaged as specified in Section 620.3(a)1.

**678.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 679—SLAB STABILIZATION

**679.1 DESCRIPTION**—This work is the filling of voids beneath existing rigid base courses or pavements at locations as directed.

**679.2 MATERIAL—**

**(a) Cement.** Section 701

**(b) Water.** Section 720.1

**(c) Admixtures.** Section 711.3
A multiphase wetting agent and an expansive agent may be used. Use an accelerator if required.

**(d) Pozzolan.** Section 724.2

**(e) Rapid Set Concrete Patching Materials.** Supplied by a manufacturer listed in Bulletin 15. Use within the shelf life and temperature limitations set by the manufacturer.

**(f) Mix Design.** Submit a mix design to the District Executive for review and acceptance before starting work. Include with the submittal: independent laboratory testing showing 1, 3, and 7-day compressive strengths; flowability; shrinkage and expansion results; and the time of initial set. Proportion the mix as follows:

One part cement (by volume)
Three parts pozzolan (by volume)
Admixtures—if required and accepted
Water—an amount such that the time of efflux is within 10 seconds to 15 seconds (ASTM C 939)

Furnish mix with an expansion of 0% to 10% (ASTM C 940), an initial setting time of 1 hour to 6 hours (AASHTO T 131) and bleeds no more than 2.5% of the volume (ASTM C 940).

A 7-day compressive strength of 4.8 MPa (700 pounds per square inch) minimum is required, based on the average of five test cylinders (PTM No. 521).

Submit a new mix design if the source of any material is changed.

**679.3 CONSTRUCTION—**

**(a) General.** Do begin this work until it is satisfactorily shown that qualified personnel, with successful experience, are available at the job.

Do not perform work if daytime temperatures are below 2 °C (35F) or if the subgrade and/or base course material is frozen.

**(b) Deflection Testing.** If no preliminary testing was performed, test each joint and crack as directed, and as follows:

Do not perform testing if air temperature exceeds 21 °C (70F). Do not test during spring thaw conditions or if subgrade is frozen.

Furnish and maintain four gauges capable of detecting slab movement to within 0.03 mm (0.001 inch). Use approved gauge mounts. Furnish and maintain a vehicle having a dual-tire single axle with an 80 kN (18,000-pound) single axle load. Verify by measuring the force of gravity upon a certified scale.

Position two gauges as shown on the Standard Drawings. Zero both gauges to the pavement surface with no force on the slab on both sides of the joint or crack.

Slowly move the test vehicle into position and stop when the test axle is in the position shown on the Standard Drawings for the loaded approach slab condition. Read both gauges and record the results.

Move the test vehicle slowly across the joint and stop it in the position shown on the Standard Drawings for the loaded leave slab condition. Read both gauges and record the results.

Repeat this procedure at every transverse joint and crack.

Stabilize all joints or cracks that have a loaded slab corner deflection of 0.5 mm (0.020 inch) or more, and a joint efficiency at 65%* or more.

Patch and stabilize all joints or cracks that have a loaded slab corner deflection of 0.5 mm (0.020 inch) or more, and a joint efficiency of less than 65%.

Joint efficiency (JE) is defined as follows:

$$JE = \frac{\text{Unloaded Slab Corner Deflection}}{\text{Loaded Slab Corner Deflection}} \times 100$$

* Use the highest Loaded Slab Corner Deflection and the lowest joint efficiency at each joint or crack.

**(c) Equipment.**

**1. Grout Plant.** Provide a satisfactory positive displacement cement injection pump and a satisfactory mixing machine, capable of operating at a minimum speed of 800 rpm and a maximum speed of 2000 rpm.

**2. Water Tanker.** Supply water from a water truck with adequate capacity and pressure for delivery to the grout machine.

**3. Drill.** Provide generator, core drill, and diamond-tip core barrels, or other satisfactory equipment capable of drilling the grout injection holes through the pavement and base material; and equipment in satisfactory condition and operated to produce holes that are smooth, vertical, and do not break out the bottom of the slab.

**4. Vertical Movement Testing.** Supply satisfactory equipment to measure slab lift, capable of detecting simultaneously the lift of the pavement edge, or of any two outside slab corners adjacent to a joint and the adjoining shoulder. Use equipment with a capability of making these measurements to within 0.03 mm (0.001 inch).

**5. Miscellaneous.** Provide necessary hoses, valving, and valve manifolds with positive cutoff and bypass provisions to control pressure and volume, pressure gauges with gauge protectors, expanding packers or hose for positive seal during grout injection, hole washing tools, drill steel, bits, and any other miscellaneous tools required.

**(d) Procedure.**

**1. Drilling Holes.** Drill grout injection holes in the pattern shown on the Standard Drawings, or as directed. Drill holes not larger than 38 mm (1 1/2 inches) in diameter, vertical and round, and to a depth sufficient to penetrate any stabilized base.

**2. Mixing.** Accurately measure the dry materials by mass, if in bulk, or provide them packaged in uniform volume sacks. Batch with water through a meter or scale that totals the day's consumption.

Do not hold mixed material in the mixer or injection pump sump for more than one hour after mixing. Dispose of material held for longer times.

Make flowability measurements at least two times during each work shift.

**3. Void Filling.** During the filling operation, use a positive means of monitoring lift as specified in Section 679.3(c)4. Upward movement of the pavement greater than 1.3 mm (0.05 inch) will not be allowed. Lower an expanding rubber packer or hose, connected to the discharge from the pump, into the hole. Do not extend the discharge end of the packer or hose below the lower surface of the concrete pavement. Pump each hole until maximum pressure is built up or material is observed flowing from hole to hole. Do not exceed a maximum pressure of 1.4 MPa (200 pounds per square inch), unless otherwise directed. Monitor the pressure in the grout line. Protect the gauge from the grout slurry. Allow the water, displaced from the void structure by the grout, to flow out freely. Excessive loss of the grout through the cracks, joints, or from back pressure in the hose or in the shoulder area will not be allowed.

**4. Correcting Panel Displacement.** Grind pavement, raised in excess of the 1.3 mm (0.05-inch) allowable tolerance, to the correct grade. Grind as specified in Section 514.3, except grind into the high slab.

**5. Radial Cracks.** Radial cracks spreading outward from the grout injection holes indicate poor quality or improper methods. Stop work until the cause is determined and corrected.

**6. Transverse Cracks.** If transverse cracks develop between adjacent grout injection holes, replace the entire slab at no cost to the Department.

**7. Hole Patching.** Upon completion of the work, patch drill holes full depth with a rapid set, non-shrink concrete patching material. Strike patches flush with the surface of the surrounding pavement.

**(e) Retesting.** Twenty-four hours after grouting and before acceptance, retest each stabilized joint or crack as specified in Section 679.3(b). Regrout slabs that deflect 0.5 mm (0.020 inch) or more and retest. The Representative may accept any slab that continues to show movement, in excess of that specified, after two properly performed groutings; or direct the removal and replacement, with a full depth concrete patch, as specified in Section 516 and paid for separately.

**(f) Opening to Traffic.** Do not open to traffic for a minimum of 12 hours after grouting operations have been completed.

## 679.4 MEASUREMENT AND PAYMENT—

**(a) Deflection Test.** Each

**(b) Holes Drilled.** Each
The price includes patching of the hole.

**(c) Grout Material.** Kilograms of Cement (Bags of Cement)
The unit price includes an accelerator, if required. For each 1.5 m (5 linear feet) of radial cracking, as specified in Section 679.3(d)5, the Department will reduce this pay item by 42.6 kg (one bag) of cement. The Department will not pay for any wasted grout material.

# SECTION 680—WATERPROOFING

**680.1 DESCRIPTION**—This work is the furnishing and placing of adhesive preformed membrane waterproofing systems to concrete or other surfaces as indicated.

**680.2 MATERIAL**—Unless specified or shown on the plans, select from the waterproofing systems listed in Bulletin 15.

**(a) Adhesives, Conditioners, Primers, Mastics, Two-Part Liquid Urethane Membranes and Sealing Tapes.** As recommended for use with the respective preformed membrane sheet materials. Contact the membrane manufacturer or its representative for instructions.

**(b) Adhesive-Backed Preformed Membrane Sheet.** Furnish Adhesive-Backed Preformed Membrane Sheet consisting of a sheet of rubberized asphalt or polymer modified bitumen permanently applied to a polyethylene film, or reinforced with a stitch-bonded polyester/polypropylene fabric, or reinforced with a fiberglass mesh and conforming to the minimum requirements specified in Table A.

**(c) Protective Covers.** Provide a 3.0 mm (1/8-inch) thick, asphalt protective board or 26.5 kg (65-pound) roofing material without mica coating, or approved equal that furnishes equivalent protection to the membrane from being cut, scratched, or otherwise damaged from the backfill or equipment.

For bridge deck surfaces, the bituminous overlay is the protective cover.

**(d) Bonding Material.** Section 460 and as recommended by the manufacturer.

**(e) Manufacturer Technical Representative.** Ensure that a trained Manufacturer's Technical Representative is present during every phase of application, unless applied by a factory trained licensed installer, as indicated by written approval from the material supplier. The Manufacturer's Technical Representative will provide training and technical assistance on surface preparation, equipment, mixing of components, type, and method of application, and finish.

**(f) Certification.** Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the membranes or containers with the manufacturer's name, membrane trade name, lot number, and material quantity.

**TABLE A (Metric)**
**Adhesive-Backed Preformed Membrane Sheet Minimum Requirements**

| Preformed Membrane Sheets | | For Bridge Deck Surfaces | | For Surfaces Other Than Bridge Decks | |
|---|---|---|---|---|---|
| **Property** | **Test** | **Rubberized Asphalt Type** | **Modified Bitumen Type** | **Rubberized Asphalt Type** | **Modified Bitumen Type** |
| Tensile Strength, N/mm (minimum)(1)(3) | ASTM D 882 (2) | 8.8 | 7.0 | 3.5 | 3.5 |
| % Elongation at Break, (min) (3)(4) | ASTM D 882 (2) | 15 | 10 | 25 | 25 |
| Pliability | ASTM D 146 (5) | No cracks | No cracks | No cracks | No cracks |
| Thickness, mm (minimum)(6) | ASTM D 1000 | Polyethylene Film Backed—1.5 Fabric Reinforced Backed—1.7 | 1.8 | 1.5 | 1.5 |
| Softening Point, °C (minimum) | ASTM D 36 | 87.8 | 98.9 | 87.8 | 98.9 |
| Permeance, kg/(Pa·s·$m^2$) (maximum) | ASTM E 96, Method B | 5.74 E-12 | 5.74 E-12 | 5.74 E-12 | 5.74 E-12 |
| Puncture Resistance, N (min) | ASTM E 154 | 110 | 110 | 178 | 178 |

Notes:
(1) Breaking factor in machine direction.
(2) Method A, 25 mm wide strip with 100 mm minimum initial separation and 100 mm gage length at 50 mm per minute. Average 5 samples.
(3) At 23.0 °C ± 2.0 °C.
(4) Machine direction.
(5) 180-degree bend over a 25 mm mandrel at -26°C.
(6) Total thickness of preformed membrane sheet and polyethylene film or fabric reinforcement.

**TABLE A (English)**
**Adhesive-Backed Preformed Membrane Sheet Minimum Requirements**

| Preformed Membrane Sheets | | For Bridge Deck Surfaces | | For Surfaces Other Than Bridge Decks | |
|---|---|---|---|---|---|
| **Property** | **Test** | **Rubberized Asphalt Type** | **Modified Bitumen Type** | **Rubberized Asphalt Type** | **Modified Bitumen Type** |
| Tensile Strength, lbs/in (minimum)(1)(3) | ASTM D 882 (2) | 50 | 40 | 20 | 20 |
| % Elongation at Break, (min) (3)(4) | ASTM D 882 (2) | 15 | 10 | 25 | 25 |
| Pliability | ASTM D 146 (5) | No cracks | No cracks | No cracks | No cracks |
| Thickness, mils (minimum)(6) | ASTM D 1000 | Polyethylene Film Backed—60 Fabric Reinforced Backed—65 | 70 | 60 | 60 |
| Softening Point, F (minimum) | ASTM D 36 | 190 | 210 | 190 | 210 |
| Permeance, perms (maximum) | ASTM E 96, Method B | 0.1 | 0.1 | 0.1 | 0.1 |
| Puncture Resistance, lbs. (min) | ASTM E 154 | 25 | 25 | 40 | 40 |

Notes:
(1) Breaking factor in machine direction.
(2) Method A, 1-inch wide strip with 4-inch minimum initial separation and 4-inch gage length at 2 inches per minute. Average 5 samples.
(3) At 73.4F ± 3.6F.
(4) Machine direction.
(5) 180-degree bend over a 1-inch mandrel at -15F.
(6) Total thickness of preformed membrane sheet and polyethylene film or fabric reinforcement.

## 680.3 CONSTRUCTION—

**(a) Limitation of Operations.** Apply waterproofing only if protective covering or bituminous overlay can also be placed within a time that ensures that the membrane will not be damaged by personnel, equipment, exposure to weathering, or from any other cause.

Do not install any part of a waterproofing system in wet, humid, or foggy weather conditions, or if the ambient or concrete surface temperature is below 10 °C (50F), unless recommended by the manufacturer and authorized in writing by the Representative. Apply the primer and waterproofing membrane only when the concrete surfaces are completely dry.

**(b) Surface Preparation.** Prepare the surface to be waterproofed to a condition free from holes or projections that might puncture or otherwise damage the membrane. Round (outside) or chamfer (inside) all sharp corners to be covered.

Thoroughly clean all concrete surfaces that are to be waterproofed. Remove any excess laitance, oil, concrete curing compounds, previous membrane treatments, and other foreign materials by sandblasting. Remove all dirt, dust, loose or unsound concrete, and other extraneous material by vacuuming or blowing with compressed air.

Use a scratch coat of asphalt as a leveling course on decks that have been milled and lack a surface that is acceptable to receive a membrane system. Asphalt paving less than one year old does not require a primer or surface conditioner to achieve proper membrane adhesion.

**(c) Applying Conditioners and Primers.** Thoroughly mix and continuously agitate all primers and conditioners during application according to the manufacturer's instructions. Uniformly apply primer or conditioner to the entire area to be sealed, at the rate stated in the manufacturer's instructions, by squeegee, brush, or roller. Do not apply the primer by spraying. Apply a second coat of primer to any areas of concrete that appear dry. Brush out primer that tends to puddle in low spots to allow complete drying. Cure the primer according to the manufacturer's instructions. Do not let primed areas stand uncovered overnight.

After the primer has dried to a tack free condition, use squeegees or brooms to break any bubbles in the primer. Unless otherwise directed, do not repair the areas where bubbles were broken. If membrane sheets are not placed over primer or conditioner within the time recommended by the manufacturer, recoat the surfaces at no additional cost to the Department.

Before applying the primer or conditioner on a bridge deck, place an oil resistant protective film, held with an adhesive or tape, to any deck areas that will later be covered by expansion dams or headers. Place membrane seal and asphalt concrete across the protective film. If directed, cut the protective film and the preformed sheet at or near the expansion joint.

**(d) Adhesive-Backed Preformed Membrane Waterproofing Systems.**

**1. Installation on Bridge Decks.** Before installing any membrane waterproofing systems, drill drain holes, install the drain pipes and galvanized screens as shown on the Standard Drawings.

Apply the preformed membrane sheets, adhesive side down, to the primed or conditioned surfaces either by hand methods or by mechanical applicators. Start placing the membrane sheets at the low side of the deck and work using a shingle overlap toward the high side of the deck so that a shingled effect is achieved in the direction that the water will drain.

Use either of the two acceptable methods indicated if working from a curb line or barrier railing.

METHOD ONE: As shown on the Standard Drawings and as follows:

Install a 19 mm x 19 mm (3/4-inch by 3/4-inch) cant strip made of wood, metal, plastic, mastic, or other approved joint sealing material at a 90 degree angle between the curb face or barrier railing and the deck. Next, install a 300 mm (12-inch) wide curb strip with the top edge of the strip kept a minimum of 13 mm (1/2 inch) below the wearing surface of the asphalt overlay. Put the 300 mm (12-inch) wide curb strip into positive contact with the curb face, cant strip and bridge deck. Seal the curb strip at the top edge with a two-part urethane liquid membrane or mastic. Overlap the curb strip that extends onto the deck with the next full width membrane sheet by butting the sheet against the curb face at the gutter line. Lay subsequent membrane sheets longitudinally with 75 mm (3-inch) minimum side laps and 150 mm (6-inch) minimum end laps. Install sheets across the deck until the high side curb line is reached. Install a curb strip along the high side curb line as indicated for the low side curb line.

METHOD TWO: Apply a bead of two-part urethane liquid membrane or mastic, as recommended by the manufacturer, between the low side curb face or barrier railing and the deck, extending from the gutter line 50 mm to 75 mm (2 inches to 3 inches) onto the deck. Butt the edge of the membrane firmly against the curb face at the gutter line and embed into the liquid membrane or mastic. Seal the top edge of the membrane at the curb face with a 50 mm (2-inch) bead of liquid membrane or mastic. Lay subsequent membrane sheets longitudinally and side lap with the adjacent sheets not less than 75 mm (3 inches) and end lap by not less than 150 mm (6 inches). Install sheets across the deck until the high side curb line is reached. Terminate the membrane sheet against the high side curb face. Place a bead of liquid membrane or mastic between the high side curb face and deck. Butt the membrane against the curb face along the gutter line and embed into the bead of liquid membrane or mastic. Seal the top edge of the membrane along the gutter line with a 50 mm (2-inch) bead of liquid membrane or mastic.

After placement, roll the membrane sheets with hand rollers or other apparatus as necessary to develop a firm and uniform bond with the primed or conditioned concrete surfaces. Seal with mastic any laps that were not thoroughly sealed by rolling.

Use procedures that minimize wrinkles and air bubbles. Patch any tears, cuts, or narrow overlaps, using a satisfactory adhesive and by placing sections of membrane sheet over the defective area in a manner that the patch extends at least 150 mm (6 inches) in every direction beyond the edges of the defect. Vent bubbles of 25 mm (1-inch) diameter and larger by piercing with a suitable instrument at a nearly horizontal angle and expel the trapped air. Coat vented bubbles with mastic sealer.

Lay the bituminous overlay the same day as the membrane. If overnight delay is unavoidable, keep the construction traffic off the membrane and make a careful inspection for punctures before placing the bituminous overlay. Provide the bituminous overlay at a mix temperature between 149 °C and 171 °C (300F and 340F). Rubber tired pavers and trucks may be driven on the membrane provided care is taken to prevent sudden starts and stops. Do not allow trucks to turn their front wheels while standing still.

**2. Installation of Other Surfaces.** Install as shown on the Standard Drawings, and as specified in Section 680.3(b) and as follows:

On vertical surfaces, place preformed membrane material with each successive horizontal sheet lapped top over bottom to the preceding by a minimum of 75 mm (3 inches). Lap horizontal splices by a minimum of 150 mm (6 inches). Seal the exposed edges of membrane sheets after the membrane is placed with a troweled bead of a manufacturer's recommended mastic, or two-part urethane liquid membrane, or with sealing tape.

Provide watertight construction by flashing all projecting pipes, conduits, sleeves, or other facilities passing through the preformed membrane waterproofing with prefabricated or field fabricated boots, fitted coverings, or other approved devices as necessary.

Install protective covers after the application of waterproofing membrane. Apply bonding material, of a type recommended by the waterproofing manufacturer to the surface of the membrane and adjacent concrete surface at a rate, approximately 0.23 $L/m^2$ (0.05 gallon per square yard), sufficient to hold the protective covering in position until the backfill is placed. Allow the bonding material to dry until tacky. Place the sheets of protective board or roofing material on the bonding material with edges or ends of the boards either loosely butt-jointed or overlapped.

**(e) Nonstandard Applications.** For areas not covered in this specification regarding special application techniques of the waterproofing materials, or regarding special application restrictions, follow the manufacturer's recommendations.

**(f) Defective Work.** Before placing backfill, structural backfill, subbase, or bituminous material, repair or replace damaged membranes or protective coverings according to the manufacturer's recommendations at no additional expense to the Department.

## 680.4 MEASUREMENT AND PAYMENT—

**(a) Membrane Waterproofing Systems Installed on Bridge Deck.** Square Meter (Square Yard)

**(b) Membrane Waterproofing Systems Installed on Other Surfaces.** Square Meter (Square Yard)

# SECTION 681—SLABJACKING

**681.1 DESCRIPTION**—This work is filling voids beneath existing rigid base courses or pavements and pressure-jacking the pavement or base course to grade with cement grout.

**681.2 MATERIALS**—Section 679.2, modified as follows:

**(f) Mix Design.**

One part cement (by volume)
Three parts pozzolan (by volume)
Admixtures—if required and accepted
Water—an amount such that the time of efflux is within 16 seconds to 26 seconds (ASTM C 939). A more fluid mix with an efflux time of 10 seconds to 15 seconds may be used for the initial injection in each hole.
Use a stiffer mix, if the above mix fails to raise the pavement slab.

**681.3 CONSTRUCTION**—

**(a) General.** Section 679.3(a)

**(b) Equipment.**

**1. Grout Plant.** Section 679.3(c)1

**2. Water Tanker.** Section 679.3(c)2

**3. Drill.** Section 679.3(c)3

**4. Miscellaneous.** Section 679.3(c)5

**(c) Slabjacking.**

**1. Drilling Holes.** Section 679.3(d)1, except penetration of the stabilized base may not be necessary.

**2. Mixing.** Section 679.3(d)2

**3. Jacking.** Connect an expanding rubber packer to the discharge hose on the grout pump and lower into the holes. Do not extend the discharge end of the packer below the lower surface of the concrete pavement. If jacking continuously reinforced concrete pavement, pump in a pattern and in the amount required to raise the pavement to within 6 mm (0.02 foot), plus or minus, from a string line grade, or as directed. If jacking jointed slabs of concrete pavement and bridge end slabs, pump in a pattern and in the amount required to raise the pavement to within 9 mm (0.03 foot), plus or minus, from a string line grade, or as directed.

Continuous pressures to 1.4 MPa (200 pounds per square inch) will be allowed. Pressure to 2.0 MPa (300 pounds per square inch) will be allowed only for short periods, except in the event the pavement is bonded to the subgrade, brief pressure rises to 4.0 MPa (600 pounds per square inch) will be allowed.

**4. Overjacking.** Bring pavement, raised above the tolerances listed above, to grade by grinding. If the overjacking is greater than 30 mm (0.10 foot), satisfactorily remove and replace the pavement in as specified in Section 501 at no cost to the Department.

**5. Radial Cracks.** Section 679.3(d)5

**6. Transverse Cracks.** Section 679.3(d)6

**7. Hole Patching.** Section 679.3(d)7

**681.4 MEASUREMENT AND PAYMENT—**

**(a) Holes Drilled.** Section 679.4(b)

**(b) Grout Material.** Section 679.4(c)

# SECTION 686—CONSTRUCTION SURVEYING

**686.1 DESCRIPTION**—This work is construction surveying for roadways, roadway appurtenances, and structures. This work is to preserve vertical and horizontal controls, and stationing throughout the construction phase up to and including final inspection, and to provide the Department inspection force with surveying control points to ensure quality of construction activities.

Construction surveying is classified into six types as follows:

**(a) Construction Surveying, Type A.** Surveying for new construction based on precise horizontal and vertical geometry established from surveys and 1:250 (25) scale or 1:500 (50) scale topographic mapping referenced to the National Geodetic Reference System/Pennsylvania State Plane Coordinate System.

**(b) Construction Surveying, Type B.** Surveying for reconstruction with the alignment based on, or related to, as-built plan horizontal and vertical geometry, or horizontal and vertical geometry produced on the existing roadway with minimal realignment. The planimetric features and cross sections may have been developed from mapping or by electronic surveying.

**(c) Construction Surveying, Type B Modified.** Surveying for reconstruction, the alignment may have been based on various alignment data such as:

- As built plan horizontal geometry, horizontal geometry, produced on the existing roadway;
- Random traverse baseline;
- Flatchain alignment along the center of the existing roadway; or
- A combination of horizontal geometry, random traverse base line, and flatchain alignment.

The vertical reference may have been based on:

- Plan profile or finish grade only;
- Cross sections related to the existing roadway section;
- Produced base line grades; or
- Templates based on the existing roadway cross sections.

**(d) Construction Surveying, Type C.** Surveying for general maintenance construction based on existing roadway alignment with no horizontal or vertical geometry. The drawings or detail sketches are developed using flatchain stations or segments/offsets for location reference. Grade and elevations relate to the existing roadway, unless otherwise indicated.

**(e) Construction Surveying, Type D.** Surveying for the construction or replacement of a bridge, culvert, arch, or special structure. The horizontal alignment is based on Second Order, Class II surveys, closure 1:10 000 (10,000:1). Reference all work points shown on the structure stakeout plan.

**(f) Construction Surveying, Type D Modified.** Surveying for the minor or major rehabilitation of a bridge, arch, or culvert. Bridge rehabilitation may involve repair or replacement of part of the substructure, or all or part of the superstructure. Rehabilitation of an arch or culvert may involve the repair or extension of the existing structure, or both.

## 686.2 MATERIAL—

**(a) Tack.** Standard Engineer's tack.

**(b) Stake.** Planed hardwood, 450 mm (18 inches).

**(c) Hub.** Planed hardwood, 450 mm (18 inches).

**(d) Nail.** Metal, 10 pennyweight.

**(e) Guard Stake.** Stake, 450 mm (18 inches), with space to identify the point guarded.

**(f) Grade Point.** Hub with Engineer's tack; or 60-pennyweight spike.

**(g) Reference for Bridge.** Hub with Engineer's tack, or iron pin with work center punch.

**(h) Paint.** Latex, yellow, orange, or white.

**(i) Flat.** Planed hardwood, 900 mm (36 inches).

**(j) PK Nail.** Hardened masonry nail.

**(k) Flagging.** Vinyl material.

**(l) Benchmark Discs.** Furnished by the Department.

## 686.3 CONSTRUCTION—

**(a) General.** The Department will provide all pertinent survey information at the preconstruction conference. Do not begin construction surveying until on or after the Notice to Proceed date. Upon completion of the survey work, return all survey information to the Representative.

The centerline or base lines, or both; side road and channel alignments; plan base lines; and interchange alignments will be established during project design. If there is an extensive time lapse between the design phase and the beginning of work, the Representative will refurbish the alignment by marking and placing new guard stakes at the pre-established control points.

The Contractor is responsible for verifying the alignment, grades, elevations, and dimensions indicated.

The Contractor is responsible for documenting any design error. Immediately notify the Representative of any error, omission, or discrepancy upon discovery.

Prior to removal of any existing benchmark disc(s), give the Representative written notice at least 3 weeks in advance of intent to remove the disc(s). Return the old disc(s) to the Representative.

Place the new benchmark disc(s) as directed, at a point that can be occupied by a survey level rod. Provide a written statement of completion to the Representative. The Representative will establish the new elevation on the new disc(s) and stamp the disc(s) accordingly.

Provide all construction surveying services, material, and equipment needed to stake, mark, reference, and monitor the project. Provide the Representative with any assistance requested for verification of lines, grades, widths, elevations, and measurements or for QA verification. Record geometric or coordinate ties on all lines produced.

All survey activities will be performed according to the standards set forth in Publication 122M, the Department's Surveying and Mapping Manual.

Employ a Professional Land Surveyor or Professional Engineer, registered in the State, qualified in the use of highway and bridge plans; cross sections and specifications; and procedures for establishing line and grade, structure locations, and dimensions, as may be required. Assume full responsibility for dimensions and elevations taken from control stakes and for the setting of structure location and line and grade stakes.

For Type A, Type B, Type B Modified, Type D, and Type D Modified construction surveying provide a surveyor or engineer, to work under the direction of the registered Professional Land Surveyor or Professional Engineer. This individual shall have as a minimum, highway surveying knowledge, skills, and abilities equivalent to those of the State's Surveyor Technician Supervisor Job Classification, or have experience in the prerequisite work elements of the NICET Transportation Engineering Technician/Highway Surveys Level III Technician.

References to "minor structure work" or "minor roadway work" refer to structure or roadway work representing 20% or less of the total contract price.

For all projects, including those with unsuitable and borrow excavation material, the Department will provide all cross sections needed to compute quantities for payment purposes.

**(b) Construction Surveying, Type A.** The centerline or base lines, or both; side road and channel alignments; plan base lines; and interchange alignments will be established, on the ground, at major control points. The maximum interval between referenced major control points will not exceed 300 m (1,000 feet). All major control points will be referenced and vertical benchmarks will be established at appropriate locations.

The Contractor is responsible for the construction stakeout of the project, using the horizontal and vertical control established by the Department.

The Contractor is responsible for relocation and/or preservation of all horizontal references of major control points and vertical benchmarks established by the Department.

Provide the Representative with a comprehensive stakeout schedule for development of the project, listing areas or grading sections by plan designation or station location.

The Contractor is responsible for checking the cross section (original ground and template intersection) on each side of the grade point(s) at each station for accuracy and acceptance. In case of any cross sectional or template discrepancy, forward documentation to the Representative.

Where the finished grade is 1.5 m (5 feet) or more vertically above or below existing grade, place an offset grade point with a guard stake at right angles to the centerline or base line controlling the grade point(s), or at 90 degrees from the tangent to the curve, at each 40 m (100-foot) station. Offset grade points from the intersection of the cross section template and original ground. Mark guard stakes according to the rounding, station, offset right or left of centerline/base line, and offset from the intersection of the template and original ground.

Establish a finished grade control line offset, parallel to the centerline or base line, by setting grade points at 20 m (50-foot) intervals. Establish grade points at 10 m (25-foot) intervals for arcs/curves equal to or less than 100 m radius (of 16 degrees or greater).

Furnish the Representative with grade sheets for all grade points and finish grade points. Show the grade point elevation, finish grade elevation, and offset right or left of the grade point or finish grade point from the centerline or base line on Form D-413.

The Contractor is responsible for staking the plan alignments and grade points for temporary construction easements and temporary roadways or crossovers.

The Contractor is responsible for staking legal right-of-way lines and temporary easement lines if required.

Provide the Representative with all coordinate networks used in staking the project, including coordinate geometry, horizontal geometry, and referenced network points.

**(c) Construction Surveying, Type B.** Provide this type of surveying for roadway construction with minor structure work. Construction surveying required for the minor structure work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

The centerline or base lines, or both, and side road and channel alignments will be established on the ground, at major control points. The maximum interval between referenced major control points will not exceed 300 m (1,000 feet). All major control points will be referenced and vertical benchmarks will be established at appropriate locations.

The Contractor is responsible for the construction stakeout of the project, using the horizontal and vertical control established by the Department.

The Contractor is responsible for relocation and or preservation of all horizontal references of major control points and vertical benchmarks established by the Department.

Establish all base lines, grade lines, parallel lines, traverse lines, and reference lines deemed necessary by the Engineer to control construction operations.

The Contractor is responsible for staking the plan alignment and grade for temporary roadways and crossovers.

The Contractor is responsible for staking legal right-of-way lines and temporary easement lines as required to construct the project. Stake the lines based on plan data.

Provide the Representative with all coordinate networks used in staking the project, including coordinate geometry, horizontal geometry, and reference network points.

**(d) Construction Surveying, Type B Modified.** Provide this type of surveying for roadway construction with minor structure work. Construction surveying required for the minor structure work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

The centerline or base lines, or both, will be established on the ground at major control points. Vertical control will be established at appropriate locations.

Legal right-of-way lines or temporary easement lines will be established, as required, at project locations controlled by flatchain stations. The Department will stake R/W on flatchain projects, if curved alignments or complex configurations are beyond the scope of the flatchain survey.

The Contractor is responsible for the construction stakeout of the project, using the alignment established by the Department.

The Contractor is responsible for the relocation or preservation, or both, of any major control point or vertical benchmark.

The Contractor is responsible for placing and maintaining all grade points, guard stakes, nails, hubs, or paint marks necessary to control construction of the project.

The Contractor is responsible for staking plan alignment and grade for temporary roadways and crossovers.

The Contractor is responsible for staking legal right-of-way lines or temporary easement lines where controlled by horizontal geometry. Stake the lines based on plan data.

**(e) Construction Surveying, Type C.** Only the limits of work will be established by marking the beginning and ending station, or the beginning and ending segments and offsets. The limits of work will be established only once during the life of the Contract.

For Group Contracts, the limits of work will be established using State Route and segment markers.

Establish the stationing or segments and offsets, or both, at 40 m (100-foot) intervals, between the limits of work, by flatchain measurements. Establish stationing at the centerline or edges of pavement with paint marks, or by placing stakes at right angles to the station or segment/offset.

Place additional stakes or marks as necessary to control construction operations.

**(f) Construction Surveying, Type D.** Provide this type of surveying for structure construction with minor roadway work. Construction required for the minor roadway work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

All centerline or base line, or both, structure control points will be established on the ground.

The Contractor is responsible for the construction stakeout of bridges, arches, culverts, and other special structures, as required to facilitate and control the work, using the horizontal and vertical control established by the Department.

Review, with the Representative, the structure stakeout plan sheet designating work points to be referenced, before performing the field stakeout.

Obtain approval for any variance or exception to the field stakeout plan, before performing the work.

Reference all designated work points. Reference each work point on a direct line through any adjacent work point(s). Establish three reference points for the work point at each corner of abutments and at each end of wingwalls. Establish three reference points for work points on proprietary or other walls. For land piers, establish three reference points, on each side of the substructure, for work points on the centerline of bearing. The distance between a work point and its first reference point is to be less than 30 m (100 feet), with the exception of centerline pier reference.

Establish a Second Order, Class II traverse network, at each structure site, coordinating abutment and pier reference. Show the precision ratio, and comparisons of longitudinal distances.

Furnish the Representative prior to any structure construction activities with a field stakeout sketch, based on the structure plan stakeout, showing only centerline/base line stations, span lengths, reference angles, and reference lengths. Show two described vertical benchmarks.

Furnish the Representative prior to any structure construction activities with a sketch showing a triangulation network or traverse network at each structure site. For water-bound piers, include base line control showing length of sides “a” and “b” and interior angles A and B.

Include the date, structure description, Contractor's name, and person responsible for the stakeout, on field stakeout sketches.

**(g) Construction Surveying, Type D Modified.** Provide this type of surveying for structure construction/rehabilitation with minor roadway work. Construction surveying required for the minor roadway work, if any, is incidental. Perform incidental surveying as specified for the applicable type.

All centerline or base line, or both, structure control points will be established on the ground.

The Contractor is responsible for the construction stakeout of the structure rehabilitation, using the horizontal and vertical control established by the Department.

Review, with the Representative, the structure stakeout plan sheet designating the work points to be referenced, before performing the field stakeout.

Reference all designated work points. Reference each work point on a direct line through any adjacent work point(s). Establish three reference points for the work point at each corner of abutments and at each end of wingwalls. For land piers, establish three reference points, on each side of the substructure, for work points on the centerline of bearing or as indicated on the structure plan stakeout. The distance between a work point and its first reference point is to be less than 30 m (100 feet), with the exception of pier reference. For water-bound piers, use base line reference.

Furnish the Representative prior to any structure construction activities with a field stakeout sketch, based on the structure plan stakeout, showing reference points, lengths, vertical control, and pertinent plan data.

Furnish the Representative prior to any structure construction activities with a separate sketch showing a triangulation network or traverse network, or methodology for a mathematical check of the survey produced.

## 686.4 MEASUREMENT AND PAYMENT—

**(a) Construction Surveying.** Lump Sum

For the type indicated.

The Department will pay for this item as specified in Section 110.05, in four payments, according to the following schedule:

- When work representing 10% of the total contract price is completed, excluding the bid price for this item, the Department will pay 25% of the amount bid for this item.
- When work representing 30% of the total contract price is completed, excluding the bid price for this item, the Department will pay 25% of the amount bid for this item.
- When work representing 90% of the total contract price is completed, excluding the bid price for this item, the Department will pay 20% of the amount bid for this item.
- Upon completion of the project, the Department will pay the remaining 30% of the amount bid for this item.

**(b) Unidentified Work.** The Department will pay for unidentified work as follows:

**1. Negotiated Price.** At an agreed upon price. The Department and the Contractor will agree upon this price before performing the work.

**2. Force Account Basis.** Section 110.03(d)

# SECTION 688—MICROCOMPUTER SYSTEM

**688.1 DESCRIPTION**—This work is furnishing, setting up, and maintaining a microcomputer of the type specified, and a battery backup system if indicated, for the exclusive use of Department personnel.

**688.2 MATERIAL—**

**(a) General.** Provide all material necessary for setup and operation of microcomputer, including all cords and cabling. Upon delivery to the field office, ensure that all hardware and software are compatible and operational.

**(b) Microcomputer.** The Type A microcomputer is a desktop or tower model. The Type C microcomputer is a laptop computer. The minimum hardware specifications for each type microcomputer are as indicated in Table A and as follows:

**1. Monitor.** For the Type A microcomputer, provide a 17-inch, color, non-interlaced monitor (SVGA equivalent or greater), with enhanced graphics capabilities; having, at a minimum, 16-bit color, a resolution of 1024 x 768 dpi, and 0.26 mm dot pitch; supported by a 32 MB (minimum), 64-bit graphics video card.

For the Type C microcomputer, provide a 13.9-inch (minimum), TFT active matrix, color display screen having a minimum of 16-bit color and a resolution of 1024 x 768 dpi.

**2. Surge Protector.** Provide a surge protector, with a minimum of six AC outlets and one telephone outlet, having a line voltage regulator/conditioner that protects against chronic low or high voltage, voltage spikes, and radio frequency interference.

**3. Keyboard.** Provide a Windows compatible, 104 key, full function keyboard.

**4. Miscellaneous.**

- Provide two Lithium-Ion batteries, AC adapter, automobile adapter, and external battery charger with Type C microcomputer.
- Provide a carrying case large enough to carry the Type C microcomputer, spare battery pack, external pointing device (mouse), AC adapter, automobile adapter, and external battery charger.

**(c) Software.** All system software must be installed on the C: drive partition.

- Provide MS Windows XP Professional operating system, including SP 1. Set up this operating system as a new installation, not as an upgrade from a previously installed, older version of Windows.
- Provide MS Office XP, Professional Edition, with all current Service Packs.
- Provide Symantec PC Anywhere 32 Host Mode, most current version.
- Provide MS Windows XP compatible software for the CD-RW and Zip Drives, as applicable.
- Provide antivirus software that meets the Department's current standard, with updates for the duration of the project.
- Provide the Inspector-In-Charge with all OEM software CD's/licenses, manuals, and documentation, to be maintained in the Department's Project Field Office for the duration of the project.
- Provide a compatible Internet browser that meets the Department's current standard for ECMS.

**(d) Battery Backup System.** For the Type A microcomputer, provide a UPS (uninterrupted power supply) battery backup system meeting the following minimum requirements:

- Load Wattage (minimum) — 500
- Full Load maximum time — 9 minutes
- Number AC Outlets Regulated — 4
- Number AC Outlets w/battery backup — 2
- Number AC Outlets with noise isolation and spike protection — 4
- Indicator Lights — Line and Battery Power
- Circuit Protection
  - Line — Breaker
  - Battery (internal) — Fuse
- Alarm (audible tone during battery operation with defeat switch)

**TABLE A**
**Minimum Specifications**

| System Type | Type A | Type C |
|---|---|---|
| Central Processing Unit (Min) | Pentium IV | Pentium IV |
| CPU Speed (Min) | 2.6 GHz | 1.7 GHz |
| Random Accessible Memory (RAM) (Min) | 512 MB | 512 MB |
| Internal EIDE Hard Drive 7200 RPM (Min) | 40GB | 40GB |
| Internal CD-ROM Drive (Min) | 40X | 24X* |
| 3 1/2-inch Internal Disk Drive | 1.44 MB | 1.44 MB |
| 250 MB ZIP Drive (Min) | Yes | — |
| 250 MB External ZIP Drive (Min)<br>USB Interface | — | Yes |
| Internal CD-RW Drive 48x10x40 Speed (Min) | Yes | — |
| External CD-RW Drive 32x8x32 Speed (Min) USB Interface | — | Yes* |
| External Serial or PS/2 Mouse | Yes | Yes |
| Internal Pointing Device | — | Yes |
| Serial/Parallel Ports (Min) | 1/1 | 1/1 |
| USB Ports (Min) | 6 (2 front, 4 rear) | 2 |
| External USB 2.0 4-Port Hub (Min) | — | Yes |
| Type II PCMCIA Slots | — | 2 |
| Internal Modem (Min) | 56K V.92<br>Data/Fax/Voice | — |
| PCMCIA or Internal Modem (Min) | — | 56K V.92<br>Data/Fax |

* One Internal CD-RW Drive, meeting the specifications for External CD-RW Drive, may be used in lieu of two separate drives

**(e) Maintenance Agreement.** Furnish a maintenance agreement, which provides for on site repair service within 24 hours of notification. If the system can not be repaired, provide a replacement within 48 hours of notification.

**(f) Compatibility.** All references to compatibility require that compatibility be demonstrated in the Inspector's Field Office.

**688.3 CONSTRUCTION**—Furnish microcomputer(s) for Department use no later than 5 working days after the Notice to Proceed date or 5 days before the scheduled start of work. Provide the type of microcomputer specified and install in the Inspector's Field Office. Maintain the system from installation until 30 days after physical work has been satisfactorily completed unless released earlier by the Representative. The Representative may direct that the system be maintained for more than 30 days after physical work has been satisfactorily completed, as necessary, to allow time for Department personnel to process outstanding project records. Remove and properly dispose of all dispensable items for the life of the project and upon release by the Representative.

**688.4 MEASUREMENT AND PAYMENT**—Lump Sum

For the type indicated.

Paid in three payments, in accordance with the following schedule:

- Whenever all the requirements specified of Section 688.2(a) have been met and compatibility satisfactorily demonstrated to the Representative, 80% of the amount bid for this item will be paid.
- Whenever work is performed equal to 40% of the original contract amount, excluding the bid price for this item, 10% of the amount bid for this item will be paid.
- Whenever work is performed equal to 80% of the original contract amount, excluding the bid price for this item, the remaining 10% of the amount bid for this item will be paid.

**(a) Price Adjustments.** Adjustments to the lump sum prices for the indicated type microcomputer system, as applicable, will be made as follows:

**1. Time Extensions and Reductions.** In the event the time for completion of all work on the project is extended or reduced, as specified in Section 108.06, to be more than A percent or less than B percent of the original contract time, where A and B are as specified in Table B, an appropriate adjustment (payment to the Contractor or rebate to the Department) will be made to the lump sum prices bid for the indicated microcomputer systems, as applicable, for that portion of adjusted contract time in excess of A percent of (payment) or less than B percent of (rebate) the original contract time, at the following daily rate:

$$\text{Daily Price Adjustment Rate} = \frac{75\% \times \text{Contract Lump Sum Price}}{\text{Original Contract Time in Days}}$$

**TABLE B**
**Contract Time**

| Original Contract Time in Days | | Percent | |
|---|---|---|---|
| **From More Than** | **To and Including** | **A** | **B** |
| 0 | 100 | 130 | 70 |
| 100 | 300 | 120 | 80 |
| 300 | 500 | 115 | 85 |
| 500 | 1000 | 112 | 88 |
| 1000 | | 110 | 90 |

**2. Systems Maintained More than 30 Days After Physical Work Completion.** In the event the Representative directs that the microcomputer systems be maintained for more than 30 days after the date of physical work completion, as specified in Section 688.3, an appropriate adjustment (payment to the Contractor) will be made to the lump sum prices bid for the indicated microcomputer systems, as applicable, for the days in excess of 30 until released by the Representative, at the Daily Price Adjustment Rate specified in Section 688.4(a)1.

No adjustment will be made if the Representative directs that the microcomputer systems be maintained for more than 30 days after the date of physical work completion due to the Contractor's failure to submit, complete, and/or correct required certificates or documents, as established during the final inspection.

# SECTION 692—SHOULDER RELIEF JOINT

**692.1 DESCRIPTION**—This work is construction of a shoulder relief joint on a prepared surface.

**692.2 MATERIAL—**

- Bituminous Wearing Course, ID-2—Section 420.2
- Bituminous Concrete Base Course—Section 305.2
- Superpave Asphalt Mixture Design, HMA Wearing Course, SRL-L—Section 504.2
- Superpave Asphalt Mixture Design, HMA Base Course—Section 504.2
- Asphalt Cement, PG 64-22—Section 702

**692.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Base Course.** Construct either Bituminous Concrete Base Course as specified in Section 305.3; or Superpave Asphalt Mixture Design, HMA Base Course as specified in Section 309.3.

**(b) Wearing Course.** Construct either Bituminous Wearing Course ID-2 as specified in Section 420.3; or Superpave Asphalt Mixture Design, HMA Wearing course as specified in Section 409.3.

**692.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)
Measured transversely.

# SECTION 694—BUILT-UP CURB RAMPS

**694.1 DESCRIPTION**—This work is construction of a built-up curb ramp on a completed surface.

**694.2 MATERIAL—**

- Bituminous Binder Course, ID-2—Section 421.2
- Bituminous Wearing Course, ID-2—Section 420.2
- Bituminous Wearing Course, FJ-1—Section 422.2

**694.3 CONSTRUCTION**—As shown on the Standard Drawings; as specified in the applicable parts of Section 420.3, Section 421.3, and Section 422.3; and as follows:

**(a) Preparation of Surface.** Before placing built-up curb ramp, clean the surface on which it is to be placed, then apply a tack coat, if indicated, as specified in Section 460.3.

**694.4 MEASUREMENT AND PAYMENT**—Tonne (Ton)

# SECTION 696—TEMPORARY IMPACT ATTENUATING DEVICES

**696.1 DESCRIPTION**—This work is the furnishing, placing, and removing of temporary impact attenuating devices for maintenance and protection of traffic during construction, as indicated.

**696.2 MATERIAL—**

- Temporary impact attenuating devices from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

**696.3 CONSTRUCTION—**

**(a) General.** Submit shop drawings as specified in Section 105.02(d).

**(b) Installation.** Install according to manufacturer's specifications and installation instructions, or as indicated.

**696.4 MEASUREMENT AND PAYMENT—**

**(a) Temporary Impact Attenuating Device.** Each

**(b) Repair of Impact Attenuating Device.** The Department will pay for repair of Temporary Impact Attenuating Devices as specified in Section 110.03(d) Force-Account Work, if money has not been secured through other sources for the same purpose.

# SECTION 697—RESET TEMPORARY IMPACT ATTENUATING DEVICES

**697.1 DESCRIPTION**—This work is the resetting of a temporary impact attenuating device from one construction area to another within the project limits, as indicated.

**697.2 MATERIAL**—Section 696.2

**697.3 CONSTRUCTION**—Section 696.3 and as follows:

Reset temporary impact attenuating device if construction operations require a change in the protection of traffic, or as directed. Store or transport the attenuating devices as required.

**697.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 700
# MATERIAL

## SECTION 701—CEMENT

**701.1 GENERAL**—Obtain cement from a producer listed in Bulletin 15 and from silos set aside for Department use. Do not use retrieved or reclaimed cement. Do not use cement with a material temperature exceeding 65 ºC (150F) at the time of delivery to the plant.

**(a) QC.** Section 106.03(a)2

**(b) Certification.**

**1. General.** Conduct a Monthly Mill Test according to ASTM C 150. Submit a copy of the Monthly Mill Test to the MTD for verification of compliance with Department specifications:

- Base the Monthly Mill Test on actual or historical statistical process controls.
- Specify the type of material and cross-reference the test to the bill of lading.
- Ensure that a responsible company official sign the Monthly Mill Test.
- Submit split sample with corresponding test results monthly.

**2. Levels of Certification.** The MTD will determine the level of certification for each producer listed in Bulletin 15 based on the producers' ability to comply with the specifications listed below. Producers will initially be assigned a Level 1 certification until performance dictates a reevaluation. Material provided by producers listed in Bulletin 15 is approved for use only in its intended application(s).

**2.a Level 1.** Test material at the minimum frequency identified in the approved QC Plan. Ship on the basis of certification.

**2.b Level 2.** Test material at an increased frequency according to a revised QC Plan coordinated with the MTD. Continue to ship on the basis of certification. Submit an action plan that demonstrates how material and processes will be controlled to ensure the product consistently conforms to specification requirements.

**2.c Level 3.** Test material at Level 2 frequency and arrange for additional testing at Level 2 frequency by an independent laboratory. Correlate in-house and independent laboratory test results and continue to ship on the basis of certification.

**2.d Level 4.** Test material at Level 2 frequency and arrange for additional testing at Level 2 frequency by an independent laboratory. Correlate in-house and independent laboratory test results. Certify that the material conforms to specifications and submit samples to the MTD for verification. Ship only after notification of acceptable lot test results from the BOCM.

If the producer fails to advance above this level of certification, the Department will initiate action for the producer's suspension and removal from Bulletin 15 according to the State's Contractor Responsibility Program.

**(c) Handling and Transportation.** Section 106.06 and as follows:

For each shipment to the project, furnish two copies of the vendor's bill of lading. Include one copy with the shipment to the project; the vendor shall retain the other copy. Use a form acceptable to the MTD that contains the following information:

- Statement that material has been tested and conforms to Department specifications.
- Type of material
- Silo number
- Company lot identification
- Date of shipment
- Producer's name and location
- Consignee's name and location
- Temperature of cement
- Trailer number
- Quantity (tonnes (tons))
- Alkali content (%)—determined according to AASHTO T 105.

Ship bulk cement in clean, acceptable, metal, rubber, or plastic waterproof containers or compartments. Ship bagged cement (42.6 kg (94 pounds) net per bag) in suitable paper bags with the brand, type, and manufacturer's name printed on them. Protect cement bags from the weather. Reject cement bags with net mass (weight) more than 3% below that specified.

**(d) Storage.** Section 106.05 and as follows:

- Provide storage capacity sufficient to maintain the paving schedule.
- Store bulk cement in acceptable silos.
- Store bagged cement in enclosed buildings.
- Store bagged cement in stacks not exceeding eight bags in height and cover.

**(e) Chemical and Physical Requirements and Testing.** AASHTO M 85 and AASHTO M 240, except sample according to PTM No. 509.

**(f) Limited Number of Sources.** Obtain cement for each project from a single source, unless otherwise allowed by the Representative in writing. If using more than one source, separate cement of different types and from different sources. Use each type and source in continuous, segregated portions of the project. If possible, limit cement used in an individual structure to a single type and source. If this is not possible, use one type and source for footers, piers, and abutments, and one type and source for superstructures.

# SECTION 702—BITUMINOUS MATERIAL

**702.1 GENERAL**—Obtain bituminous material conforming to the requirements of Bulletin 25 from a producer listed in Bulletin 15.

**(a) QC.** Prepare a QC Plan as specified in Section 106.03(a)2. Submit the QC Plan to the MTD for review before shipping material to the project and at least annually. For PG-Binder suppliers, the QC Plan shall conform to AASHTO R 26 as supplemented by Bulletin 25.

**(b) Certification.**

**1. General.**

- Obtain a verification sample from each batch and test according to Bulletin 25. A batch is a tank completely filled, partially filled, or refilled with a blend of residual and new material. Test one-half of each sample and forward the results and remaining one-half of each sample to the MTD. The MTD will evaluate QC on the basis of verification samples.

- Provide a certificate of compliance signed by a responsible company official that lists the type of material, tank number, and company lot number for cross-referencing to the bill of lading.

**2. Levels of Certification.** The Department's QA Teams will periodically review the QC Plan, inspect the facilities, and take QA samples of material at the point where the material is introduced into the final product. The MTD will determine the level of certification based on the results of verification and QA samples. Producers will initially be assigned a Level 1 certification until performance dictates a reevaluation.

**2.a Level 1.** Test material at the minimum frequency identified in the approved QC Plan. Ship on the basis of certification.

**2.b Level 2.** Test material at an increased frequency according to a revised QC Plan coordinated with the MTD. Continue to ship on the basis of certification. Submit an action plan that demonstrates how material and processes will be controlled to ensure the product consistently conforms to specification requirements.

**2.c Level 3.** Test material at Level 2 frequency and arrange for additional testing at Level 2 frequency by an independent laboratory. Correlate in-house and independent laboratory test results and continue to ship on the basis of certification.

**2.d Level 4.** Test material at Level 2 frequency and arrange for additional testing at Level 2 frequency by an independent laboratory. Correlate in-house and independent laboratory test results. Certify that the material conforms to specifications and submit samples to the MTD for verification. Ship only after notification of acceptable lot test results from the BOCM.

If the producer fails to advance above this level of certification, the Department will initiate action for the producer's suspension and removal from Bulletin 15 according to the State's Contractor Responsibility Program.

**(c) Handling and Transportation.** Section 106.06 and as follows:

For each shipment to the project or bituminous concrete producer, submit one copy of the vendor's bill of lading on a form acceptable to the MTD that contains the following information:

- Statement that the material has been tested and conforms to Bulletin 25.

- Statement that the shipment container was free of contamination before loading.

- Class of material.
- Tank number.
- Company batch number.
- Date of shipment.
- Producer's name and location.
- Consignee's name and location (Bituminous Concrete Plant or Maintenance District).
- For cutback asphalts and emulsified asphalts, minimum and maximum mix or application temperature requirements, handling and storage requirements for proper usage, percent bitumen residue by mass (weight), and statement that material is compatible with job aggregate.
- For non-polymer-modified PG-Binders, a temperature-viscosity chart (Figure 1, Bulletin 25) for each lot or batch of material to be shipped based on the rotational viscosities in either Pascal-seconds (Pa-s) or centipoises at 135 ºC and 165 ºC (275F and 329F). Instead of plotted data, provide minimum and maximum laboratory mixing and compaction temperatures based on Figure 1, Bulletin 25. The bituminous mixture placement temperatures for the type and class of PG-Binder used are listed in Section 401, Table B, Section 409, Table A, and Bulletin 25.
- For polymer-modified PG-Binders, any specific handling and storage requirements and minimum and maximum laboratory mixing and compaction temperatures. The bituminous mixture placement temperatures for the type and class of PG-Binder used are listed in Section 401, Table B, Section 409, Table A, and Bulletin 25.
- Specific gravity at 15 ºC (60F).
- Quantity of material.

# SECTION 703—AGGREGATE

## 703.1 FINE AGGREGATE—

**(a) General.** Fine aggregate is natural or manufactured sand consisting of hard, durable, and uncoated inert particles reasonably free from clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances that are present in amounts large enough to cause inconsistent performance in the properties of bituminous concrete or plastic or hardened Portland cement concrete are considered deleterious. Spent foundry sand may be used as fine aggregate in asphalt concrete and flowable fill.

Obtain fine aggregate with physical properties conforming to Table A from a source listed in Bulletin 14 or approved by the MTD.

**1. Natural Sand.** Natural sand is fine aggregate resulting from glacial or water action. Fine aggregate produced simultaneously with gravel coarse aggregate may contain crushed particles.

**2. Manufactured Sand.** Manufactured sand is fine aggregate from the controlled mechanical breakdown of rock, air-cooled blast furnace slag, or air-cooled steel slag into sound, approximately cubical particles. The Department will accept manufactured sand only if it is the primary product of the crushing operation and sized by a sand classifier. However, for fine aggregate used in bituminous concrete mixtures, a sand classifier is not required.

Fine aggregate manufactured from limestone may not be used in concrete wearing surfaces.

Fine aggregate manufactured from steel slag may not be used in cement concrete or mortar mixtures. Steel slag fine aggregate may only be used in bituminous wearing courses with the approval of the MTD; however, do not use steel slag fine aggregate in conjunction with steel slag coarse aggregate. Provide steel slag fine aggregate that is uniform in density and quality. Cure steel slag fine aggregate according to the following procedure:

- After gradation preparation, place steel slag fine aggregate, whether reclaimed from an old stockpile or processed directly from the steel-making process, in a controlled stockpile. Completely soak the steel slag fine aggregate with water before or during stockpiling. Submit the method of constructing and controlling the stockpile to the Representative for review.

- Maintain the stockpile in a uniform moist condition for a period of not less than 6 months. After the minimum cure period, the Representative will sample and test the stockpile for expansive characteristics according to PTM No. 130. The Representative will approve the stockpile for use if the average total volumetric expansion according to PTM No. 130 is less than 0.50%.

- If the stockpile fails expansion criterion, continue curing the stockpile for a minimum of 2 additional months. The Representative will resample and retest the stockpile after the required additional cure period.

The MTD will evaluate the quality of fine aggregates by conducting petrographic analysis according to ASTM C 295 and other tests necessary to demonstrate that required construction of acceptable durability can be achieved.

**(b) Production Testing.**

**1. Personnel and Equipment.** Provide and assign to the work a PENNDOT Certified Aggregate Technician who will test fine aggregate at the source according to the requirements listed in Bulletin 14.

Provide the following equipment for acceptance testing and for developing and maintaining a QC program to ensure compliance with specification requirements during production:

| No. | Equipment |
|---|---|
| 1 | Fine aggregate mechanical sieve shaker with timer |
| 1 | Sample splitter having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of twelve total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 20 mm (3/4-inch). Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material. |
| 2 | Set of standard sieves for fine aggregate. |
| 1 | Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principal sample mass (weight) of the sample being tested, PTM No. 616. |
| 1 | Oven capable of maintaining a uniform temperature of 110 ºC ± 5 °C (230F ± 9F). |
| 1 | Thermometer, ASTM E 1. |

Provide a separate set of sieves for exclusive use by the Department for acceptance testing. The remaining equipment is to be shared by the producer and the Department. If time or space conflicts arise, or if the Department does not have consistent access to shared equipment when acceptance testing is to be performed, provide a separate set of equipment for the Department. Perform routine maintenance and repair all equipment whether shared or for exclusive Department use. Have balances calibrated annually by an independent agency acceptable to the Department. Verify oven temperatures every 120 days using the thermometer required above. Maintain accurate records of calibration and temperature checks. Ensure that the producer has back-up equipment available so that no acceptance tests are missed.

Provide the following office equipment for exclusive Department use:

| No. | Equipment |
|---|---|
| 1 | Desk and chair |
| 1 | Electronic calculator with tape |
| 1 | Work table 760 mm x 2100 mm x 760 mm high (2 1/2 feet by 7 feet by 2 1/2 feet high) |
| 1 | Four-drawer, fire resistant (D-label) metal file cabinet |
| 1 | Closet or locker for storage |

If testing equipment is to be shared, provide a minimum of 14 $m^2$ (150 square feet) of office and workspace. If a separate set of testing equipment is provided for the Department, provide a minimum of 22 $m^2$ (240 square feet) of office and workspace to accommodate both the office and the testing equipment. The office and workspace area provided shall be heated/air-conditioned and have on-site access to a water cooler, telephone, fire extinguisher, and sanitary toilet facilities.

**2. Testing and Documentation.** During production, provide the necessary incidental equipment to conduct and document the specified tests.

Perform strength ratio and soundness tests at intervals sufficient to ensure the quality of the material. The strength ratio and soundness tests may be performed by the producer, a laboratory accredited by the AASHTO Materials Reference Laboratory (AMRL), or other inspection agency approved by the MTD.

Document the results of tests made during production and make them available to the Department upon request. The equipment and test result documentation is a condition for source acceptance, source requalification, and listing in Bulletin 14.

**(c) Grading and Quality Requirements.**

**1. Gradation.** Table A lists the extreme limits for determining the suitability of supply sources.

Control the grading of Type A Fine Aggregate so that the fineness modulus of at least nine out of ten consecutive test samples from a single source delivered to a project or plant varies less than ± 0.20 from the average fineness modulus of the consecutive test samples. Determine the fineness modulus according to PTM No. 501.

For bituminous mixtures:

- If directed, vary the gradations within the limits listed in Table A.
- A blend of fine aggregates may be used if the proposed gradation limits for blending are approved by the District Executive in writing.
- If filler is required, provide fine aggregate conforming to the gradation of Table A and use cement, cement dust, fly ash, or fines from the crushing of stone, gravel, or slag that are reasonably free of clay.

**2. Material Finer than the 75 µm (No. 200) Sieve.** Determine the loss by washing according to PTM No.100.

**3. Minimum Strength Ratio.** AASHTO T 21. If color No. 5 or darker results, determine the minimum strength ratio according to AASHTO T 71.

**4. Soundness Test.** Determine the percentage of mass (weight) loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510.

**TABLE A**
**Fine Aggregate**
**Grading and Quality Requirements**

| | Cement Concrete Sand | Bituminous Concrete Sand Type B | | | | Mortar Sand |
|---|---|---|---|---|---|---|
| **Sieve Size** | **Type A** | **#1** | **#2** | **#3** | **Filler** | **Type C** |
| 9.5 mm (3/8-inch) | 100 | 100 | — | 100 | — | — |
| 4.75 mm (No. 4) | 95-100 | 95-100 | 100 | 80-100 | — | 100 |
| 2.36 mm (No. 8) | 70-100 | 70-100 | 95-100 | 65-100 | — | 95-100 |
| 1.18 mm (No. 16) | 45-85 | 40-80 | 85-100 | 40-80 | — | — |
| 600 µm (No. 30) | 25-65 | 20-65 | 65-90 | 20-65 | 100 | — |
| 300 µm (No. 50) | 10-30 | 7-40 | 30-60 | 7-40 | 95-100 | — |
| 150 µm (No. 100) | 0-10 | 2-20 | 5-25 | 2-20 | 90-100 | 0-25 |
| 75 µm (No. 200) | — | 0-10 | 0-5 | 0-10 | 70-100 | 0-10 |
| Material Finer Than 75 µm (No. 200) Sieve Max. Percent Passing | 3 | — | — | — | — | — |
| Strength Ratio Min. Percent | 95 | — | — | — | — | 95 |
| Soundness Test Max. Loss Percent | 10 | 15 | 15 | 15 | — | 10 |
| Fineness Modulus | 2.30-3.15 | — | — | — | — | 1.6-2.5 |

## 703.2 COARSE AGGREGATE—

**(a) General.** Coarse aggregate consists of hard, tough, durable, and uncoated inert particles reasonably free from clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances that are present in amounts large enough to cause inconsistent performance in the properties of bituminous concrete or plastic or hardened Portland cement concrete are considered deleterious.

The MTD will evaluate the quality of coarse aggregates by conducting petrographic analysis according to ASTM C 295 and other tests necessary to demonstrate that required construction of acceptable durability can be achieved.

Furnish coarse aggregate crushed and prepared from one of the materials described below with physical properties conforming to Tables B, C, and D. Obtain coarse aggregate from a source listed in Bulletin 14 or approved by the MTD before use.

**1. Stone.** Durable stone free from slate texture or cleavage planes.

**2. Gravel.** Durable gravel particles. For use in cement concrete, wash thoroughly during production. For use in heavy duty bituminous base courses, heavy duty binder courses, and all bituminous wearing courses, a minimum of 85% crushed particles with at least two faces resulting from fracture is required. For use as No. OGS, a minimum of 75% crushed particles with at least three faces resulting from fracture is required. For all Type A use, the maximum allowable absorption determined according to AASHTO T 85 is 3.0%; however, this restriction does not apply to dredged river gravel used in Portland cement concrete. For all Type B use, the maximum allowable absorption determined according to AASHTO T 85 is 3.5%.

**3. Blast Furnace Slag.** By-product of a pig-iron making process. Tough, hard, and durable pieces of air-cooled blast furnace slag. Blast furnace slag is excluded from the abrasion requirements. The density (unit weight) of blast furnace slag cannot be less than 1120 kg/m$^3$ (70 pounds per cubic foot).

**4. Steel Slag.** By-product of a steel making process. Tough, hard, and durable pieces of steel slag reasonably uniform in density and quality. After crushing, grading, and forming a stockpile, take a sample from the stockpile and submit it to the MTD for testing of expansive characteristics. The MTD will accept the stockpile for use if the total expansion determined according to PTM No. 130 is less than 0.50%. Once a stockpile is accepted, do not add to it if it is for Department use. If the stockpile fails expansion requirements, cure the aggregate stockpile as follows:

- Rework the stockpile and soak the aggregate completely with water.
- Submit the proposed method of constructing and controlling the stockpile during the cure period for review and acceptance.
- Maintain the aggregate in a uniformly moist condition in the stockpile for a period of at least 6 months. Take a sample after this curing period and submit it to the MTD for testing according to PTM No. 130.
- The Representative will accept the stockpile for use if the total expansion is less than 0.50%. If the stockpile still fails the expansion requirement, continue curing for at least 2 additional months before resampling and retesting.

Aggregate manufactured from steel slag is not acceptable for pipe or structure backfill or in cement concrete. Steel slag may be used for subbase, selected granular material, shoulders, selected material surfacing, and in bituminous surface courses.

**5. Granulated Slag.** By-product of an iron-making process. Granulated blast furnace slag is the granular glassy material formed when molten slag from iron-making is rapidly quenched by immersion in water and contains not more than 3% total iron reported as $Fe_2O_3$. Provide material containing not more than 20% by mass (weight) of substances that are not granulated slag. Use material with a dry rodded density (unit weight) determined according to AASHTO T 19 of not more than 1300 kg/m$^3$ (80 pounds per cubic foot). Provide uniform material having a maximum size of 50 mm (2 inches) and not more than 20% passing the 150 µm (No. 100) sieve. Granulated slag may only be used for subbase material as specified in Section 350.

**6. Lightweight Aggregate.** Acceptable types of lightweight aggregate are as follows:

- Aggregate prepared by expanding or sintering products such as clay, shale, or slate.
- Aggregate prepared by processing natural materials such as pumice, scoria, or tuff.

Furnish lightweight aggregate conforming to AASHTO M 195, the soundness and abrasion limits for Type A aggregate as specified in Table B, and the following durability requirements.

- Aggregate Absorption Factor (PTM No. 526) Max. % 2.5
- Freeze-Thaw Resistance of Concrete, Decrease of Dynamic Modulus at 300 Cycles (AASHTO T 161, Procedure B, except that after 14 days of moist cure, dry the beams 76 mm x 102 mm x 406 mm at 22 °C ± 2 °C (3 inches by 4 inches by 16 inches at 72F ± 3F) and approximately 50% relative humidity for 14 days. Then soak the beams in water for 3 days before starting the freezing and thawing test.) Max. % 60
- Freeze-Thaw Resistance of Aggregate (PTM No. 525) Max. % 25

**TABLE B**
**Coarse Aggregate**
**Quality Requirements**

| | Type A | Type B | Type C |
|---|---|---|---|
| Soundness, Max. % | 10 | 12 | 20 |
| Abrasion, Max. % | 45****** | 45****** | 55****** |
| Thin and Elongated Pieces, Max. % | 15 | 20 | — |
| Material Finer Than 75 µm (No. 200) Sieve, Max. % | * | * | 10 |
| Crushed Fragments, Min. % | 55** | 55** | 50 |
| Compact Density (Unit Weight), Min. kg/m$^3$ (lbs./cu. ft.) | 1100 (70) | 1100 (70) | 1100 (70) |
| Deleterious Shale, Max. % | 2 | 2 | 10 |
| Clay Lumps, Max. % | 0.25 | 0.25 | 3 |
| Friable Particles, Max. % (excluding shale) | 1.0 | 1.0 | — |
| Coal or Coke, Max. % | 1 | 1 | 5 |
| Glassy Particles, Max. % | 4 or 10*** | 4 or 10*** | — |
| Iron, Max. % | 3***** | 3***** | 3***** |
| Absorption, Max. % | 3.0**** | 3.5**** | — |
| Total of Deleterious Shale, Clay Lumps, Friable Particles, Coal, or Coke Allowed, Max. % | 2 | 2 | 15 |

* See Section 703.2(c)4.
** See Section 703.2(a)2.
*** See Section 703.2(c)10.
**** Gravel only. See Section 703.2(a)2.
***** See Section 703.2(c)11.
****** Blast Furnace Slag excluded. See Section 703.2(a)3.

**7. Recycled Concrete.** Salvaged and crushed concrete pavements and concrete highway structures from Department, county, or municipal projects for use as aggregate in subbase only. Other recycled concrete may be used in subbase if the concrete was made using materials approved by the Department. Provide recycled concrete conforming to Table B and Table C.

**(b) Production Testing.**

**1. Personnel and Equipment.** Provide and assign to the work a PENNDOT Certified Aggregate Technician who will test coarse aggregate at the source according to the requirements listed in Bulletin 14.

Provide the following equipment for acceptance testing and for developing and maintaining a QC program to ensure compliance with specification requirements during production.

| No. | Equipment |
|---|---|
| 1 | Coarse aggregate mechanical sieve shaker with timer |
| 1 | Sample splitter having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of eight total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material. |
| 2 | Set of standard sieves for coarse aggregate. |
| 1 | Cylindrical metal measure (25 L (1 cubic foot)) AASHTO T 19 |
| 1 | Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principle sample mass (weight) of the sample being tested, AASHTO T 85. |
| 1 | Platform scale conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principle sample mass (weight) of the sample being tested, PTM No. 616. |
| 1 | Oven capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F). |
| 1 | Thermometer, ASTM E 1. |

Provide a separate set of sieves for exclusive use by the Department for acceptance testing. The remaining equipment is to be shared by the producer and the Department. If time or space conflicts arise, or if the Department does not have consistent access to shared equipment when acceptance testing is to be performed, provide a separate set of equipment for the Department. Perform routine maintenance and repair of all equipment whether shared or for exclusive Department use. Have balances calibrated annually by an independent agency acceptable to the Department. Verify oven temperatures every 120 days using the thermometer required above. Maintain accurate records of calibration and temperature checks. Ensure that the producer has back-up equipment available so that no acceptance tests are missed.

Provide the following office equipment for exclusive Department use:

| No. | Equipment |
|---|---|
| 1 | Desk and chair |
| 1 | Electronic calculator with tape |
| 1 | Work table 760 mm x 2100 mm x 760 mm high (2 1/2 feet by 7 feet by 2 1/2 feet high) |
| 1 | 4-drawer, fire resistant (D-label) metal file cabinet |
| 1 | Closet or locker for storage |

If testing equipment is to be shared, provide a minimum of 14 $m^2$ (150 square feet) of office and workspace. If a separate set of testing equipment is provided for the Department, provide a minimum of 22 $m^2$ (240 square feet) of office and workspace to accommodate both the office and the testing equipment. The office and workspace area provided shall be heated/air-conditioned and have on-site access to a water cooler, telephone, fire extinguisher, and sanitary toilet facilities.

**2. Testing and Documentation.** During production, provide the necessary incidental equipment to conduct and document the specified tests.

Perform soundness and abrasion tests at intervals sufficient to ensure the quality of the material. The soundness and abrasion tests may be performed by the producer, a laboratory accredited by the AMRL, or other inspection agency approved by the MTD.

Document the results of tests made during production and make them available to the Department upon request. The equipment and test result documentation is a condition for source acceptance, source requalification, and listing in Bulletin 14.

**(c) Quality Requirements.** The following notes are applicable to Table B.

**1. Soundness.** Determine the percentage of mass (weight) loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510. The MTD may accept aggregate failing the test if it can be demonstrated in writing that the aggregate has a satisfactory service record in both pavements and structures. Acceptable aggregate produced from recycled concrete need not conform to soundness requirements since cementitious material cannot be evaluated with this test.

**2. Abrasion.** Determine the percentage of mass (weight) loss according to AASHTO T 96.

**3. Thin and Elongated Particles.** When directed, determine the percentage of particles retained on the 9.5 mm (3/8-inch) sieve that have a ratio greater than 1:5 (5:1) between the maximum and minimum dimensions of an imaginary enclosing rectangular prism. If the material retained on the 9.5 mm (3/8-inch) sieve constitutes less than 5.0% of the total mass (weight) of the test sample, do not determine the percentage of thin and elongated particles.

**TABLE C**
**Size and Grading Requirements for Coarse Aggregates**
**(Based on Laboratory Sieve Tests, Square Openings)**

| AASHTO Number | Total Percent Passing | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 mm (4") | 90 mm (3 1/2") | 63 mm (2 1/2") | 50 mm (2") | 37.5 mm (1 1/2") | 25.0 mm (1") | 19.0 mm (3/4") | 12.5 mm (1/2") | 9.5 mm (3/8") | 4.75 mm (No. 4) | 2.36 mm (No. 8) | 1.18 mm (No. 16) | 150 µm (No. 100) | 75 µm (No. 200) *** |
| 1 | 100 | 90-100 | 25-60 | | 0-15 | | 0-5 | | | | | | | |
| 3 | | | 100 | 90-100 | 35-70 | 0-15 | | 0-5 | | | | | | |
| 467 | | | | 100 | 95-100 | | 35-70 | | 10-30 | 0-5 | | | | |
| 5 | | | | | 100 | 90-100 | 20-55 | 0-10 | 0-5 | | | | | |
| 57 | | | | | 100 | 95-100 | | 25-60 | | 0-10 | 0-5 | | | |
| 67 | | | | | | 100 | 90-100 | | 20-55 | 0-10 | 0-5 | | | |
| 7 | | | | | | | 100 | 90-100 | 40-70 | 0-15 | 0-5 | | | |
| 8 | | | | | | | | 100 | 85-100 | 10-30 | 0-10 | 0-5 | | |
| 10 | | | | | | | | | 100 | 85-100 | | | 10-30 | |
| 2A** | | | | 100 | | | 52-100 | | 36-70 | 24-50 | 16-38* | 10-30 | | |
| OGS** | | | | 100 | | | 52-100 | | 36-65 | 8-40 | | 0-12 | | |

* Applies only for bituminous mixtures.
** PENNDOT Number
*** For 75 µm (No. 200), see Table D.

Note A: A combination of No. 7 and No. 5 may be substituted for No. 57, provided that not more than 50% or less than 30% of the combination is No. 7 size.

Note B: Provide No. OGS material that has a minimum average coefficient of uniformity of 4.0. The average coefficient of uniformity is defined as the average of the sublots within each lot. Determine the coefficient of uniformity according to PTM No. 149 each time the gradation is determined. The required minimum coefficient of uniformity for individual samples is 3.5. If the coefficient of uniformity of any sample falls below 3.5, reject the lot. Do not use the coefficient of uniformity in the multiple deficiency formula.

**4. Material Finer than the 75 µm (No. 200) Sieve.** Determine the loss by washing according to PTM No. 100 and Table D.

This test is not required for aggregate processed through a mechanical dryer for use in bituminous concrete; however, the aggregate is required to be clean and free of fines that would adversely affect the coating of the aggregate with bituminous material.

**TABLE D**
**Material Passing the 75 µm (No. 200) Sieve —**
**(Based on Laboratory Sieve Tests, Square Openings)**

| Section | Specification | % Maximum |
|---|---|---|
| 350 | Subbase (No. 2A) | 10 |
| 350 | Subbase (No. OGS) | 5 |
| 430 | Bit. Wear. Crse. FB-2 | 2 |
| 431 | Bit. Bind. Crse. FB-2 | 2 |
| 439 | Bit. Wear. Crse. FB-1 | 2 |
| 440 | Bit. Bind. Crse. FB-1 | 2 |
| 441 | Bit. Bind. Crse. CP-2 | 2.0 |
| 450 | Bit. Bind. Crse. DP-1 | 2.0 |
| 470 | Bit. Seal Coat | 1.0 |
| 471 | Bit. Seal Coat w/ Precoat. Aggr. | 2.0 |
| 480 | Bit. Surf. Treatment | 1.0 |
| 704 | Cement Concrete | 1 |
| — | All other uses | 2 |

**5. Crushed Fragments.** ASTM D 5821

**6. Compact Density.** AASHTO T 19, for slag.

**7. Deleterious Shale.** Determine the percentage of mass (weight) by four cycles of wetting and drying according to PTM No. 519. The MTD will use petrographic analysis to confirm the results.

**8. Friable Particles.** PTM No. 620, by percentage of mass (weight).

**9. Coal or Coke.** Determine the percentage of mass (weight) by visual identification and hand separation. If required, the MTD will use petrographic analysis to confirm the results.

**10. Glassy Particles.** Determine the percentage of mass (weight) by visual identification and hand separation. Pieces of slag containing more than 50% glass are considered to be glassy particles. Waste glass is also considered to be glassy particles. For coarse aggregate used in cement concrete, the maximum percentage of glassy particles allowed is 4%. For other uses, the maximum percentage of glassy particles allowed is 10%. Coarse aggregate containing glassy particles consisting of waste glass may not be used in cement concrete or bituminous wearing courses.

**11. Metallic Iron.** The MTD will use petrographic analysis to determine the content of metallic iron. Pieces of slag containing metallic iron are considered to be metallic iron. This requirement is waived when aggregate with metallic iron is used in bituminous mixtures or subbase.

**12. Clay Lumps.** Determine the percentage of mass (weight) by visual identification and hand separation. If required, the MTD will use petrographic analysis to confirm the results.

**(d) Testing and Acceptance.** Section 703.5(b)

## 703.3 SELECT GRANULAR MATERIAL (2RC)—

**(a) General.** Select granular material consists of durable bank or crushed gravel, stone, or slag mixed or blended with suitable filler materials to provide a uniform mixture. Obtain select granular material from a source listed in Bulletin 14. Stockpile, sample, and test material before it is used to ensure reasonable uniformity and acceptability. Use material free from vegetable or organic matter, lumps, or an excessive quantity of clay or other objectionable or foreign substances, and not more than 10% deleterious shale by mass (weight).

**(b) Gradation.** Conforming to the following gradation, determined according to PTM No. 619:

- Passing 50 mm (2-inch) sieve—100%
- Passing 4.75 mm (No. 4) sieve—15% to 60%
- Passing 150 µm (No. 100) sieve—0% to 30%

## 703.4 ANTI-SKID MATERIAL—

**(a) General.** For use on ice or snow-covered pavement surfaces, furnish anti-skid material conforming to Table E from a supplier listed in Bulletin 14. Do not use material containing metal, glass, or substances that may be harmful to automotive equipment and vehicles. Use material reasonably free of deleterious substances or foreign materials including, but not limited to, dirt, shale, slate, incinerated bituminous coal mine waste, and as specified in Section 703.2(a), Table B, Type C.

**(b) Description.**

**1. Types 1 and 1A.** Cinders, coke, crushed coal boiler bottom ash, or a combination of these. Bottom ash is residue of molten ash obtained from coal-burning boilers.

**1.a** Furnish bottom ash having no pyritic material or mill rejects commingled, mixed, or combined with it.

**1.b** Furnish Type 1 or 1A anti-skid material conforming to the following requirements:

- An air-dry loose density (weight) of not less than 560 kg/m$^3$ (35 pounds per cubic foot), determined according to AASHTO T 19, Section 7;
- Type 1, having a density (unit weight) of 1220 kg/m$^3$ (76 pounds per cubic foot) or less, or Type 1A, having a density (unit weight) of more than 1220 kg/m$^3$ (76 pounds per cubic foot);
- Crushed brick, crushed stone, blast furnace slag, steel slag, or gravel may be present in amounts not exceeding a total of 3% by mass (weight) of total dry mass (weight) of the sample, determined by the mass (weight) of this material retained on the 12.5 mm (1/2-inch) sieve;
- Unburned or partially burned coal or coke may be present in amounts not exceeding 7% by mass (weight) of total dry mass (weight) of the sample, determined by the mass (weight) of this material retained on the 9.5 mm (3/8-inch) sieve, except unburned coal, partially burned coal, or coke may not be present in bottom ash.

**2. Type 2.** Crushed stone, crushed gravel, or crushed slag, conforming to the following requirements:

- Not exceeding 1680 kg/m$^3$ (105 pounds per cubic foot);

- Los Angeles Abrasion loss not exceeding 55% by mass (weight), determined according to AASHTO T 96, Gradation D; and

- If crushed gravel is furnished, not less than 85% of the fragments retained on the 2.36 mm (No. 8) sieve are required to be crushed, one face, determined according to ASTM D 5821.

- Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by the mass (weight) of particles retained on the 4.75 mm (No. 4) sieve and by the total dry mass (weight) of the sample.

**3. Types 3, 3A, and 3B.** Either natural sand, with not less than 35% of the material retained on the 2.36 mm (No. 8) sieve being crushed fragments, determined according to ASTM D 5821; or manufactured sand, except limestone sand; or a combination of these.

Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by the mass (weight) of particles retained on the 4.75 mm (No. 4) sieve and by the total dry mass (weight) of the sample.

**4. Type 4.** Burned anthracite coal mine refuse with a Los Angeles Abrasion loss not exceeding 55% by mass (weight), determined according to AASHTO T 96.

**5. Type 6S.** Crushed stone, crushed gravel, or crushed slag conforming to the following requirements:

- Not exceeding 1680 kg/m$^3$ (105 pounds per cubic foot);

- Los Angeles Abrasion loss not exceeding 55% by mass (weight), determined according to AASHTO T 96, Gradation D; and

- If crushed gravel is furnished, not less than 60% of the fragments retained on the 4.75 mm (No. 4) sieve are required to be crushed, one face, determined according to ASMT D 5821.

- Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by the mass (weight) of particles retained on the 4.75 mm (No. 4) sieve and by the total dry mass (weight) of the sample.

**(c) Gradations.** Conforming to Table E.

**TABLE E**
**Anti-Skid Gradation**

| Anti-Skid Type | Maximum Percent Passing Sieve | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 31.5 mm (1 1/4") | 19.0 mm (3/4") | 12.5 mm (1/2") | 9.5 mm (3/8") | 4.75 mm (No. 4) | 2.36 mm (No. 8) | 300 µm (No. 50) | 150 µm (No. 100) | 75 µm (No. 200) |
| Type 1 | 100 | | | | | 70 | 18 | | |
| Type 1A | | 100 | 90-100 | | | 55 | 18 | | |
| Type 2 | | | 100 | 95-100 | | 30 | | 8 | |
| Type 3 | | | | 100 | | 85 | | 8 | |
| Type 3A | | | | 100 | | 55 | | 8 | |
| Type 3B | | | | 100 | 85-100 | 55 | | 5 | 4* |
| Type 4 | | | 100 | 95-100 | | 30 | | 8 | |
| Type 6S | | | | 100 | 35-85 | 55 | | 8 | 5* |

* Determined by PTM No. 100.

**(d) Testing.** If shipping to Department stockpiles, test material for moisture content according to PTM No. 513. A minimum of two tests per day is required. If conditions exist that would cause a change in moisture content, conduct additional tests. A Department representative will verify the test results.

Document tests at the end of delivery quantity at the end of the day and determine the average moisture content. The Department will adjust the delivery quantity by deducting the average moisture content from the aggregate quantity shipped. Payment is based on the calculated oven dry mass (weight).

## 703.5 ACCEPTANCE OF CONSTRUCTION AGGREGATES—

**(a) General.** The following describes the certification acceptance of construction aggregates. Accept AASHTO No. 1 Coarse Aggregate as specified in Section 850.2(a)1.

**(b) Testing and Acceptance.** Certify each day's shipment of aggregate as specified in Section 106.03(b)3.

**1. QC.** Section 106.03(b)2 and as follows:

- Submit for annual review a QC Plan conforming to the minimum Department requirements for aggregate suppliers.
- Establish and positively identify aggregate stockpiles that have been tested according to the approved QC Plan and conform to Department Specifications. Material may be added to or shipped from stockpiles at the producer's discretion.

**2. Source Verification Samples.** Under the direction and supervision of the Representative, obtain a verification sample (n=3) from each stockpile to be tested. Obtain the sample from the stockpile according to AASHTO T 2 or from a mini-stockpile. If the mini-stockpile method is chosen, obtain the sample according to the following procedure:

- Place approximately 10 tonnes (10 tons) of aggregate into a mini-stockpile on a suitable surface. Use a loader to strike off the top of the mini-stockpile.
- Obtain sufficient material for sampling from random locations on the mini-stockpile using a square faced shovel.

Immediately deliver the sample to the Representative for testing using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Representative will test all three increments for compliance with Tables A, B, C, and D, as applicable. If the test results verify that the material conforms to the specifications, use the material under certification.

If the material does not conform to the specifications, the Representative will determine the percent within limits (PWL) according to Section 106.03(a)3. If results indicate a PWL for the material of less than 90, the Representative will reject the stockpile.

If a stockpile is rejected, increase QC testing according to the reviewed QC Plan. Construct another stockpile of the aggregate to be tested consisting of 300 tonnes to 500 tonnes (300 tons to 500 tons) of material or the remainder of the quantity identified for Department projects, whichever is less. The Representative will accept the material under certification if test results verify that the material from the new stockpile conforms to the specifications.

**3. Project Verification Samples.** Under the direction and supervision of the Inspector, obtain verification samples (n=3) according to Table F for each type of aggregate at the point of placement (loose aggregate sample immediately before compaction):

**TABLE F**
**Verification Samples**

| Aggregate Quantities | Number of Samples (n=3) |
|---|---|
| 500 tonnes (500 tons) or more, but less than 2000 tonnes (2,000 tons) | 1 |
| 2000 tonnes (2,000 tons) or more, but less than 10 000 tonnes (10,000 tons) | 2 |
| 10 000 tonnes (10,000 tons) or more, up to 25 000 tonnes (25,000 tons) | 3 |
| Each additional increment of 25 000 tonnes (25,000 tons) | 1 |

The Inspector will select sample locations according to PTM No. 1.

Under the direction and supervision of the Inspector, immediately deliver the sample(s) to the test site at either the producers' location or the project site. The Inspector will test the sample(s) using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Inspector will test all three increments for compliance with Tables C and D, plus the Crushed Fragments Test of Table B when applicable. The Department will continue to accept material under certification if test results verify that the material conforms to the specifications.

If the material does not conform to the specifications, the Inspector will determine the average PWL of the material as specified in Section 106.03(a)3. If results indicate a PWL for the material of less than 90, immediately obtain an additional verification sample (n=3) at the project site from the next 150 tonnes (150 tons) of material.

Discontinue all operations using that type of aggregate until the results of the second verification sample are evaluated. If results indicate a PWL of 90 or more, resume operations using the evaluated aggregate. If the results indicate a PWL of less than 90, conduct acceptance testing at the point of placement according to the following procedure:

- Provide a separate field laboratory as specified in Section 609 at no additional expense to the Department. Do not resume operations using the material until the field laboratory is in place at the project site.

- Under the direction and supervision of the Inspector, obtain an acceptance sample (n=3) at the point of placement (loose aggregate sample immediately before compaction) for each day's placement. The Inspector will select sample locations according to PTM No. 1. Immediately transport the sample from the sampling point to the testing site. The Inspector will test all three sample increments for compliance with Section 703.2(c), Tables C and D.

- The Department will continue project acceptance testing until ten consecutive day's placements are accepted with no rejected material. The Contractor will be charged $200 per day, for each day the material is placed, for project acceptance testing performed by the Department.

- For test values not conforming to the specifications, the Department will determine the PWL according to Section 106.03(a)3. If results indicate a PWL for the material of less than 90, remove and replace the material at no additional cost to the Department.

**4. QA Samples.** BOCM QA samples (n=3) may be taken at the source of supply or at the point of placement on the project. Submit samples to the MTD for testing. If results for any type of material indicate a PWL of less than 90, the District will immediately obtain an additional verification sample (n=3) at the appropriate site (project or source). The Department will test all three sample increments at either the producer's location or at the project site and determine the PWL for the material. If results indicate a PWL for the material of less than 90, obtain source verification samples and project verification samples as specified in Section 703.5(b)2 and Section 703.5(b)3.

**(c) Weighing Responsibilities.** Prepare weight slips and certifications attesting to the accuracy of the weights recorded and ensuring conformance with Section 107.23(b). Designate a licensed weigh person(s) to act as the Contractor's agent. Ensure that scales are calibrated annually by an independent agency acceptable to the Department. A Department Inspector may provide random checking.

Weigh empty trucks used to haul material measured by mass (weight) daily unless otherwise directed. If the invoice mass (weight) exceeds the net mass (net weight) determined by a Department mobile weigh team by more than 3%, the Department will consider the deviation to be excessive. Take immediate corrective action upon notification of an excessive deviation. Within 30 days of notification, provide the District Executive with a written description of corrective actions and safeguards and the time that they were implemented.

# SECTION 704—CEMENT CONCRETE

## 704.1 GENERAL—

**(a) Description.** Furnish the indicated class of cement concrete according to the requirements of Table A. Cement concrete is a mixture of Portland cement, fine aggregate, coarse aggregate, water and air-entraining admixture, with or without water reducing admixture, retarding admixture, or pozzolan.

The methods of producing concrete referred to in these Specifications are defined as follows:

**1. Plant Mixed Cement Concrete.** Concrete proportioned and mixed in either a stationary, commercial, and central plant or a stationary plant located near the project. Concrete is delivered to the work site by truck, agitator truck, or mixer truck.

**2. Truck Mixed Cement Concrete.** Concrete prepared by dry batching in a proportioning plant and placing the dry ingredients in a truck mixer. Measured water is then added to the truck drum from the plant water system and the concrete is mixed in the truck at the plant. Mixing is not allowed en-route to or at the work site.

**3. Volumetric Mixed Cement Concrete.** Concrete proportioned and mixed in a truck-mounted mobile mixer. The unit is capable of proportioning concrete ingredients from self-contained bins and mixing the materials with measured water in a self-contained mixer. The concrete is mixed and discharged at the work site.

**(b) Material.**

- Cement—Section 701
- Fine Aggregate, Type A—Section 703.1
- Coarse Aggregate, Type A, No. 57, (Stone, Gravel, or Slag)—Section 703.2
- Water—Section 720.1
- Admixtures—Section 711.3
- Pozzolan—Section 724

**TABLE A (Metric)**
**Cement Concrete Criteria**

| Class of Concrete | Use | Cement Factor[3][5] ($kg/m^3$) | | Maximum Water Cement Ratio[6] (kg/kg) | Minimum Mix[2] Design Compressive Strength (MPa) Days | | | Proportions Coarse[1] Aggregate Solid Volume ($m^3/m^3$) | 28-Day Structural Design Compressive Strength (MPa) |
|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | | 3 | 7 | 28 | | |
| AAA | Bridge Deck | 376[4] | 446 | 0.43 | — | 25 | 31 | — | 28 |
| AA | Slip Form Paving[7] | 349 | 446 | 0.47 | — | 21 | 26 | 0.40-0.49 | 24 |
| AA | Paving | 349 | 446 | 0.47 | — | 21 | 26 | 0.37-0.49 | 24 |
| AA | Structures and Misc. | 349 | 446 | 0.47 | — | 21 | 26 | 0.37-0.49 | 24 |
| A | | 335 | 446 | 0.50 | — | 19 | 23 | 0.38-0.50 | 21 |
| C | | 234 | 390 | 0.66 | — | 10 | 14 | 0.42-0.56 | 14 |
| HES | | 446 | 502 | 0.40 | 21 | — | 26 | 0.34-0.44 | 24 |

Notes 1 and 3 pertain to structure and miscellaneous concrete only.

(1) Proportions shown in the table are shown on the reverse side of Form TR 4221-B and are controlled by class of concrete, fineness modulus of fine aggregate (PTM No. 501) and the solids percent in coarse aggregate (PTM No. 617).

(2) Test Procedures: Slump—AASHTO T 119; Strength—PTM No. 604, Compressive.

(3) For use in miscellaneous or structural concrete, if the Fineness Modulus (FM) is between 2.3 and 2.5, increase the minimum cement factor for the class of concrete 28 $kg/m^3$. This requirement may be waived after adequate strength data is available and analyzed according to the mix-design section in Bulletin 5.

(4) If mixing bridge deck concrete with a truck mounted volumetric plant, use a minimum cement factor of 390 $kg/m^3$.

(5) For exception, see Section 704.1(c).

(6) If a portion of the cement is replaced by pozzolan, use a water to cement plus pozzolan ratio by mass.

(7) For slip form paving, provide No. 57 coarse aggregate that has a minimum of 35% passing the 12.5 mm sieve. Base these results on the average of three samples, with no single sample result below 30% passing. Conduct testing at the concrete plant according to the QC Plan. Segregated stockpiles may be reworked and retested if material fails to conform to this requirement.

**TABLE A (English)**
**Cement Concrete Criteria**

| Class of Concrete | Use | Cement Factor[3][5] (lbs/cu. yd.) | | Maximum Water Cement Ratio[6] (lbs/lbs) | Minimum Mix[2] Design Compressive Strength (psi) Days | | | Proportions Coarse[1] Aggregate Solid Volume (cu. ft./cu. yd.) | 28-Day Structural Design Compressive Strength (psi) |
|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | | 3 | 7 | 28 | | |
| AAA | Bridge Deck | 634.5[4] | 752 | 0.43 | — | 3,600 | 4,500 | — | 4,000 |
| AA | Slip Form Paving[7] | 587.5 | 752 | 0.47 | — | 3,000 | 3,750 | 11.00-13.10 | 3,500 |
| AA | Paving | 587.5 | 752 | 0.47 | — | 3,000 | 3,750 | 9.93-13.10 | 3,500 |
| AA | Structures and Misc. | 587.5 | 752 | 0.47 | — | 3,000 | 3,750 | 9.93-13.10 | 3,500 |
| A | | 564 | 752 | 0.50 | — | 2,750 | 3,300 | 10.18-13.43 | 3,000 |
| C | | 394.8 | 658 | 0.66 | — | 1,500 | 2,000 | 11.45-15.10 | 2,000 |
| HES | | 752 | 846 | 0.40 | 3,000 | — | 3,750 | 9.10-12.00 | 3,500 |

Notes 1 and 3 pertain to structure and miscellaneous concrete only.

(1) Proportions shown in the table are shown on the reverse side of Form TR 4221-B and are controlled by class of concrete, fineness modulus of fine aggregate (PTM No. 501) and the solids percent in coarse aggregate (PTM No. 617).

(2) Test Procedures: Slump—AASHTO T 119; Strength—PTM No. 604, Compressive.

(3) For use in miscellaneous or structural concrete, if the Fineness Modulus (FM) is between 2.3 and 2.5, increase the minimum cement factor for the class of concrete 47 lbs/cu. yd. This requirement may be waived after adequate strength data is available and analyzed according to the mix-design section in Bulletin 5.

(4) If mixing bridge deck concrete with a truck mounted volumetric plant, use a minimum cement factor of 658 lbs/cu. yd.

(5) For exception, see Section 704.1(c).

(6) If a portion of the cement is replaced by pozzolan, use a water to cement plus pozzolan ratio by weight.

(7) For slip form paving, provide No. 57 coarse aggregate that has a minimum of 35% passing the 1/2-inch sieve. Base these results on the average of three samples, with no single sample result below 30% passing. Conduct testing at the concrete plant according to the QC Plan. Segregated stockpiles may be reworked and retested if material fails to conform to this requirement.

**1. Density of Material.** Except for admixtures, use the following material densities (unit weights) when proportioning cement concrete:

| Type of Material | Density |
|---|---|
| Water | 1 000 kg/m$^3$ (62.4 pounds per cubic foot) |
| Cement | 1 510 kg/m$^3$ (94.0 pounds per cubic foot) |
| Fine Aggregate | Based on bulk specific gravity as specified in Section 704.1(b)2 |
| Coarse Aggregate | |
| Stone or Gravel | Based on bulk specific gravity as specified in Section 704.1(b)2 |
| Slag | Based on field tests as specified in Section 704.1(b)2 |
| Pozzolan | Based on the MTD Tests |

**2. Specific Gravity of Aggregates.** For fine and coarse aggregates, use the bulk specific gravity (saturated, surface-dry basis) listed in Bulletin 14.

If slag is used, test at the site to determine its loose-struck density (unit weight), solid volume per cubic meter (cubic yard), and bulk specific gravity factor (saturated surface-dry basis). Establish the concrete proportions on the basis of the bulk specific gravity factor determined by the test. Check the density (unit weight) of the slag daily to maintain the established solid-volume proportions.

**3. Adjustment of Mass (Weight) of Free Water.** Adjust the batch mass (weight) of the aggregate to compensate for the free water on the aggregate. Base this adjustment on tests of representative samples taken from aggregate stockpiles.

**4. Batching.** For plant and truck mixed cement concrete, batch by mass (weight). For volumetric mixed cement concrete, batch by volume.

**(c) Design Basis.**

**1. General.** Compute and prepare concrete mix designs according to Bulletin 5. Base concrete mix designs on the materials to be used in the work.

Make trial mixtures for each class of concrete and mold and cure test specimens. If the requirements of Table A cannot be achieved, furnish other acceptable materials or make necessary changes in the mixing procedure to conform to the specified requirements.

At the start of construction, mix a full-sized batch using the type of mixer and the mixing procedure planned for the project. Use this batch to provide the basis for final adjustment of the accepted design.

**2. Cement Factor.** For all classes of concrete, use the minimum cement factor (cement or cement and pozzolan combined) specified in Table A, except as follows:

Portland cement may be replaced with pozzolan (flyash or ground granulated blast furnace slag) weighing as much as or more than the Portland cement replaced. If pozzolan is used, do not place flyash and ground granulated blast furnace slag in the same mix. The maximum limit of the cement factor may be waived if pozzolan is added to the mix provided the Portland cement portion does not exceed the maximum cement factor specified. If flyash is used, the Portland cement portion may be reduced by a maximum of 15%. If ground granulated blast furnace slag is used, the Portland cement portion may be reduced by a minimum of 25% to a maximum of 50%.

**3. Air Content.** Design cement concrete to have an air content of 6.0% in the plastic state. Obtain the air content through the addition of a solution of an air-entraining admixture as specified in Section 704.1(e)4. Use the quantity of air-entraining admixture necessary to maintain the plastic concrete air content, determined according to AASHTO T 152 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) for stone and gravel and AASHTO T 196 for slag coarse aggregate, within a tolerance of ± 1.5% during the work. The plastic concrete air content includes entrapped and entrained air.

If the hardened concrete exhibits deficiencies or the Representative suspects the hardened concrete to have deficiencies, and, if directed, determine the percent of entrained air in the hardened concrete according to PTM No. 623. Voids 1 mm (40 mils) or more in size are considered entrapped air and voids less than 1 mm (40 mils) in size are considered entrained air. The entrained air in the hardened concrete must be between 3.5% and 7.5%, inclusive.

**4. Mix Design Acceptance.** Submit a copy of each completed mix design to the Representative before its use in the work. The Department reserves the right to review any design through plant production before its use in Department work at no additional cost to the Department. The concrete design submitted for review is required to comply with the specified concrete class requirements, supported by slump, air content, and compressive strength test data according to Bulletin 5.

The Department will accept concrete designs on the basis of the 7-day strength tests (Class high early strength (HES) may be accepted on the basis of 3-day strength tests); however, conduct 28-day tests to show the potential of the design mix. The Department may also accept designs based on the 28-day tests.

A higher class concrete may be used in place of an indicated lower class concrete if the higher class concrete conforms to all of the requirements of the indicated lower class, and if approved by the Department.

**(d) Testing and Acceptance.**

**1. QC Plan.** Prepare a QC Plan as specified in Section 106.03 and submit it for review before the start of the project and at least annually thereafter. Include in the QC Plan testing frequencies and action points to initiate corrective measures. Do not start work until the Department has reviewed the QC Plan. Furnish a copy of the QC Plan to be maintained in the Department's project field office.

**1.a Field Operation QC Plan.** Prepare a field operation QC Plan for the Representative's review, as outlined on Form CS-704, to evaluate concrete field operation. Submit the field operation QC Plan at the Pre-construction conference or at least 2 weeks before the first concrete pour. Describe the construction equipment, personnel, and methods necessary to construct and test concrete courses for all structural elements. Include testing frequencies and action points to initiate corrective measures. Do not establish action points at either the upper or lower specification limits.

**2. Concrete Technician.** Provide, and assign to the work, a concrete technician properly instructed and trained to develop the concrete design, to control the quality and gradation of aggregates used, to perform required concrete tests, and to control the operations and concrete deliveries so that the completed mixture conforms to the specifications at the point of placement.

The Department's concrete plant Inspector will not allow concrete that is considered unacceptable to be shipped to the project. The Inspector will not assume, by act or by word, any responsibility for batch control adjustments; calculations; or for setting of any dials, gauges, scales, or meters. Failure of the Inspector to reject unacceptable concrete will not relieve the Contractor's obligation to provide concrete conforming to the specifications.

**2.a Concrete Field Testing Technician – Grade I.** Provide, and assign to the work, an ACI/PENNDOT certified field testing technician during placement of material to perform the required acceptance testing. The technician must carry a valid ACI and PENNDOT certification card during placement of material.

**3. Testing Facilities and Equipment.** Provide sufficient thermometers, air meters (AASHTO T 196 and T 152) and slump cones (AASHTO T 119) for each separate project operation as needed. In the presence of the Inspector, calibrate all air meters a maximum 2 weeks before beginning concrete placement. Re-calibrate all air meters, in the presence of the Inspector, every 2 weeks during concrete placement. Have back-up equipment available to ensure that no tests are missed. Provide sufficient 150 mm x 300 mm (6-inch by 12-inch) cylinder molds and tight-fitting domed caps (PTM No. 611) for QC, acceptance, verification, and QA samples. Provide sufficient incidental equipment such as wheelbarrows, shovels, and scoops as needed.

Provide acceptable means to conduct compressive strength testing using a compression machine and capping device conforming to PTM No. 604. Provide a curing tank conforming to PTM No. 611. Provide curing boxes, or other acceptable equipment, conforming to PTM No. 611 and capable of maintaining the air temperature immediately adjacent to the field-cured cylinders in the range of 16 ºC to 27 ºC (60F to 80F) for the first 24 ± 2 hours. Provide sufficient high-low thermometers or other temperature recording devices to monitor the temperatures next to the test cylinders. If required, cap cylinders at the testing site under the Representative's supervision.

Maintain all equipment used for testing in an operable condition. Using an independent agency acceptable to the Department, calibrate scales, balances, and the compression machine at least once per year. Re-calibrate the compression machine whenever it is relocated. Maintain accurate records of calibration. If the compression machine is out of tolerance or malfunctions, return it to working order within 24 hours or supply a back-up machine until the problem is corrected.

Provide the necessary facilities for inspection, including a plant office as specified in Section 714.5(a), with the exception of a minimum floor space of 11.1 $m^2$ (120 square feet).

**4. QC Testing.** Perform QC testing according to the reviewed QC Plan and as follows:

**4.a QC Sampling and Testing of Plastic Concrete.** Select an appropriate slump value that will provide a workable mix for the construction element. The Contractor's technician must have a copy of the Department reviewed QC Plan in their possession during testing and must be aware of the target slump for the structural element being placed. Do not exceed the following slump upper limits:

| Type of Mix | Slump Upper Limit |
|---|---|
| without water reducing admixtures | 125 mm (5 inches) |
| with water reducing admixtures | 165 mm (6 1/2 inches) |
| with high range water reducing admixtures (superplasticizers) | 200 mm (8 inches) |
| mixes specified in Section 704.1(h) (except tremie concrete as specified in Section 1001.2(j)) | 63 mm (2 1/2 inches) |

Perform plastic concrete slump, air, and temperature tests on the first three consecutive trucks at the beginning of concrete placement operations or after a significant stoppage such as plant or equipment breakdown to determine if material control has been established. Material control is established when all test results of concrete slump, air, and temperature for three consecutive trucks are determined to be within the established action points. Obtain samples of fresh concrete according to PTM 601. Perform slump tests according to AASHTO T 119, air content tests according to AASHTO T 152 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) or T 196 and temperature tests according to ASTM C 1064. Report test data to the concrete technician promptly in order to facilitate necessary changes. Continue testing consecutive trucks until material control is established. Once material control is established, the frequency of testing may be reduced to a minimum of one test per 40 $m^3$ (50 cubic yards). Select concrete batches for sampling according to the reviewed QC Plan or as directed by the Inspector. Notify the Inspector when sampling and QC testing are to be performed. The Inspector will witness the sampling and QC testing. If a QC test fails to conform to the specified requirements or exceeds the upper or lower action points included in the reviewed QC Plan, increase the testing frequency to every truck until material control has been reestablished.

Maintain the cement concrete consistency within 40 mm (1 1/2 inches) of the selected target slump value (target range). If the upper slump limit is exceeded on any slump test, the Contractor's technician shall reject the cement concrete. If any slump test result falls outside the target range and has not exceeded the upper limit, immediately perform the air content and temperature tests. If the air content and concrete temperature is within the specified limits, the Contractor may incorporate the material into the work provided a full set of quality control and acceptance cylinders are molded in addition to the cylinders made for the originally selected PTM No. 1 sample location, for compressive strength testing according to PTM No. 611 and PTM No. 604. If one or more truckloads of cement concrete exceeds the slump target range, make additional quality control and acceptance cylinders from each truck. Use the lowest compressive strength cylinders for acceptance of the lot.

Do not incorporate any concrete into the work that does not conform to the specified requirements.

**4.b QC Compressive Strength Test Cylinders.** From the same sample of concrete selected for acceptance testing as specified in Section 704.1(d)5, mold a sufficient number of concrete QC cylinders to be tested for 3-day or 7-day compressive strength, 28-day compressive strength, form removal strength, and loading strengths, as specified.

Field cure cylinders according to PTM No. 611, Section 11.2, for the specified curing period. After concrete curing is discontinued, QC cylinders may be relocated to a pre-approved, acceptable, secure area, to protect them from damage. Provide maintenance and security for the area at no additional cost to the Department. The secure area must be easily accessible for inspection at all times. Continue to provide the same field cure and protection from the elements on all surfaces of the cylinders as that provided for the in-place concrete the cylinders represent until the cylinders are tested for compressive strength. Remove cylinders from molds at the same time formwork is removed.

Perform QC testing for 3-day or 7-day compressive strength, 28-day compressive strength, and form removal and loading strengths according to PTM No. 611. Notify the Inspector when QC testing is to be performed. The Inspector will witness the QC testing.

Unless otherwise directed, use QC test results for 3-day or 7-day compressive strength and form removal and loading compressive strength to determine whether to place additional concrete in areas that will be impacted by the lot of concrete represented by the QC cylinders. Acceptable QC compressive strength test results do not relieve the Contractor's responsibility for providing concrete conforming to the 28-day minimum mix design compressive strength acceptance requirements specified in Section 704.1(d)5.

**4.b.1 3-Day or 7-Day QC Compressive Strength.** If the 3-day (HES concrete only) or 7-day QC compressive strength test result is greater than or equal to the minimum mix design compressive strength requirement specified in Table A, the Contractor may discontinue the field cure on the lot of concrete represented by the QC cylinders unless otherwise directed.

If the 3-day (HES concrete only) or 7-day QC compressive strength test result is less than the minimum mix design compressive strength requirement specified in Table A, continue the field cure on the lot of concrete represented by the QC cylinders until the specified 28-day minimum mix design compressive strength is obtained, or for a maximum of 28 days.

**4.b.2 28-Day QC Compressive Strength.** If the 28-day QC compressive strength test result is greater than or equal to the 28-day minimum mix design compressive strength specified in Table A, acceptance of the concrete lot will be based on the compressive strength testing of acceptance cylinders as specified in Section 704.1(d)5.

If the 28-day QC compressive strength test result is less than the 28-day minimum mix design compressive strength specified in Table A, but greater than or equal to the 28-day structural design compressive strength specified in Table A, acceptance of the concrete lot will be based on the compressive strength testing of acceptance cylinders as specified in Section 704.1(d)5, and as follows:

- Perform an investigation of procedures for material sampling, testing, and concrete cylinder molding and curing, and evaluate the concrete mix design and specification compliance to determine possible causes for the QC test result not meeting the specified minimum mix design compressive strength.
- Implement corrective actions as required.
- Submit an investigation report to the District Executive within 10 working days for review and approval.

If the 28-day QC compressive strength test result is less than the 28-day structural design compressive strength specified in Table A, acceptance of the concrete lot will be based on compressive strength testing of cores obtained from the lot of concrete represented by the QC cylinders as specified in Section 110.10(d).

**5. Acceptance Testing**. Determine the lot size, or portion thereof for partial lots, for material acceptance according to Table B. Establish new lots daily for each class of concrete. Lots must be specific to a particular structural element, except for incidental concrete items. The Contractor may use a lot combining structural elements if allowed in writing before concrete placement and if the following conditions are met:

- The total volume is 80 $m^3$ (100 cubic yards) or less.
- The combined structural elements are constructed using the same mix design concrete.
- The combined structural elements are cured using identical curing methods and conditions.

Cylinders (and cores when necessary) for this lot will represent all of the combined elements.

**TABLE B**
**Lot Size for Concrete Acceptance**

| Construction Area | Lot Size |
|---|---|
| Structural Concrete | 80 $m^3$ (100 cu. yd.) |
| Pavement Concrete | 380 $m^3$ (500 cu. yd.) |
| Pavement Patching Concrete | 150 $m^3$ (200 cu. yd.) |
| Incidental Concrete | 80 $m^3$ (100 cu. yd.) |
| Pavement Concrete RPS | Section 506.3(v) |

The Representative will select sample locations for acceptance testing according to PTM No. 1 (n=1). Perform sampling and testing for acceptance in the presence of the Representative. Obtain samples of fresh concrete at the point of placement according to PTM No. 601. Perform concrete temperature tests. Perform air content tests according to AASHTO T 196 or T 152. Reject all concrete not conforming to the specification requirements at the point of placement.

If the results of plastic concrete testing conform to the specification requirements, mold a sufficient number of acceptance cylinders according to PTM No. 611 from the same sample of concrete taken for slump, air content, and temperature determination. Standard cure acceptance cylinders according to PTM No. 611, Section 11.1, for 28 days at an acceptable location. Conduct 28-day compressive strength testing of two acceptance cylinders according to PTM No. 604. If for any reason two testable acceptance cylinders are not available for compressive strength testing, obtain two cores of the representative concrete within 3 working days as directed, and at no additional cost to the Department. Conduct 28-day compressive strength testing of the cores according to PTM No. 604.

The Department will accept the lot of concrete when the 28-day acceptance cylinder compressive strength test result is greater than or equal to the 28-day minimum mix design compressive strength specified in Table A and when the 28-day QC compressive strength requirements specified in Section 704.1(d)4.b have been met.

If the 28-day acceptance cylinder compressive strength test result is less than the 28-day minimum mix design compressive strength specified in Table A, acceptance of the concrete lot will be based on the procedures specified in Section 110.10.

**6. Verification Testing.** The Representative will perform verification testing on the initial acceptance sample for each type of concrete specified in Table B and a minimum of one verification test for every ten acceptance samples thereafter. Verification testing will consist of testing for temperature, air content, and compressive strength. Verification tests will be performed on concrete from the same sample used for acceptance testing.

The Representative will obtain the temperature of the sample concurrently with the acceptance sample. Immediately after an acceptable air content test result for acceptance is obtained, the Representative will test the sample for air content according to AASHTO T 196 or T 152 using the same air meter.

The Representative will mold two verification cylinders according to PTM No. 611. Standard cure the verification cylinders along with the acceptance cylinders according to PTM No. 611, Section 11.1, for 28 days. Conduct 28-day compressive strength testing of the verification cylinders according to PTM No. 604 in the presence of the Representative. Conduct the testing at the same time the acceptance cylinders are tested and using the same equipment.

Verification test results will be compared to the associated acceptance test results and will not be used to determine acceptance of the lot. If there is a difference in test results of more than 3 ºC (5F) for temperature, 1.0% for air content, or 3.5 MPa (500 pounds per square inch) for compressive strength, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances. The Representative will record the acceptance test results, the verification test results and applicable corrective measures in the Concrete Inspector's Daily Record Book, Form CS-472.

**7. QA Testing.** The BOCM QA personnel will obtain QA samples as part of the operation review process according to the QA Manual, Publication 25.

QA personnel will select concrete to be sampled. Obtain samples of fresh concrete at the point of placement according to PTM No. 601. Perform concrete temperature tests adjacent to those conducted by QA personnel. Perform air content tests according to AASHTO T 196 or T 152 with the air meter used for acceptance testing and the backup air meter. Immediately report all test results to the QA personnel. Reject all concrete not conforming to the specification requirements at the point of placement.

QA personnel will immediately perform an independent assurance evaluation of the temperature and air content test results. If the difference in test results is more than 3 ºC (5F) for temperature or 1.0% for air content, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances.

Mold five QA cylinders from the selected sample according to PTM No. 611. Field cure the QA cylinders according to PTM No. 611, Section 11.2, for the specified curing period for the structural element the cylinders represent. After curing of the in-place concrete is discontinued, QA cylinders may be relocated to a pre-approved, acceptable, secure area, to protect them from damage. Provide maintenance and security for the area at no additional cost to the Department. The secure area must be easily accessible for inspection at all times. Continue to provide the same field cure and protection from the elements on all surfaces of the cylinders as that provided for the in-place concrete the cylinders represent until the cylinders are tested for 28-day compressive strength.

Conduct 28-day compressive strength testing on two QA cylinders according to PTM No. 604 using the same equipment used for acceptance and verification testing.

The Representative will forward the remaining three QA cylinders to the MTD for 28-day compressive strength testing according to PTM No. 604 and hardened air content testing according to PTM No. 623. Furnish packaging material and package cylinders under the direction and supervision of the Representative. Place the cylinders in individual containers cushioned with suitable material to prevent damage during shipment. The total mass (weight) of each container, cylinder and cushioning material must not exceed 22 kg (50 pounds).

QA personnel will perform an independent assurance evaluation of the 28-day compressive strength test results. If the difference between the test results of the cylinders tested at the project site and the cylinders tested at the MTD is more than 3.5 MPa (500 pounds per square inch), the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances.

**(e) Measurement of Material.**

**1. Cement.** AASHTO M 157 and as follows:

For plant and truck mixed concrete, measure by mass (weight). The Contractor may measure the mass (weight) of the cement separately in an enclosed compartment in the aggregate hopper. The Contractor may measure the mass (weight) of the cement and discharge it simultaneously with the aggregates, except as specified in Section 106.05(c).

For volumetric mixed concrete, measure by volume.

**2. Aggregates.** AASHTO M 157 and as follows:

For plant or truck mixed concrete, measure by mass (weight) unless otherwise allowed. Base measurements on the material mass-volume (weight-volume) relationship, as specified in Section 704.1(b)1.

For volumetric mixed concrete, measure by volume.

**3. Water.** AASHTO M 157 except as follows:

Use water-measuring systems capable of discharging the total quantity of measured water into the plant or truck mixer drum in a time not greater than one-fourth of the specified mixing time. For truck mixed concrete, do not add water from the truck water system. Add water only from the plant water measuring system.

**4. Admixtures.** Incorporate the air-entraining admixture solution into the batch with the mixing water using a suitable visual measuring device. If another type of admixture is used with an air-entraining admixture, add it in solution to another portion of the mix water, as directed, by an additional suitable visual measuring device, except high range water reducing admixtures will be added according to the manufacture's recommendations .

Equip the measuring device with interlocks to prevent discharging during the charge cycle and to prevent charging during the discharging cycle. Provide a means to calibrate the measuring device to within ±3%.

Dispense the air-entraining admixture solution into the batch from a bulk supply tank. For paving, and if directed, provide a bulk supply tank containing sufficient solution for the entire day's concreting operations.

On the dispensing system, provide device(s) capable of detecting and indicating the presence or absence of admixture flow. Agitate admixtures, as required, to insure consistency of the solution.

**5. Pozzolan.** If the use of pozzolan is allowed by the specification, add separately and measure cumulatively as specified in Section 704.1(e)1.

**(f) Mixing Conditions.**

**1. During Cool and Cold Weather.** If concrete is to be placed at air temperatures below 5 °C (40F), or if the local weather bureau forecasts air temperatures to descend to 5 °C (40F) or lower at any time during the 24-hour period following concrete placement, use an acceptable method to ensure that the aggregate is free of frozen lumps and at a temperature of not less than 5 °C (40F) or more than 40 °C (100F) at the time of charging into the mixer. Heat mixing water, if necessary, but do not exceed 65 °C (150F). Do not allow water with a temperature above 32 °C (90F) to come in contact with the cement until the cement has been mixed with the aggregates.

**2. During Hot Weather.** In hot weather, cool the aggregates and the mixing water as necessary to maintain the concrete temperature within the range of 10 °C to 32 °C (50F to 90F) at the time of placement. For bridge deck concrete placement, maintain the concrete temperature between 10 °C and 27 °C (50F and 80F) at the time of placement.

**3. Retarding Admixtures.** The Contractor may use retarding admixtures, or may be directed to use retarding admixtures, when any of the following conditions are anticipated:

- rapid drying of the concrete as a result of low humidity
- high winds
- high air temperatures

Introduce the retarder into the concrete mixture as specified in Section 704.1(e)4. Adjust the proportions of the design as necessary but do not use the retarder to replace any portion of the specified volume of cement.

Use a retarder that is available in sufficient quantities to provide the required degree of retardation under the prevailing weather conditions at the time of concrete placement.

**(g) Mix Designs Using Potentially Reactive Aggregate.**

**1. Definition of Terms.**

**1.a Alkalis.** Oxides of sodium and potassium generally derived from Portland cement, but may also be available to concrete from other sources such as; admixtures, de-icing salts, and, in rare instances, aggregates. Alkalis are calculated according to AASHTO M 85.

**1.b Pozzolan.** A siliceous or siliceous and aluminous material that possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties. The term "pozzolan," includes flyash, ground granulated blast-furnace slag, and silica fume.

**1.c Alkali-Aggregate Reaction.** A chemical reaction in concrete between alkalis and certain constituents of some aggregates. The products of this reaction, under certain conditions, may cause deleterious expansion within the concrete.

**1.d Alkali-Silica Reaction.** An alkali-aggregate reaction involving certain siliceous aggregates and some calcareous aggregates containing certain forms of silica.[1]

Note (1)—Siliceous substances that are known to react with alkalis are as follows: opal; chalcedony as a constituent of chert in carbonate rock or sand and gravel particles; tridymite and christobalite, which are high temperature forms of silica found in andesite or rhyolite; acid glasses containing more than 65% silica; or intermediate glasses containing between 55% and 65% silica. Other siliceous substances that are potentially reactive with alkalis are strained quartz as a constituent of granite or granite gneiss and clay minerals as a constituent of graywackes, argillites, phyllites, and siltstones.

**2. Aggregate Evaluation.** The MTD will test aggregates according to AASHTO T 303. Aggregates that develop expansion greater than 0.10% after 14 days in solution (16 days - age of bar) are considered potentially reactive with cement alkalis. The Contractor may test aggregates according to ASTM C 227 to confirm potential reactivity of fine or coarse aggregate, but not to classify an aggregate as "nonreactive." If ASTM C 227 mortar bars are made with cement having an alkali content greater than 0.80%, aggregates are considered to be "reactive" if expansion is greater than 0.05% at 3 months or greater than 0.10% at 6 months.

Use aggregates that are deemed potentially reactive only with cements or cement-pozzolan combinations as specified in Section 704.1(g)3. If one or both of the aggregates (coarse or fine) used in a mix is reactive, mitigation is required as specified in Section 704.1(g)3. This requirement applies to all concrete used in paving or permanent structures on Department projects, including latex modified overlays and precast and prestress concrete products.

**3. Cement/Cement-Pozzolan Requirements.** For use with aggregate deemed potentially reactive as specified in Section 704.1(g)2, provide Portland cement, blended hydraulic cement, or Portland cement-pozzolan combinations conforming to the requirements of Section 704.1(b) and the following:

**3.a Portland Cement.** Conforming to the optional chemical requirement in AASHTO M 85 for a maximum alkali content of 0.60%.

**3.b Blended Hydraulic Cement.** Type IS or IP, ASTM C 595. From a manufacturer listed in Bulletin 15.

**3.c Portland Cement-Pozzolan Combination.** Furnish a combination of Portland cement with an alkali content no greater than 1.40% and flyash, ground granulated blast furnace slag, or silica fume tested and qualified by the MTD as follows:

- Flyash—Furnish flyash that conforms to the optional chemical requirement in AASHTO M 295 for a maximum alkali content of 1.5% and that produces a 50% minimum reduction in mortar expansion when tested by the MTD according to ASTM C 441. Use a quantity of flyash equal to a minimum of 15%, by mass, of the total cementitious material. If flyash is added to reduce alkali-silica reactivity, use a quantity of flyash between 15.0% and 25.0%, by mass, of the total cementitious material. If aggregate expansion, when tested according to AASHTO TP 14, is greater than 0.40%, use a quantity of flyash equal to a minimum of 20%, by mass, of the total cementitious material. Flyash may replace no more than 15.0% of the Portland cement; the remaining flyash is to replace the fine aggregate.

- Ground Granulated Blast Furnace Slag—Furnish slag producing a 50% minimum reduction in mortar expansion when tested by the MTD according to ASTM C 441. Use a quantity of slag between 25.0% and 50.0%, by mass, of the total cementitious material. If aggregate expansion, when tested according to AASHTO TP 14, is greater than 0.40%, use a quantity of ground granulated blast furnace slag equal to a minimum of 40%, by mass, of the total cementitious material.

- Silica Fume—Use a quantity of silica fume between 5% and 10%, by mass, of the total cementitious material. Use of silica fume will be allowed on an experimental basis only, until sufficient experience is gained.

The Department may waive flyash or ground granulated blast furnace slag requirements if the Contractor presents test results from an independent laboratory showing that a lesser amount of pozzolan will mitigate ASR expansion to below 0.10% when tested according to AASHTO TP 14.

**4. Admixture Requirements.** Furnish accelerators or other chemical admixtures as specified in Section 711.3.

**5. Exceptions.** If a service record of nonreactivity can be documented, the Department may exempt aggregates classified as potentially reactive, as specified in Section 704.1(g)2, from the cement/cement-pozzolan requirements of Section 704.1(g)3. The service record must include a minimum of 10 structures, each over 10 years of age, which have been exposed to moisture in service and contain high alkali content cement (more than 0.60%).

Include the following documentation in the service record:

- A report on the visual examination of each structure for cracking and expansion at joints.

- Petrographic analysis of cores according to ASTM C 856 to determine the presence or absence of alkali-silica gel formations and associated microcracking.

- Determination of the aggregate classification according to ASTM C 295.

**(h) Extra Cement Concrete.** If 25% extra cement is required as specified in Section 1001.3(k)3.a, the extra cement may be replaced with other cementitious material in the same proportions as established in the mix design or Section 704.1(c). Up to 50% of the water dose for the extra cementitious material, based on the water cement ratio of the mix being utilized, may be added. Add additional admixtures as required.

**704.2 PLANT AND TRUCK MIXED CEMENT CONCRETE—**

**(a) Batching Plant.** Proportion cement, aggregates, water, and admixtures in a plant conforming to the requirements of AASHTO M 157 for batching plants.

Install a moisture meter to accurately and continuously indicate the variability of the fine aggregate moisture content. If approved, automatic moisture compensating probes for fine and coarse aggregate may be used to control the amount of batched water. Calibrate moisture probes according to the reviewed QC Plan.

Provide scales with graduation increments no greater than 1/1000 of the total scale capacity to measure the mass (weight) of aggregates or cement. Increments of less than 2 kg (5 pounds) are not required. Provide scales with capacities approximately equal to the hopper capacity or the central mixer capacity under normal proportioning conditions.

Provide a minimum of ten 20 kg masses (50-pound weights) at the plant for checking the scale's accuracy. Store the masses (weights) in a manner to maintain their mass-calibration (weight-calibration) accuracy.

Check the accuracy of the bin scales according to PTM No. 410.

Provide the plant with the following equipment for developing the concrete design and to control the quality of aggregates used and the concrete produced:

| Number of Each | Equipment |
|---|---|
| 1 | Sample splitter for fine aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of 12 total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 20 mm (3/4 inch). Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material. |
| 1 | Sample splitter for course aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of eight total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material. |
| | Or |
| 1 | Adjustable sample splitter for both course aggregate and fine aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of 12 total chutes is required. For course aggregate, the minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. For fine aggregate, the minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 20 mm (3/4 inch). Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material. |
| 1 | Mechanical Sieve Shaker (with timer)—PTM No. 616 |
| 1 Set Each | Standard Sieves for Fine and Coarse Aggregate—AASHTO M92 |
| 1 | Oven capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F)—PTM No. 616 |
| 1 | Calculating machine |
| 1 | Cylindrical Metal Measure (25 L (1 cubic foot))— AASHTO T 19 and T 121, C 136 |
| 1 | Air Meter, acceptable type— AASHTO T 196 and T 152 |
| 1 | Slump Cone— AASHTO T 119 |
| 1 | Cylinder Compression Machine—PTM No. 604[(1)] |
| 1 | Curing Tank—PTM No. 611[(2)] |
| 1 | Capping Device—PTM No. 604[(1)] |
| 1 | Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required, for the principle sample mass (weight) of the sample being tested—PTM No. 616. |
| 1 | Platform scale conforming to the requirements of AASHTO M 231 for the class of general purpose scale required, for the principle sample mass (weight) of the sample being tested—PTM No. 616, and AASHTO T 121 and C 136 |
| Sufficient | 150 mm x 300 mm (6-inch by 12-inch) Cylinder Molds—PTM No. 611 |
| | Necessary Incidental Equipment |

Note (1)—Equipment requirements may be waived provided that arrangements for testing have been made at the producer's central facility or at a commercial testing laboratory that participates in the AASHTO Accreditation Program in the area of Concrete Testing. Commercial testing laboratories are to conform to ASTM E 329 for Concrete Inspection and Testing except for the equipment listed above.

Note (2)—Equipment requirements may be waived provided that, after 24 hours (±2 hours), specimens made for checking the strength of trial mixes are properly transported to a central facility or commercial testing laboratory for curing according to PTM No. 611.

Provide the plant with proper laboratory equipment, space, and utilities as specified in Section 609.

**(b) Mixers and Agitators.** AASHTO M 157. If directed, test air content of individual mixed concrete samples taken approximately at the beginning, the midpoint, and the end of the batch. If the air content varies by more than 1.5%, discontinue the use of the mixer or agitator until the condition is corrected.

If mixing in truck mixers at the plant, use inclined-axis, revolving-drum type mixers or horizontal-axis, revolving-drum high-discharge type mixers.

**(c) Mixing and Delivery.** Maintain concrete temperature after mixing between 10 °C and 32 °C (50F and 90F) for general concrete, and between 10 °C and 27 °C (50F and 80F) for bridge deck concrete. Do not ship concrete exceeding these temperature ranges. Maintain adequate two-way communications between the concrete plant and the work site to provide both uniformity and control of the concrete mixture.

For each truck, furnish a plant delivery slip signed at the plant by the technician or other designated person. Include the following information on the delivery slip:

- Contract number, complete state project number or purchase order number.
- The concrete plant supplier code.
- Method of concrete mixing (i.e., central or truck).
- Class of concrete, JMF number, and trial mix number (i.e., trial #1, 2, etc.).
- Number of cubic meters (cubic yards).
- Time of completion of mixing.
- Truck number.
- Number of mixing revolutions, if applicable.
- Total amount of batch water used in each truck (in kilograms (pounds)).
- The total mass (weight) in kilograms (pounds) of the total cementitious materials.
- The types of additives used in each truck (i.e., water reducer, AEA, retarder, etc.).

Submit the plant delivery slip and batcher-mixer slip (as specified in AASHTO M 157) to the Inspector-in-Charge. Do not use any concrete until it is approved for use by the Inspector-in-Charge.

Comply with the requirements of AASHTO M 157, except as follows:

- If mixing in a plant, mix for not less than 50 seconds or more than 90 seconds for normal strength concrete, and not less than 70 seconds for HES concrete.

- If mixing in the truck drum at the plant, mix for not less than 70 or more than 125 truck-drum revolutions, at a mixing speed of not less than 6 truck-drum rpm nor more than 18 truck-drum rpm. Upon completion of the designated number of mixing revolutions, reduce the truck-drum speed to not less than 2 rpm or more than 6 rpm. Do not exceed a total of 300 truck-drum revolutions.

- Deliver the mixed concrete to the work site and discharge within 1 1/2 hours after completion of mixing. Agitate, but do not mix the concrete en-route to the work site.

- In hot weather, under conditions contributing to quick concrete stiffening, or if the concrete temperature is 27 °C (80F) or above, do not allow the time between completion of mixing and discharge to exceed 1 hour. As an alternative to maintaining the concrete temperature below 27 °C (80F), use an approved, set retarding admixture to extend the initial set time and enable the mix to remain workable for the full 1 1/2 hours of allowable mixing time.

- If using mixer or agitator trucks, agitate concrete for at least 20 revolutions immediately before placement. Do not use concrete that has exceeded 45 minutes without agitation.

- If wash water is used to clean the truck drum, completely discharge this wash water before the introduction of the succeeding batch.

- Do not allow concrete to come in contact with aluminum unless the aluminum is coated with an acceptable coating (delivery of concrete in an aluminum truck bed is allowed).

## 704.3 VOLUMETRIC MIXED CEMENT CONCRETE—

**(a) General.** Use a plant inspected and listed in Bulletin 42. Make trial mixtures with a calibrated mixing plant. Provide plant equipment, facilities, and a concrete technician(s) as specified in Section 704.1. Do not begin production until the mixing plant and all equipment and facilities necessary for performing the work have been inspected and accepted. Mixing plants may be truck mounted.

**(b) Usage.** Volumetric mixing plants may be used to produce concrete for endwalls, inlets, manholes, end anchors, sign posts, and similar miscellaneous structures requiring small quantities of concrete. If allowed by the District Executive in writing, volumetric mixing plants may also be used for pavement patching and structures. Approved plants may produce concrete for precast items.

**(c) Equipment.** Prominently attach a permanent metal plate(s) to the plant plainly marking the gross volume in terms of mixed concrete, the operating speed, the plant auger mixing angle, and the plant mass-calibrated (weight-calibrated) cement constant in terms of a revolution counter or other output indicator, all as rated by the manufacturer.

**1. Compartments.** Provide separate compartments to carry the ingredients. Cover the aggregate bins and prevent contamination and intermixing of the fine and coarse aggregates during loading and transporting. Keep the cement bins free of moisture and contamination. Provide suitable means to carry water and additives and to incorporate the additives with the mixing water in the mix.

**2. Feed System.** Provide a feeder system mounted under the compartment bins to deliver the ingredients to the mixing unit. Equip each bin with an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from the bin compartment. Do not charge aggregate bins more than 4 hours before mixing.

Set the cement bin feeding mechanism to discharge a given volumetric mass (weight) equivalent of cement at a continuous and uniform rate during the concrete mixing operation. Coordinate the coarse and fine aggregate feeding mechanisms with the cement feeding mechanisms to deliver the required proportions.

**3. Mixing Unit.** Provide an auger-type mixer incorporated in the plant's discharge chute, or another suitable mixing mechanism that produces concrete of uniform consistency and discharges the mix without segregation. Examine the mixing screw daily and clean as necessary to prevent the build-up of mortar or concrete.

**4. Dials and Measuring Devices.** Equip the plant with accurate revolution-counter indicators that allow the volumetric mass (weight) equivalent of cement, fine aggregate, and coarse aggregate discharged to be read during the concrete-mixing operation. Equip the counter with a ticket print-out to record this quantity.

Equip the plant with a water flow meter or gauge to indicate the discharge rate of water (by volume) entering the mix and a water meter to register the total amount of water discharged during the mixing operation. Also, equip the plant with suitable gauges for checking the rate of flow of any additive entering the mix. Coordinate the water and additive flow meters with the cement and aggregate feeding mechanisms. Equip the flow meters with scales appropriate for the type and amount of material being measured. Mount a tachometer indicating the drive shaft speed on the plant.

Place gauges, dials, and other devices that indicate the accuracy of concrete proportioning and mixing in full view so that the operator can accurately read or readjust them while concrete is being produced. Provide the operator convenient access to all controls.

**(d) Calibration.** Use a unit constructed to allow convenient calibration of the gate openings and meters. Conduct a calibration once a year in the presence of Department representatives. Make satisfactory arrangements with the Department at least 1 week in advance of calibration. During the yearly calibration, calibrate the cement meter according to the manufacturer's recommendation and check the aggregate gate settings against the calibration data for the plant. Maintain the calibration data in the plant and submit the data to the District.

After performing the yearly calibration and before starting work, provide a mix design for review and acceptance and run a yield test to verify the design. Adjustments to correct for yield may require recalibration or a design change.

Conduct a recalibration if there is a change in the source of fine or coarse aggregate or cement. Conduct additional calibrations if directed. Provide each plant with data on the accepted recalibration.

If hydraulic drive units are used, perform the following additional calibration procedure: At the beginning of the actual batching operation, check the cement meter against the count and time used for the cement during the calibration of the individual materials. If a discrepancy occurs, adjust the belt speed of the unit so that the actual cement meter count does not vary from the calibrated meter count by more than two counts per 60 seconds.

**(e) Mixing and Delivery.** Proportion, measure, and batch cement and aggregates by a volumetric mass (weight) equivalent method. The measuring and batching mechanism is required to produce the specified proportions of each ingredient within the following tolerances:

- Cement, Mass (Weight) 0 to +4%
- Fine Aggregate, Mass (Weight) ±2%
- Coarse Aggregate, Mass (Weight) ±2%
- Admixtures, Mass (Weight) or Volume ±3%
- Water, Mass (Weight) or Volume ±2%

The tolerances are based on a volume/mass (volume/weight) relationship established during the calibration of the measuring devices.

During mixing, maintain the drive shaft speed, as indicated by the tachometer, within 50 rpm of the operating speed. Set the auger mixer angle in the range determined by the manufacturer. Do not exceed 1/2 hour between the continuous placing of succeeding batches.

**1. Testing.** Conduct slump and air content tests according to PTM No. 601. Conduct the unit mass (weight) test, the concrete uniformity test, and the output meter calibration test according to AASHTO T 121, C 136, AASHTO M 157, and PTM No. 626. If there is any doubt in the uniformity of the concrete, perform further testing as directed.

**2. Recording.** Provide a batcher mixer slip with each load of ingredients. Include the following information on the batcher mixer slip:

- Aggregate gradation and moisture information.

- Class of concrete and the corresponding dial setting, as determined in the design.
- Water discharge rate limitations.

Use a separate batcher mixer slip for each class of concrete. Deliver the batcher mixer slip to the Inspector-in-Charge at the work site. Do not use the concrete until the Inspector-in-Charge verifies the data noted on the slip complies with the specifications.

# SECTION 705—JOINT MATERIAL

**705.1 PREMOLDED EXPANSION JOINT FILLER**—From a manufacturer listed in Bulletin 15, provide cork or sponge rubber or fiber joint fillers conforming to the following requirements:

**(a) General.** As shown on the Standard Drawings, or as indicated.

When used for transverse joints in reinforced or plain cement concrete pavement, furnish lengths equal to the width of the traffic lane, ramp, or taper with a minimum thickness of 25 mm (1 inch). Also, provide a smooth top surface and holes punched for dowel bars to provide a snug fit without loss in thickness of the material.

When used for longitudinal joints in concrete base courses, furnish pieces at least 2.4 m (8 feet) in length and join securely.

When used for joints in structures, furnish pieces at least 2.4 m (8 feet) in length, or as otherwise indicated, and join securely.

**(b) Cork or Preformed Rubber.** AASHTO M 153 and as follows:

Joint filler modified to include polyurethane bonded recycled rubber, consisting of preformed strips of a durable composite of ground recycled rubber from automobile tires bonded together with polyurethane adhesive, is allowed.

**(c) Fiber.** AASHTO M 213, except that a specimen at least 100 mm (4 inches) on a side, with a minimum area of 0.01 $m^2$ (16 square inches), is necessary for the compression test. For glass fiber tested for compression, the applied force may be less than the minimum 689 kPa (100 pounds per square inch).

**(d) Certification.** Section 106.03(b)3.

**705.2 LONGITUDINAL JOINT MATERIAL**—From a manufacturer listed in Bulletin 15 and as shown on the Standard Drawings or as indicated. Use tie bars, tiebolts, and key formers, conforming to the following requirements:

**(a) Tie Bars.**

**1. Deformed Tie Bars.** Section 709.1(a)1, 709.1(b)1, 709.1(d)1, or 709.1(e), and epoxy coated as specified in Section 709.1(d).

**2. Deformed Bent Tie Bars.** Section 709.1(a)1, 709.1(b)1, 709.1(d)1, or 709.1(e) and epoxy coated as specified in Section 709.1(d).

**(b) Tiebolts.** Certify as specified in Section 106.03(b)3 and as follows:

- Manufactured from mild steel.
- A 14 mm (9/16-inch) diameter bar with rolled threads or a 16 mm (5/8-inch) diameter bar with cut threads, with a threaded sleeve nut.
- For the nut, steel pipe or hexagonal steel bar (27 mm diameter x 48 mm long (1 1/16 inches diameter by 1 7/8 inches long)), or a high strength steel bar (21 mm diameter x 50 mm long (27/32-inch diameter by 2 inches long)).
- For the assembled tiebolt, a minimum yielding load of 66 700 N (15,000 pounds) is necessary.
- Epoxy coated or galvanized, excluding threads, as specified in Section 709.1(c) or 1105.02(s).

**(c) Key Former.** Manufactured of a material that does not deform during concrete placement.

**705.3 FORCE-TRANSFER UNITS FOR REINFORCED AND PLAIN CEMENT CONCRETE PAVEMENTS—**

**(a) General.** As shown on the Standard Drawings and as follows:

**1. Coated Dowel Bars and Supporting Members.** Section 709.1(a)2. Provide bars with their free end a true circle and having no burrs.

**2. Alternate Shaped Coated Dowel Bars.** Bars with properties equivalent to conventional, round steel-coated dowel bars, may be used, when accepted by the MTD.

**3. Bondbreaking Requirements.** AASHTO M 254

**3.a Type A.** Coating material develops sufficiently low bond strength with concrete so that a bondbreaker is not necessary.

**3.b Type B.** Coating material develops bond strength with concrete so that a bondbreaker is necessary. Shop-applied bondbreakers are to conform to the pull-out load requirements of AASHTO M 254.

**(b) Dowel Bar Coating.** AASHTO M 254 modified as follows:
Provide fusion-bonded epoxy coating as a Type B coating with a nonabraded thickness of 0.13 mm to 0.30 mm (5 mils to 12 mils). No more than 6 holidays per meter (2 holidays per linear foot) average, as detected with a 67.5 V holiday detector, are allowed. Repair areas damaged during shipment, handling, fabrication, or placement. The sum of all damaged areas to be repaired per meter (linear foot) may not exceed 2% of the bar surface area per meter (linear foot). Repair any visible signs of rust, and any visible defects. Repair is accomplished by means of a mechanical wire brush cleaning, or another acceptable procedure, followed by application of an approved epoxy paint utilizing the paint manufacturer's recommended procedure. Do not cover in excess of 5% of the total bar surface area with patching material.

**(c) Mechanically Galvanized Dowel Bars.** Provide galvanizing as specified in Section 1105.02(s) (ASTM B 695 and B 696). Coating thickness to be not less than 0.086 mm (610 g/m$^2$) (3.4 mils (2.0 ounces per square foot)).

**(d) Certification.** Section 106.03(b)3

**705.4 JOINT SEALING MATERIAL—**

**(a) Silicone Joint Sealing Material.** Low modulus, nonsag-silicone, sealing material in a nonacid-curing, one part formulation, which requires tooling, from a manufacturer listed in Bulletin 15. Furnish silicone joint sealing material conforming to the following physical requirements:

| | |
|---|---|
| • Tensile Stress at 150% elongation, kPa (psi), max. (ASTM D 412, Die C) 7-day cure at 25 °C ± 2 °C (77F ± 3F) and 45% to 55 % relative humidity | 310 (45) |
| • Elongation at maximum tensile strength, %, min. (ASTM D 412, Die C) | 600 |
| • Extrusion rate, grams/second (grams/minute), min. -18 °C to 38 °C (0F to 100F) (Test for extrusion using an air-powered caulking gun, having a 3 mm (1/8-inch) orifice, at 620 kPa (90 psi)) | 1.25 (75) |
| • Specific gravity (ASTM D 792, Method A) | 1.010 to 1.515 |
| • Durometer hardness, shore "A" (ASTM D 2240) 7-day cure at 25 °C ± 2 °C (77F ± 3F) and 45 to 55% relative | 10 to 25 @ -18 °C (0F) |

humidity.

| | |
|---|---|
| • Shelf life, days, min., from date of manufacture. | 180 |
| • Ozone and ultraviolet resistance (ASTM C 793) | No chalking, cracking, or bond loss after 5000 hours. |
| • Flow (MIL S 8802) | Nil |
| • Bond to cement mortar, kPa (psi), min., primed if required. (Mold three cement mortar briquets according to AASHTO T 132 and moisture cure for at least 28 days. Saw briquets in half, clean, and oven dry to a constant mass (weight) in an oven at 110 °C ± 5 °C. After cooling, bond halves together with approximately 0.3 mm (10 mils) of silicone sealant, cure 7 days at 25 °C ± 2 °C (77F ± 3F) and 45 to 55% relative humidity, and test using clips conforming to AASHTO T 132. Test specimens in tension at loading rate of 0.13 mm/s (0.3 inch/minute). | 345 (50) |
| • Tack free time, minutes, max. (ASTM C 679) | 90 |
| • Movement capability and adhesion (ASTM C 719) | Cyclic movement: +100% / -50% (extension/compression), no adhesive or cohesive failure after 10 cycles @ -18 °C (0F) |

**(b) Rubberized Joint Sealing Material.** Low Modulus, ASTM D6690-Type IV, from a manufacturer listed in Bulletin 15.

**(c) Rubberized Joint Sealing Material.** Modified ASTM D6690-Type I, from a manufacturer listed in Bulletin 15. Furnish a rubberized joint sealing material conforming to the following physical requirements:

| Test | Specification Limits |
|---|---|
| Cone penetration, non-immersed @ 25 °C (77F), 150 g, 5 s | 50 to 90 |
| Flow @ 60 °C (140F) for 5 hours | 1.0 cm max. |
| Resilience @ 25 °C (77F) | 25% to 60% |
| Ductility @ 25 °C (77F) (ASTM D 113) | 40 cm max. |
| Bond, non-immersed @ -18 °C (0F), 100% extension (Specimen thickness 12.7 mm (1/2 inch)) | Pass 5 cycles |
| Asphalt compatibility @ 60 °C (140F) | Pass |
| Sealant life at application temperature | 8 hours min. |

**(d) Preformed Neoprene Compression Seals and Strip Seals and Lubricant Adhesive.**

**1. Physical Requirements.** AASHTO M 220 and ASTM D 3542 (Movement Range) for pavement seals, ASTM D 3542 for bridge seals, and as follows:

**1.a Seals.**

- Free of pin holes and uncured areas and uniform in all dimensions.
- Function properly at temperatures between -29 °C and +60 °C (-20F and +140F).
- Misalign the walls by not more than 3 mm (1/8 inch) when the pavement seal is in a compressed condition.
- Exceed nominal width by not more than 1.5 mm (1/16 inch) for seals up to 38 mm (1 1/2 inches); 5 mm (3/16 inch) for seals greater than 38 mm (1 1/2 inches) up to 64 mm (2 1/2 inches); 6 mm (1/4 inch) for seals greater than 64 mm (2 1/2 inches) up to 100 mm (4 inches); and 8 mm (5/16 inch) for seals greater than 100 mm (4 inches). Allow no negative tolerance from nominal width.
- Vary from nominal height by not more than 3 mm (1/8 inch) if pavement seals are used and 6 mm (1/4 inch) if bridge seals are used.
- Allow no tolerance in the movement range for initial qualification samples. Allow up to a -5% tolerance in the movement range for routine production samples.
- Allow no negative tolerance on the movement classification for bridge seals. The movement classification for each bridge seal configuration is determined by rounding the movement range criterion down to the nearest 10 mm (1/2-inch) increment.

Pavement seals have a minimum seal recovery as follows:

| Temperature | Percent Recovery* Plant Verification Samples (PV) | Field Samples (QA, DQA, FV, etc.) |
|---|---|---|
| -29 °C (-20F) | 88 | 83 |
| -10 °C (14F) | 95 | 88 |
| 100 °C (212F) | 90 | 85 |

*based on nominal width

| Seal Size | Minimum Movement |
|---|---|
| 25 mm (1 inch) | 9.27 mm (0.365 inch) |
| 32 mm (1 1/4 inches) | 13.72 mm (0.540 inch) |

- Pavement seals have a minimum side wall bearing pressure of 27 kPa (4 pounds per square inch) at 85% nominal width.

**1.b Lubricant Adhesive.** ASTM D 4070 and as follows:

Of suitable viscosity at installation temperature and compatible with application equipment. Do not use lubricant adhesive more than nine months after date of manufacture.

**2. Acceptance.** Before using each lot of seal, obtain the CAMMS generated laboratory test report with the automated statement of approval or rejection. A seal lot is a continuous production not exceeding 3 km (10,000 linear feet) for pavement seals, and not exceeding 0.9 km (3,000 linear feet) for bridge seals.

**3. Marking and Shipping.** As follows:

**3.a Seals.** Clearly and permanently mark the top of each seal with appropriate line characters of not less than 2 mm (0.0625 inch) in height, in increments not exceeding 1.2 m (4 feet). The line characters must designate the lot or batch number, the curedate code, and the type of seal designation. Also, mark the top of each pavement seal at 300 m ±3 mm (1 foot ±1/8 inch) intervals in a manner clear and durable to enable stretch/compression determinations of the seal.

**3.b Lubricant Adhesive.** Label each container with the code or type designation, the plant place, lot number, and manufacture date.

**(e) Preformed Closed Cell Polyethylene Joint Filler.** ASTM D 3204, Type I, and as follows:

Compressibility:

| | |
|---|---|
| Pressure necessary to compress test specimen by 25% | min. 35 kPa (5 pounds per square inch) |
| Pressure necessary to compress test specimen by 85% | max. 205 kPa (30 pounds per square inch) |

**(f) Preformed Polyurethane Foam Joint Filler.** A semi-open, flexible, polyurethane foam that is molded to a cross-sectional shape and easily installed in a pavement joint with parallel sides and is sufficiently self-locking to prevent the material from floating out of the joint. Furnish joint filler from a manufacturer listed in Bulletin 15 and as follows:

**1. Dimensions.**

- Length—minimum 2.4 m (8-foot) lengths
- Width—113 mm to 121 mm (4 7/16 inches to 4 3/4 inches)
- Depth—197 mm to 330 mm (7 3/4 inches to 13 inches)

**2. Properties.** Determine using a skinless sample.

| | |
|---|---|
| • Density, kg/m$^3$ (lbs/cu. in.) | 96-160 (6.0-10.0) |
| • Compressive deflection (ASTM D 3204) | |
| • Pressure (Load) necessary to compress the test specimen 25% | min. 35 kPa (5 psi) |
| • Pressure (Load) necessary to compress the test specimen 65% | max. 205 kPa (30 psi) |
| • Recover, % of original, min.<br>65% deflection, calculated after 60 seconds of relaxation form deflection return. | 95% |
| • Water absorption, max. | 30% vol. |

**(g) Asphalt Rubber Sealing Compound.** ASTM D 5078 from a manufacturer listed in Bulletin 15.

**(h) Certification.** Section 106.03(b)3

**705.5 GASKETS AND WATERSTOPS**—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

**(a) Shipment and Certification.** Label shipments with style or code number, lot or batch number, plant, place, and manufacture date. Certify materials, as specified in Section 106.03(b)3.

**(b) Gaskets.**

**1. Elastomeric.** ASTM C 443 for rubber gaskets and ASTM C 361 for neoprene gaskets.

**2. Flexible Plastic (Hydrocarbon Blend).** AASHTO M 198, Type B, with the following exceptions:

- Flash Point, Cleveland Open Cup (C.O.C.) min.,°C (F) 177 (350)
- Fire Point, C.O.C. min.,°C (F) 190 (375)

**(c) Waterstops.**

**1. Metal.** ASTM B 370. Copper sheets used for waterstops, of a mass (weight) indicated and containing a minimum copper mass of 99.5%.

**2. Polyvinyl Chloride.**

**2.a Physical Requirements.**

- Manufactured from virgin polyvinyl chloride resin with the addition of only those plasticizers, stabilizers, and other materials necessary to ensure aging stability and in-place durability.
- Not factory scrap or reclaimed polyvinyl chloride.
- Brittleness temperature, ASTM D 746 -29 °C (-20F) max.
- Modulus of flexure, ASTM D 747, kPa (lbs/sq. in.) 2800 (400) min.
- Tensile strength, ASTM D 412,
  Die C original, kPa (lbs/sq. in.) 6890 min. (1,000 min.)
  Across job splice, kPa (lbs/sq. in.) 7930 min. (1,150 min.)
- Elongation
  Original, percent 280 min.
  Across job splice, percent 200 min.
- Tear strength, ASTM D 624, Die B
  Original, kN/m (lbs/in.) 46 min. (260 min.)
- Oven aging, ASTM D 673, 70 hours at 100 °C (212F)
  Change in tensile strength, percent change 20 max.
  Change in elongation, percent change 20 max.
- 14-Day extraction, 60 °C/66 °C (140F/150F)
  Change in tensile strength, percent change 40 max.
  Change in elongation, percent change 40 max.

**2.b Marking.** Permanently label with the manufacturer's name and style or code number, at intervals not exceeding 1.0 m (3 feet).

**2.c Acceptance.** Material shipped is subject to inspection at the delivery point. If directed, provide samples, selected at random from the shipment, consisting of one portion 1.2 m (4 feet) long and another portion from a job splice consisting of a minimum of 300 mm (12 inches) of splice, within 150 mm (6 inches) of unspliced material on each side. Submit samples to the MTD for material confirmation and compliance.

**705.6 GRAPHITE LUBRICANT**—From a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3. Consisting of flaked graphite and a vehicle, conforming to the following requirements:

| | **Percent By Mass (Weight)** | | | |
|---|---|---|---|---|
| | **Flaked Graphite[3]** | | **Vehicle** | |
| **Type** | **Minimum** | **Maximum** | **Minimum** | **Maximum** |
| Graphite Paste[1] | 55 | 65 | 35 | 45 |
| Premixed Graphite Lubricant[2] | 39.3 | 46.4 | 53.6 | 60.7 |

Note (1)—Vehicle containing not less than 52% of fixed oils, with the vehicle remainder of volatile thinners and dryers. Thoroughly mix the paste.

Note (2)—Vehicle containing not less than 24.3% vehicle solids, with the vehicle remainder of volatile thinners and dryers.

Note (3)—Flaked Graphite, composition:

| | **Percent By Mass (Weight)** | |
|---|---|---|
| | **Minimum** | **Maximum** |
| Graphite Carbon | 85 | — |
| Graphite Carbon passing 150 µm (No. 100) sieve | 84 | 92 |
| Graphite Carbon passing 45 µm (No. 325) sieve | 46 | 50 |

**705.7 MORTAR**—Mix mortar in an acceptable type of mixer, unless otherwise allowed. Do not use retempered mortar or mortar mixed for more than 1/2 hour, unless otherwise specified. Certify as specified in Section 106.03(b)3.

**(a) For Pipe Joints.**

**1. Job-Mixed Mortar.** Mix one part cement, two parts fine aggregate, and sufficient water to form a plastic composition. Use materials conforming to the following requirements:

- Cement—Section 701
- Fine Aggregate—Section 703.1, Type C
- Water—Section 720.1

**(b) For Masonry Joints and Horizontal Joints Between Components in Manholes.** ASTM C 270, Type N

**705.8 CAULKING COMPOUND**—Certify as specified in Section 106.03(b)3. From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

**(a) For Caulking Pipe Joints.** ASTM D 2822

**(b) For Other Caulking.** ASTM C 834 or C 920

**705.9 JOINT BACKING MATERIAL**—Expanded, low-density, polyethylene foam from a manufacturer listed in Bulletin 15 and conforming to the requirements of ASTM D 5249. Certify each shipment as specified in Section 106.03(b)3. When indicated, the foam may be used as a bond breaker between joint filler material and joint sealer.

# SECTION 706—CONCRETE BONDING COMPOUND

**706.1 Epoxy-Bonding Compound**—Provide an epoxy bonding compound conforming to ASTM C 881 and specify Type and Grade as per operation. Obtain compound from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3. Submit a copy of the manufacturer's recommendations for proper application to the Representative. Apply the compound according to the manufacturer's recommendations.

**(a) General.** If epoxy-bonding compounds are used, the Type and Grade of epoxy must be specified for each specific operation. Use the following classifications in conjunction with Bulletin 15:

**1. Application/Operation Specific Types.**

- Type I—For use in non-load bearing applications, bonding hardened concrete (28 days or older) to hardened concrete surfaces.
- Type II—For use in non-load bearing applications, bonding freshly mixed concrete to hardened concrete.
- Type III—For use in bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars or epoxy concretes used on traffic bearing surfaces (or surfaces subject to thermal or mechanical movements).

**2. Grades.** Flow characteristics.

- Grade 1—Low viscosity
- Grade 2—Medium viscosity
- Grade 3—Non-sagging consistency

**3. Classes.** Temperature use range.

- Class A—For use below 4 ºC (40F), to the lowest allowable temperature defined by the manufacturer.
- Class B—For use between 4 ºC and 16 ºC (40F and 60F).
- Class C—For use above 16 ºC (60F), to the highest allowable temperature defined by the manufacturer.

**706.2 Non-Epoxy-Bonding Compound**—Provide a non-epoxy-bonding compound with a minimum 14-day bond strength of 10.3 MPa (1,500 pounds per square inch) as tested according to ASTM C 882. Obtain compound from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3. Submit a copy of the manufacturer's recommendations for proper application to the Representative. Apply the compound according to the manufacturer's recommendations.

# SECTION 709—REINFORCEMENT STEEL

**709.1 REINFORCEMENT BARS**—As indicated, from a manufacturer listed in Bulletin 15, and conforming to the following requirements:

**(a) Billet-Steel Bars.**

**1. Deformed.** AASHTO M 31M (ASTM A 615M), Grade 420 (Grade 60). Where AASHTO M 31M (ASTM A 615M), Grade 300 (Grade 40) is indicated (non-bridge items only), Grade 420 (Grade 60) may be substituted on a bar-to-bar basis at no additional cost to the Department. If using deformed bent tie bars in pavement structures, use only Grade 300 (Grade 40).

**2. Plain.** AASHTO M 227/M 227M (ASTM A 663/A 663M) or AASHTO M 255/M 255M (ASTM A 675/A 675M), Grade 485, 515, or 550 (Grade 70, 75, or 80). AASHTO M 31/M 31M (ASTM A 615/A 615M), Grades 300 or 420 (Grade 40 or 60).

**(b) Rail-Steel Bars.**

**1. Deformed.** AASHTO M 42/M 42M (ASTM A 996/A 996M), Grade 420 (Grade 60), including supplementary requirements. Do not weld or bend.

**2. Plain.** AASHTO M 42/M 42M (ASTM A 996/A 996M), Grades 350 or 420 (Grade 50 or 60), including supplementary requirements. Do not weld or bend.

**(c) Epoxy Coating (Where Indicated).**

**1. Coating.** Coat bars according to ASTM A 775/A 775M, modified as follows:

- Section 5—Materials
  Subsection 5.2. Revise completely to read: "Maintain the certification for the powder coating material at the applicator's site and provide a powder coating material meeting the requirements listed in Annex A1."

- Section 8—Requirements for Coated Steel Reinforcing Bars.
  Subsection 8.1.1. Revise the first sentence to read: "For acceptance purpose, provide a coating thickness after curing of 250 ± 50 µm (10 ± 2 mils) on 90% of all recorded thickness measurements."

- Coating Color—Provide only a light colored coating that will reveal rusted or undercoated areas of steel.

**2. Fabrication.**

**2.a QC.** Section 106.03(a)2. Submit a QC Plan to the BOCM.

**2.b** Repair all sheared or cut ends and/or damaged areas with epoxy patching material according to the QC Plan and ASTM D 3963/D 3963M, modified as follows:

- Section 3—Coating Repair Materials
  Subsection 3.1. Add the following sentences: "Provide verification that the material has been tested and conforms to Annex 1. Certify each shipment of this material as specified in Section 106.03(b)3."

- Section 7- Repairs
  Subsection 7.1.3. Add the following sentence: "Provide patch coating thickness after curing of 7 to 12 mils."

Handle and store coated bars at the fabricator's facility according to the requirements of ASTM D 3963/D 3963M.

**(d) Low-Alloy Steel Bars.**

**1. Deformed.** ASTM A 706/A 706M, Grade 420 (Grade 60).

**(e) Galvanized Reinforcement Bars.** Separate bundled pieces before pickling. Galvanize in accordance with ASTM A 767/A 767M. Provide a Class 1 coating mass (weight) conforming to the requirements given in Table 1. Ensure that each piece is completely galvanized. During galvanization, do not handle entire bundles by picking them up at two or more points with a cinched chain or other device that may prevent complete galvanization of the reinforcement bars. Immediately quench the galvanized reinforcement bars in the chromate bath specified in ASTM A 767/A 767M. Use equipment with protected contact areas for handling galvanized reinforcement bars. Test galvanized reinforcement bars for embrittlement after galvanizing by bend testing samples of the galvanized reinforcement bars in accordance with ASTM A 615/A 615M. If bent bars are indicated, perform reverse bend testing to check for embrittlement in accordance with ASTM A 143/A 143M. Reject any lots found to be enbrittled. Require the fabricator and the galvanizer to witness testing with both parties retaining signed copies of test results.

**709.2 BAR MATS**—Steel Bars, Section 709.1, assembled into mats, as shown on the Standard Drawings, by rigidly welding or clipping the bars at joints or points of intersection.

**(a) Clips.** For mechanical assembly, use 3.8 mm (No. 9 gage) steel wire of sufficient ductility to prevent clip fracture in mat fabrication.

For manual assembly, use 0.74 mm (No. 12 gage) spring steel wire of high elastic limit, conforming to the following chemical analysis:

| | Percent | |
|---|---|---|
| **Element** | **Min.** | **Max.** |
| Carbon | 0.45 | 0.70 |
| Manganese | 0.90 | 1.20 |
| Sulfur | 0.00 | 0.045 |
| Phosphorus | 0.00 | 0.045 |
| Silicon | 0.08 | 0.12 |

**(b) Method of Assembly (Using Clips).** Hold the bars in close contact by clips designed to exert constant pressure. Assemble at the point of manufacture, using clips of acceptable design, and fasten by mechanical means.

Use double-latching type clips for manual assembly. Use some form of locking device on the clips' free or latching ends so that when the clips are latched in place, no creeping occurs that would allow the bars to be easily moved from their necessary positions.

Provide, approximately, a 25 mm (1-inch) spread of the clips at intersections for necessary leverage to hold bars at right angles. Latch each alternate clip at right angles to the adjacent clips, to ensure maximum rigidity. Use clips of a length so the material is not stressed beyond the elastic limit during the latching process. A minimum length of 100 mm (3 1/2 inches) is necessary for No. 10 to No. 35 (No. 3 to No. 10) bars.

Other types of clips that ensure equal rigidity may be submitted for acceptance.

**(c) Acceptance of Design.** Submit designs for acceptance, before use.

**709.3 STEEL WELDED WIRE FABRIC**—AASHTO M 55 (ASTM A 185). From a manufacturer listed in Bulletin 15, rigidly welded at joints and points of intersection to form a fabric reinforcement, and as shown on the Standard Drawings.

**(a) Epoxy Coating (Where Indicated).** ASTM A 884/A 884M, Type 1, Class A.

**(b) Galvanized Welded Wire Fabric.** Section 709.1(e). Galvanized Welded Wire Fabric may be substituted for Epoxy Coated Welded Wire Fabric. Galvanize according to ASTM A123 coating Grade 35 – 35 µm (1.4 mils) minimum. Chromate in accordance with ASTM A767, Section 4.3.

**709.4 DEFORMED WELDED WIRE FABRIC**—AASHTO M 221 (ASTM A 497). From a manufacturer listed in Bulletin 15 and as shown on the Standard Drawings.

**(a) Epoxy Coating (Where Indicated).** Section 709.3(a).

**(b) Galvanized Welded Wire Fabric.** Section 709.1(e). Galvanized Deformed Wire Fabric may be substituted for Epoxy Coated Deformed Wire Fabric. Galvanize according to ASTM A123 coating Grade 35 – 35 µm (1.4 mils) minimum. Chromate in accordance with ASTM A767, Section 4.3.

**709.5 CERTIFICATION**—Certify as specified in Section 106.03(b)3.

Identify the appropriate specification on the certification and include the grade of steel. Forward a copy to the project with the shipment of steel.

# SECTION 711—CONCRETE CURING MATERIAL AND ADMIXTURES

## 711.1 CURING AND PROTECTING COVERS—

**(a) White Polyethylene Sheeting.** AASHTO M 171, except minimum tensile strength requirements are as follows:

| Machine Direction | Cross Machine Direction |
|---|---|
| 1.22 kN/m (7.0 lbs/lin. in.) | 1.22 kN/m (7.0 lbs/lin. in.) |

**(b) White Polyethylene Sheeting—Burlap-Backed.**

**1.** White Polyethylene Sheeting—natural burlap backed. AASHTO M 171.

**2.** White Polyethylene Sheeting—synthetic burlap backed. AASHTO M 171, except mass (weight) of synthetic burlap backed white polyethylene sheeting is 271 g/m² (8.0 ounces per square yard).

**(c) White Polypropylene Sheeting—Polypropylene Fiber Backed.**

**1.** White Polypropylene Sheeting—polypropylene fiber backed, with maximum moisture loss of 0.55 kg/m$^2$ in 72 hours when testing according to ASTM C 156.

**2.** Daylight reflectance of white polypropylene sheeting is at least 70% when measured according to ASTM E 1347.

**3.** White Polypropylene Sheeting—polypropylene fiber backed, weighing not less than 203 g/m$^2$ (6.0 ounces per square yard).

**4.** A white sheeting layer with a nominal thickness of 0.1 mm (0.0040 inch) and not less than 0.075 mm (0.0030 inch).

**5.** Minimum strength requirements are as follows:

| Grab Tensile Strength | Grab Tensile Elongation | Puncture |
|---|---|---|
| 530 N (120 lbs) | 50% | 290 N (65 lbs) |
| ASTM D 4632 | ASTM D 4632 | ASTM D 4833 |

**(d) Burlap.** AASHTO M 182, Class 1.

**(e) Insulating Mats.** Treated new wood fibers, rock wool, or glass fibers, completely enclosed on all sides within weather-proof covers of asphalt-saturated kraft crepe or polyethylene sheeting, and conforming to the following requirements:

- Asphalt-saturated crepe covers manufactured from extra heavy, two-ply, kraft crepe, totaling not less than 0.147 kg/m$^2$ (30 pounds per 1,000 square feet), on the weather side and of kraft paper or kraft crepe, of not less than 0.073 kg/m$^2$ (15 pounds per 1,000 square feet), on the reverse side.

- Polyethylene covers manufactured from sheeting of not less than 0.15 mm (6 mils) normal thickness on the weather side and of not less than 0.10 mm (4 mils) normal thickness on the reverse side.

- Fiber bonded to the covers of insulating mats over 610 mm (24 inches) in width, to prevent bunching of the mats during storage, shipping, or handling.

**(f) Foam Insulation.** Molded, extruded, or spray-applied polyurethane or molded or extruded polystyrene, forming closed-cell foam insulation, with the cells uniformly distributed and conforming to the following requirements:

- Water absorption, percent by volume, tested according to ASTM D 2842—3.0 max.
- Density, kg/m$^3$ (lbs/cu. ft.), tested according to ASTM D 1622—16 - 96 (1.0 - 6.0)

**(g) Certification.** Section 106.03(b)3

**711.2 CURING COMPOUNDS—**

**(a) Liquid Membrane-Forming Curing Compound, Clear or White.** AASHTO M 148, Type 1-D, clear or translucent and containing a red fugitive dye; Type 2, white pigmented. Type 1-D and Type 2 to be certified, as specified in Section 106.03(b)3.

**(b) Liquid Membrane-Forming Curing Compound, Black.** Emulsified asphalt, (Class E-1, Bulletin 25) or cut-back asphalt, (Class RC-70, ASTM D 2028), either conforming to the performance requirements of ASTM C 309 for Type 4.

**(c) Bridge Deck Intermediate Curing Compound.** A monomolecular film, composed of a film-forming fatty alcohol, capable of retarding moisture evaporation from concrete. Use material from a manufacturer listed in Bulletin 15.

**(d) Certification.** Section 106.03(b)3

**711.3 CONCRETE ADMIXTURES**—Of an approved type, from a manufacturer listed in Bulletin 15, and conforming to the following requirements:

**(a) General.** If tested by precipitation, the chloride ion content is not to exceed the following:

- 1.0% by mass (weight) of the admixture for use in conventional reinforced cement concrete
- 0.1% by mass (weight) of the admixture for use in prestressed concrete

**(b) Certification.** Section 106.03(b)3

**(c) Shipment.** Ship and deliver in drums or in bulk. Mark or tag each drum with the batch or lot number and date of manufacture. Forward a bill of lading with each bulk shipment, bearing the same information as necessary for drums. Each shipment will be subject to sampling and testing at any time.

**(d) Air Entraining Admixtures.** AASHTO M 154

**(e) Latex Emulsion Admixture.** A nontoxic, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture and homogeneous and uniform in composition. Conform to the prequalification requirements specified in Report FHWA-RD-78-35, "Styrene-Butadiene Latex Modifiers for Bridge Deck Overlay Concrete," April 1978.

**(f) Other Admixtures.** AASHTO M 194

# SECTION 713—MASONRY UNITS

**713.1 BRICK—**

**(a) Sewer Brick.** AASHTO M 91, Grade SS; except, with a maximum water absorption of 12.0% for the average of 5 bricks and 15% for individual bricks.

**(b) Building Brick.** AASHTO M 114, Grade SW

**(c) Certification.** Section 106.03(b)3

**713.2 PRECAST CONCRETE BLOCKS**—As listed in Bulletin 15, conforming to the applicable requirements of ASTM C 90, and as follows:

**(a) General.** Machine made blocks with a minimum compressive strength of 17 MPa (2,500 pounds per square inch), when tested according to Department procedures.

Do not use liquid membrane-forming compounds for curing.

Certify each shipment of precast concrete blocks according to Section 106.03(b)3.

**(b) Material.**

- Cement—Section 701
- Fine Aggregate, Type A—Section 703.1*
- Coarse Aggregate, Type A—Section 703.2*
- Water—Section 720.1
- Pozzolan—Section 724.2

* The gradation of aggregates does not apply.

**(c) Acceptance.** Prepare a QC Plan, as specified in Section 106.03(a)2.a, and submit it for review at the start of the project. Provide two samples for each lot number, or as directed. A lot may represent each day's production. Acceptance will be based on the results of compression tests made on these samples and on inspection of the finished product to determine conformance with specifications and lack of defects.

**(d) Rejection.** Blocks exhibiting any of the following conditions will be considered defective and will not be accepted:

- Defects that indicate imperfect proportioning, mixing, and molding;
- Surface defects, such as honeycombing or open texture; or
- Areas damaged beyond satisfactory repair.

# SECTION 714—PRECAST CONCRETE PRODUCTS

**714.1 GENERAL REQUIREMENTS**—As shown on the Standard Drawings and as follows:

**(a) Description.** Precast concrete units are those cast in other than their permanent location, by a manufacturer listed in Bulletin 15.

**(b) Shop Drawings.** As approved. Standard precise elements may be fabricated as shown on the Standard Drawings without submitting shop drawings to the Bureau of Design for approval. For deviations or modifications of the standards, submit shop drawings for approval.

**714.2 PRECAST CONCRETE UNITS**—Approved plants may fabricate any of the following items:

- Concrete barrier
- Reinforced concrete manhole sections
- Inlets
- Junction boxes
- Median barrier
- Endwalls
- Sound barrier posts and panels

**714.3 MATERIAL**—

- Storage of Material—Section 106.05
- Cement Concrete—Section 704, except Sections 704.1(d)3., 704.1(d)4., and 704.2(d). Requirements for remediation of a potential alkali-silica reaction do not apply for cement concrete used in the fabrication of precast concrete barrier that is to be used in temporary installations only, as specified in Section 627, and indicated as such, as specified in Section 714.6(d).
- Coarse Aggregate, Type A, No. 8, No. 57, or No. 67—Section 703.2
- Fine Aggregate, Type A—Section 703.1
- Concrete Curing Material—Sections 711.1 and 711.2(a), Type 1-D, translucent with red fugitive dye.
- Reinforcement Steel—Section 709. Epoxy coated or galvanized reinforcement bars or epoxy coated or galvanized welded wire fabric are not required. for the fabrication of precast concrete barrier that is to be used in temporary installations only, as specified in Section 627, and indicated as such, as specified in Section 714.6(d).
- Steel Anchor Bolts—Section 1105.2(c)
- Metal Units—Sections 605.2(a) and (b)
- Manhole Steps—Section 605.2(c)

- Protective Coating (Boiled Linseed Oil)—Section 503.2

## 714.4 PLANT ACCEPTANCE—

**(a) General.** Do not begin fabrication before the Structural Materials Engineer's inspection and acceptance of the plant. Provide a permanent building offered for the Department's acceptance.

Material, equipment, test procedures, methods of fabrication, handling, storage, and transportation are subject to inspection.

Register and certify the plant under either the Prestressed Concrete Institute (PCI) or National Precast Concrete Association (NPCA) plant certification program. Submit an annual endorsed copy to the Structural Materials Engineer for continued qualification.

**(b) QC.**

**1. General.** Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Structural Materials Engineer, MTD, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and organizational chart, when required by the Structural Materials Engineer, due to changes in processes, materials, or personnel.

**2. QC Manager.** Provide a QC Manager who has overall responsibility for the adequacy of production facilities, QC, sampling and testing, and fabrication of the product, and who will ensure that items are fabricated as shown on the Standard Drawings.

**3. QC Personnel.** Assign qualified personnel, with precast concrete experience, to be responsible for QC and sampling and testing during the complete fabrication process, storage, and shipment. Do not proceed with production until appropriate personnel are present. Technicians responsible for concrete sampling and testing must possess a current ACI Grade I Field Technician Certification or have approval from the Structural Materials Engineer as a technician in training.

## 714.5 PLANTS AND PLANT SITES—

**(a) Description.** Provide adequate and acceptable lighting for operations not completed in the daylight. Provide a drainage system as needed for the removal of rainfall and curing water. Provide a stabilized area for product storage.

Furnish necessary facilities for the inspection of material and workmanship. Allow Inspectors employed by the Department unrestricted access to the premises during plant working hours. The necessary facilities for inspection include a plant office conforming to the following minimum requirements:

| Number of Each | Requirements |
|---|---|
| 13.9 (150) | Floor space: $m^2$ (square feet) |
| Yes | Air-conditioned/heated |
| 1 | Desk and chair |
| 1 | Plan rack |
| 1 | Work table |
| 1 | Two-drawer fire resistant (D-label) metal file cabinet |
| Adequate number | Chair and stools |
| 1 | Individual Access Phone line |
| 1 | Internet Service: For structural materials plants – A proprietary or mid-market internet service that provides for high-speed access via a Digital Subscriber Line (DSL). Cable or other Broadband connection. For plant mixed hot-mix asphalt and ready-mix concrete plants or where high speed access is not available, provide a 'dial up' internet service with access to the account by means of a local telephone number. |
| 1 | Telephone (business and emergency calls only) and answering |

| | |
|---|---|
| | machine or voice-mail |
| 1 | Sanitary electric water cooler |
| 1 | Fire extinguisher |
| Adequate number | Cupboards, closets, lockers |
| 1 | First-aid kit (OSHA 1926.50(d) and 1926.50 Appendix A compliant) |

## 714.6 FABRICATION—

**(a) General.** Plants must produce a sample element to verify their competency before receiving approval to produce a new product type.

**(b) Bars, Mesh Reinforcement, Inserts, and Chairs.** Fabricate and place bar and mesh reinforcement, as indicated, within specified tolerances. Secure reinforcing in beds and forms using chairs or blocking so the reinforcing maintains its position during placement and vibration of concrete. Bars may be fabricated into cages by tying and tack welding. Do not tack weld epoxy coated, galvanized, or Grade 420 (Grade 60) reinforcement bars. Use acceptable chairs or ties for support.

When bar spacing is greater than or equal to 300 mm (12 inches), tie all intersections with annealed iron wire or metal clips. When bar spacing is less than 300 mm (12 inches), either tie all intersections or tie alternate intersections with annealed iron wire or metal clips in each direction to provide a staggered tie layout prohibit movement of reinforcement bars during manufacturing. For epoxy-coated reinforcement or galvanized reinforcement, provide plastic-coated tie wire, epoxy-coated tie wire, metal clips, or plastic clips.

**(c) Beds and Forms.** Support casting beds or forms on unyielding foundations. Use forms adequate for the manufacture of products within tolerances, according to approved drawings and specifications. Clean forms after each use to prevent accumulation of coatings.

**(d) Marking.** Mark the manufacturer's name or trademark and the date of manufacture on one side or end of each precast unit as soon as possible after stripping using permanent marking system. For inlets and junction boxes, also provide the type identification. Identify barrier meeting NCHRP 350 by indenting the top section of each barrier section with minimum 50 mm (2-inch) block lettering as follows: “T 350” for temporary barrier and “P 350” for permanent barrier.

## 714.7 CONCRETE—

**(a) Testing.** Verify the minimum curing strength and the 28-day minimum concrete strength, specified in Section 704, for each lot. Select an appropriate slump value that will provide a workable mix for the precast concrete units. At no time is the slump upper limit to exceed 125 mm (5 inches) for mixes without water-reducing admixtures, 165 mm (6 1/2 inches) for mixes with water-reducing admixtures, and 200 mm (8 inches) for mixes with high range water-reducing admixtures (superplasticizers). If the upper limit is exceeded on any slump test, the plant’s technician must reject the cement concrete. Maintain the cement concrete consistency within 40 mm (1 1/2 inches) on either side of the selected value.

For precast manhole sections, test for absorption according to AASHTO M 199M; except, test cores shall have a diameter of not less than 50 mm (2 inches).

**(b) Mixture.** Furnish Class AA Cement Concrete as specified in Section 704, unless otherwise specified.

**(c) Placing Concrete.** Place concrete without segregation. Deposit concrete in its final position in each part of the form. Methods of placement are subject to acceptance. Do not work or flow concrete along the forms from the point of deposit. Work concrete under and around reinforcement.

Place concrete batches in form within one half hour of each other. Consolidate the plastic concrete by internal and/or external vibration.

Production will be restricted to periods where air temperatures within the work area are above 4 °C (40F).

**(d) Lot Size.** Lot size is one shift's production. Mold a minimum of four concrete test cylinders for each lot cast. Mold additional test cylinders for Department acceptance testing if directed.

Mold cylinders according to PTM No. 631. Cure cylinders the same as the product. Test cylinders according to PTM No. 604. Match-mark test cylinders with the lot represented. Record test results and give records to the Department representative.

**(e) Finishing.** Make concrete surfaces true and even, and free from rough, open, or honeycombed areas, depressions, or projections. Do not add water to the concrete to facilitate finishing.

**(f) Patching.** Patch and repair manufacturing defects and minor damage in accordance with Publication 145. Submit repairs beyond the scope of Publication 145 to the Chief Structural Materials Engineer for evaluation and disposition.

**714.8 CURING AND PROTECTIVE COATING—**

**(a) Curing.** Cure and protect concrete according to the approved QC Plan. Develop the QC Plan using ACI 308 as a guideline.

Set stripping time based on the inherent characteristics of the product.

Accomplish secondary curing by approved methods.

Maintain precast concrete units, after stripping and during secondary curing, in a minimum 10 $^{o}$C (50F) environment until they have reached a compressive strength of 80% of the 28-day minimum comprehensive strength for the product as indicated on the shop drawing. Do not place units in an environment of less then 0 $^{o}$C (32F) after the secondary cure, unless the differential between the units and the air temperature is less than 17 $^{o}$C (30F).

Store units until the 28-day minimum compressive strength is obtained.

**(b) Protective Coating.** Apply protective coating to concrete barrier and inlet tops before shipment. Use boiled linseed oil and apply as specified in Section 503.3(b) or use a penetrating sealer from a manufacturer listed in Bulletin 15 applied according to the manufacturer's specifications. Penetrating sealer must not discolor the concrete. If curing compound is used for secondary curing, wait 14 days before applying the protective coating. Barriers for temporary use need not receive a protective coating.

**714.9 TOLERANCES**—As shown on the Standard Drawings or according to ACI 117 Section 5 except as follows:

Length of Member—1 mm per meter (1/8 inch per 10 feet) with a minimum of 6.5 mm (1/4 inch) and a maximum of 20 mm (3/4 inch)

Cross-Sectional Dimensions— ≤ 914 mm (≤ 36-inch)… ± 6.5 mm (± 1/4-inch)
> 914 mm (> 36-inch)… ± 20 mm (± 3/8-inch)

**714.10 HANDLING AND STORAGE**—Handle and move products to the storage yard when they have gained adequate strength to be moved without causing damage. Maintain adequate support when handling and storing the product. Store the product, until shipment, in areas accessible for inspection.

**714.11 TRANSPORTATION**—Provide 24-hour advance notice of loading and shipping schedule. Do not ship unapproved items. Include Form CS-4171 with each shipment. Observe hauling restrictions. Ensure that supports, bracing, and shipping methods dampen vibration. Provide adequate padding material between the tie chains or cables to prevent concrete chipping.

**714.12 DISPUTES**—In matters of disputes over products, the Structural Materials Engineer, MTD, or the designated on-site representative have the final word on acceptability of the product.

**714.13 CERTIFICATION—**Section 106.03(b)3, and as further directed by the Structural Materials Engineer, Materials and Testing Division.

# SECTION 720—WATER

**720.1 WATER FOR MIXING OR CURING CEMENT CONCRETE, MORTAR, OR GROUT**—Use water reasonably clean, free from vegetable matter, oil, acid, alkali, sugar, or other substances injurious to the finished product. If the hydrogen ion concentration of the water, as determined either electrometrically or colorimetrically in conjunction with the necessary indicator, is less than pH 4.5 or more than pH 8.5, test the water according to AASHTO T 26. Compressive strength not less than 95% of that developed from similar samples made with potable water needs to be achieved.

**720.2 WATER FOR USE OTHER THAN IN MIXING OR CURING CEMENT CONCRETE, MORTAR, OR GROUT**—Suitable clean water may be used without testing. If the water source is relatively shallow, enclose the intake to exclude silt, mud, grass, or other undesirable foreign material.

# SECTION 721—CALCIUM CHLORIDE

**721.1 GENERAL**—As listed in Bulletin 15 and conforming to the requirements of AASHTO M 144, Type S, Grade 1, Class A or B. Certify as specified in Section 106.03(b)3.

# SECTION 722—SODIUM CHLORIDE

**722.1 GENERAL**—Furnish sodium chloride from a manufacturer listed in Bulletin 15 and conforming to the requirements of AASHTO M 143 or ASTM D 632. Certify as specified in Section 106.03(b)3.

**722.2 MATERIAL**—Sodium chloride, Type 1, Grade 1.

# SECTION 723—HYDRATED LIME

**723.1 GENERAL**—ASTM C 207, Type N. Legibly mark the manufacturer's name, the lot number, and the approximate net mass (weight) on each container or, in the case of bulk shipment, on the shipping notice. Certify as specified in Section 106.03(b)3.

# SECTION 724—POZZOLANS

**724.1 GENERAL—**From a manufacturer listed in Bulletin 15. Legibly mark the name of the manufacturer, the lot number, and the approximate net mass on each container or, in case of bulk shipment, on the shipping invoice.

Supply sources desiring approval must write the MTD, stating their present QC program, as specified in Section 106.03(a)2.

The material is subject to assurance sampling and testing by the MTD. Materials not conforming to the requirements may result in suspension of source approval. The supply source may reapply for approval after making corrections necessary to ensure that material test meet all applicable Specifications.

Obtain material from a single source, unless otherwise allowed in writing. Separate material of different types and from different sources. Use each type and source in continuous segregated portions of the project. If possible, limit material used in an individual structure to a single type or source. If this is not possible, use one type and source for footers, piers, and abutments, and one source for superstructures if allowed.

**724.2 FLYASH—**

**(a) For Use with Lime.** ASTM C 593, tested according to AASHTO T 135. Certify as specified in Section 106.03(b)3.

**(b) For Use with Cement Concrete.** AASHTO M 295, Class C, F, or N, except limit Loss on Ignition to a maximum of 6.0%. Certify as specified in Section 106.03(b)3.

**724.3 GROUND GRANULATED BLAST FURNACE SLAG—**

**(a) For Use with Cement Concrete.** AASHTO M 302 (ASTM C 989), Grade 100 or 120. Do not use ground granulated blast furnace slag with a material temperature exceeding 82 °C (180F) at time of delivery to the mixer, unless permitted in writing. Certify as specified in Section 106.03(b)3.

**724.4 SILICA FUME—**

**(a) For Use with Cement Concrete.** AASHTO M 307 (also called Micro Silica). Certify as specified in Section 106.03(b)3.

# SECTION 725—LIME POZZOLAN

**725.1 GENERAL**—Submit samples to the MTD for testing, a minimum of 60 days before anticipated use. From a manufacturer listed in Bulletin 15, and conforming to the following requirements:

- Total calcium and magnesium oxides (nonvolatile basis)—min. 45%
- Available calcium oxide (rapid sugar test, ASTM C 25) plus total MgO content calculated to be equivalent $Ca(OH)_2$—min. 25%

  As received loss on ignition (carbon dioxide plus moisture, combined and free)—max. 35%
- Free water (as-received basis)—max. 2%
- Residue—The sieve analysis of the by-product lime shall be as follows:

| Sieve | Maximum Percent Retained |
|---|---|
| 150 µm (No. 100) | 5 |
| 75 µm (No. 200) | 20 |

# SECTION 727—BITUMINOUS PAPER

**727.1 GENERAL**—Impregnated with asphalt or tar and conforming to the following requirements:

**METRIC**

| | One-Ply | Two-Ply |
|---|---|---|
| Mass per square meter, kilograms | 1.46 | 1.92 |
| Permissible variation, % | 6 | 6 |

**ENGLISH**

| | One-Ply | Two-Ply |
|---|---|---|
| Weight per square foot, ounces | 4.8 | 6.3 |
| Permissible variation, % | 6 | 6 |

# SECTION 735—GEOTEXTILES

**735.1 GENERAL**—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

**(a) Fabric.** Use fabric consisting of long chain polymeric filaments or yarns such as polyethylene, polyamide, polyvinyledene-chloride, polypropylene, or polyester formed into a stable network so that the filaments or yarns retain their relative position to each other. For Class 1, Class 2, and Class 3 Geotextiles, use woven or non-woven fabric. For Class 4 Separation Geotextiles, use a needle-punched "felt-like" non-woven fabric. For Class 4 Stabilization and Reinforcement Geotextiles, use a high strength woven fabric. Use fabric inert to commonly encountered construction chemicals or substances. During periods of shipment and storage, protect the fabric from direct sunlight, ultra-violet rays, temperatures greater than 60 °C (140F), mud, dirt, dust, and debris. To the extent possible, wrap the fabric in a heavy-duty covering or shield from direct sunlight.

Geotextiles will be rejected at the time of installation if any defects, deterioration, or damage was incurred during manufacture, transportation, or storage.

**(b) Physical Requirements.** Table A, for the indicated construction class and type.

**(c) Acceptance.** Acceptance of the geotextile will be based on certified test data submitted by the manufacturer and on testing by MTD.

**(d) Certification.** Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the fabric or its container with the manufacturer's name, fabric type or trade name, lot number, and material quantity.

**TABLE A (Metric)**
**Geotextile Physical Requirements**[1]

| Fabric Properties | Test Method | Construction Class | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Class 1 | Class 2 | | Class 3[2] | | Class 4 | | |
| | | Subsurface Drainage | Erosion Control | | Sediment Control | | Separation | Stabilization | Reinforcement |
| | | | Type A | Type B | Type A | Type B | Type A | Type B | Type C |
| 1. Grab Tensile Strength, kg | ASTM D 4632 | 72 | 91 | 41 | 91 | 41 | 122 | 181[6] | 227[6] |
| 2. Grab Tensile Elongation, % | ASTM D 4632 | 20 min | 15-50 | 15 min | 15-50 | 15 min | 50 min | 20 max | 20 max |
| 3. Burst Strength, kPa | ASTM D 3786 | 1300 | 2200 | 965 | 2200 | 965 | 2965 | — | — |
| 4. Puncture, kg (8 mm flat-end rod) | ASTM D 4833 | 25 | 36 | 18 | 36 | 18 | 45 | 64 | 91 |
| 5. Trapezoid Tear Strength, kg | ASTM D 4533 | 25 | 23 | 14 | 23 | 14 | 45 | — | — |
| 6. Apparent Opening Size (AOS) Sieve No. | ASTM D 4751 | (3), (4) | (3), (4) | (3), (4) | 850 µm max | 850 µm max | (3), (4) | >600 µm | >600 µm |
| 7. Permeability, K, cm/sec | ASTM D 4491 | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | — | — |
| 8. Permittivity, sec-1 | ASTM D 4491 | 0.2 | — | — | 0.01 | 0.01 | — | — | — |
| 9. Seam Strength, kg [5] | ASTM D 4632 | 32 | 82 | 36 | — | — | 109 | 163 | 204 |
| 10. Ultraviolet Resistance Strength Retention, % | ASTM D 4355 | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs |

(1) The numerical values indicate average minimum roll value or minimum to maximum range, except as noted.
(2) Average minimum roll value for Class 3 material in warp direction only.
(3) Soil with 50% or less particles by mass passing 75 µm sieve, AOS ≥ 600 µm sieve.
Soil with more than 50% particles by weight passing 75 µm sieve, AOS > 300 µm sieve.
(4) Design specified.
(5) Applies to both field and/or manufactured seams.
(6) Minimum grab tensile strength for the warp and fill direction at maximum elongation.

**TABLE A (English)**
**Geotextile Physical Requirements**[1]

| Fabric Properties | Test Method | Construction Class | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Class 1 | Class 2 | | Class 3[2] | | Class 4 | | |
| | | Subsurface Drainage | Erosion Control | | Sediment Control | | Separation | Stabilization | Reinforcement |
| | | | Type A | Type B | Type A | Type B | Type A | Type B | Type C |
| 1. Grab Tensile Strength, lbs. | ASTM D 4632 | 158 | 200 | 90 | 200 | 90 | 270 | 400[6] | 500[6] |
| 2. Grab Tensile Elongation, % | ASTM D 4632 | 20 min | 15-50 | 15 min | 15-50 | 15 min | 50 min | 20 max | 20 max |
| 3. Burst Strength, psi | ASTM D 3786 | 189 | 320 | 140 | 320 | 140 | 430 | — | — |
| 4. Puncture, lbs. (5/16-inch flat-end rod) | ASTM D 4833 | 56 | 80 | 40 | 80 | 40 | 100 | 140 | 200 |
| 5. Trapezoid Tear Strength, lbs. | ASTM D 4533 | 56 | 50 | 30 | 50 | 30 | 100 | — | — |
| 6. Apparent Opening Size (AOS) Sieve No. | ASTM D 4751 | (3), (4) | (3), (4) | (3), (4) | No. 20 max | No. 20 max | (3), (4) | > No. 30 | >No. 30 |
| 7. Permeability, K, cm/sec | ASTM D 4491 | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | K fabric ≥10K soil[4] | — | — |
| 8. Permittivity, sec-1 | ASTM D 4491 | 0.2 | — | — | 0.01 | 0.01 | — | — | — |
| 9. Seam Strength, lbs. [5] | ASTM D 4632 | 70 | 180 | 80 | — | — | 240 | 360 | 450 |
| 10. Ultraviolet Resistance Strength Retention, % | ASTM D 4355 | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs | 70 @ 150 hrs |

(1) The numerical values indicate average minimum roll value or minimum to maximum range, except as noted.
(2) Average minimum roll value for Class 3 material in warp direction only.
(3) Soil with 50% or less particles by weight passing No. 200 sieve, AOS ≥ No. 30 sieve.
Soil with more than 50% particles by weight passing No. 200 sieve, AOS > No. 50 sieve.
(4) Design specified.
(5) Applies to both field and/or manufactured seams.
(6) Minimum grab tensile strength for the warp and fill direction at maximum elongation.

# SECTION 736—GEOMEMBRANE

**736.1 GENERAL**—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

**(a) Geomembrane.** Fabricated from high-density polyethylene (HDPE).

**(b) Physical Requirements.**

- Density — 0.940 g/m$^3$ (59 pounds per cubic foot) minimum, ASTM D 1505
- UV stabilization — 2% carbon black, ASTM D 1603
- Sheet thickness — 0.75 millimeters (30 mils) minimum, ASTM D 5199
- Tear resistance — 97.86 N (22 pounds) ASTM D 1004
- Resistance soil burial — 90% retained strength ASTM D 3083
- Minimum roll width — 6.09 meters (20 feet) minimum

**(c) Acceptance.** Acceptance of the geomembrane will be based on certified test data submitted by the manufacturer and on testing by MTD.

**(d) Certification.** Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the geomembrane or its container with the manufacturer's name, geomembrane type, model or trade name, lot number, and material quantity.

# SECTION 737—GEOCELL

**737.1 GENERAL**—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

**(a) Physical Requirements.**

- Sheet material — High -density polyethylene (HDPE)
- UV Stabilization — 2% carbon black, ASTM D 1603
- Sheet surface — Sheet, non-perforated, smooth or textured
- Sheet density — 0.940 g/cm$^3$ (58.7 pounds per cubic foot) minimum, ASTM D 1505
- Nominal sheet thickness — 1.2 mm (47 mils) minimum, ASTM D 5199
- Cell wall joints — Assemble each joint with 20 mm (3/4-inch) maximum melt pools using continuous or uniformly spaced ultrasonic spot welding. Space welded joints conforming to the requirements of Table A for the Class of geocell.
- Cell wall joint tensile peel strength — Conform to the requirements of Table B, when tested according to Department of the Army Technical Report GL-86-19, Appendix A, Section 3.C.

**TABLE A**
**Geocell Classification and Welded Joint Spacing**

| Geocell Class | Welded Joint Spacing mm (inches) |
|---|---|
| A (Standard Cell) | 330 ± 3 (13.0 ± 0.12) |
| B (Standard Cell Plus) | 355 ± 3 (14.0 ± 0.12) |

**TABLE B**
**Cell Wall Joint Tensile Peel Strength**

| Cell Depth mm (Inches) | Minimum Joint Tensile Peel Strength |
|---|---|
| 102.0 (4) | 1 420 N (320 lbs.) |
| 152.0 (6) | 2 130 N (480 lbs.) |
| 203.0 (8) | 2 840 N (640 lbs.) |

**(b) Certification.** Certify each shipment as specified in Section 106.03(b)3. Visibly label all shipments on the geocell, or its container, with the manufacturer's name and model number or trade name.

# SECTION 800
# ROADSIDE DEVELOPMENT

## SECTION 801—STOCKPILING TOPSOIL OR TOPSOIL MIXTURE

**801.1 DESCRIPTION**—This work is separation and salvaging of topsoil or topsoil mixture encountered in grading the project and depositing it in stockpiles at locations within the right of way.

**801.2 MATERIAL—**

**(a) Topsoil.** Acceptable friable loam that is reasonably free of subsoil, clay lumps, brush, roots, weeds, other objectionable vegetation, stones, other foreign material larger than 50 mm (2 inches) in any dimension, litter, and/or other material unsuitable or harmful to plant growth.

**(b) Topsoil Mixture.** Designated top 200 mm to 300 mm (8 inches to 12 inches) of existing soil collected and combined with organic plant matter such as vegetative slashings consisting of crushed or shredded branches, stems, bark, leaves, seeds, and roots.

**801.3 CONSTRUCTION—**

**(a) Topsoil.** After clearing and grubbing the area and before starting other construction operations, remove topsoil from areas, as indicated or directed. Adjust equipment and methods of operation to avoid mixing subsoil with topsoil.

Separate the topsoil from other excavated material and stockpile at acceptable locations within the right of way. Do not compact and do not stockpile topsoil in a wet or frozen condition.

Satisfactorily and uniformly grade stockpiled topsoil not required for the project. Apply seeding and soil supplements to these stockpiles, using the formula, as directed, and apply, as specified in Section 804.3. Apply mulch of the type directed, on the stockpiles, as specified in Section 805.3.

**(b) Topsoil Mixture.** During clearing and grubbing operations and before other construction operations, shred all designated vegetation under 100 mm (4 inches) caliper in size using a crawler or loader mounted, self powered, land clearing shredder capable of shredding vegetation to a desired maximum rough size of 300 mm (12 inches) long and 50 mm (2 inches) in diameter. Collect and mix the organic slashings with the top 200 mm to 300 mm (8 inches to 12 inches) of soil to be salvaged, as indicated or directed.

Stockpile topsoil mixture at acceptable locations within the right of way. Do not compact material. Periodically water stockpile as directed.

**801.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

Measured in its final position, as specified in Section 203.4(a)2.

Stockpiled topsoil and topsoil mixture is incidental to Clearing and Grubbing, Excavation, and Borrow Excavation.

# SECTION 802—TOPSOIL FURNISHED AND PLACED

**802.1 DESCRIPTION**—This work is the furnishing and placing of topsoil from outside the project, as indicated.

**802.2 MATERIAL**—Section 801.2 and containing not less than 2.0% nor more than 10.0% organic matter, as determined according to AASHTO T 194. Certify as specified in Section 106.03(b)3.

Provide topsoil meeting the following grading analysis:

| Sieve | Minimum Percent Passing |
|---|---|
| 50 mm (2 inches) | 100 |
| 4.75 mm (No. 4) | 75 |
| 2 mm (No. 10) | 60 |

Sand, silt, and clay material passing the 2 mm (No. 10) sieve, as defined by AASHTO T 88 and within the following ranges:

| | Minimum Percent | Maximum Percent |
|---|---|---|
| Sand | 5 | 70 |
| Silt | 10 | 70 |
| Clay | 5 | 36 |

Obtain topsoil from outside the right of way, where the soil quality has proven ability to grow crops. Before topsoil removal, obtain acceptance for the quality of the source, for the depth of the topsoil to be removed, and for the method of removal.

Recondition areas from which topsoil was obtained, as specified in Section 105.14.

**802.3 CONSTRUCTION—**

**(a) Preparation of Areas to be Topsoiled.** Grade the areas to be covered by topsoil. Using acceptable methods, loosen soil to a depth of 50 mm (2 inches) before placing the topsoil. Remove stones and other foreign material 50 mm (2 inches) or larger in any dimension. Remove and satisfactorily dispose of unsuitable and surplus material.

**(b) Placing and Spreading Topsoil.** Place topsoil on the prepared areas and, unless otherwise indicated, spread and compact to a 100 mm (4-inch) uniform depth ±40 mm (±1 1/2 inches). Compact with a roller having a mass (weight) not over 180 kg/m (120 pounds per foot) width of roller or by other acceptable methods, as directed. Remove overdepth topsoil, unless otherwise agreed upon in writing. Do not place topsoil in a wet or frozen condition.

**802.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

Measured in the hauling vehicle at the delivery point, as specified in Section 109.01(b). The Contractor may leave overdepth topsoil in place, at no cost to the Department.

# SECTION 803—PLACING STOCKPILED TOPSOIL OR TOPSOIL MIXTURE

**803.1 DESCRIPTION**—This work is the preparation of indicated areas and the placement of topsoil or topsoil mixture on the prepared areas, using topsoil or topsoil mixture removed from stockpiles located on the project or from other indicated areas.

**803.2 MATERIAL**—Section 801.2

**803.3 CONSTRUCTION**—Section 802.3 and as follows:

**(a) Topsoil.** Remove topsoil from stockpiles using an acceptable method, which does not mix the topsoil with foreign materials.

**(b) Topsoil Mixture.** Scarify and loosen soil surfaces to a depth of 150 mm (6 inches) lateral to the slope face. Moisten loosened soil, if dry, to optimum moisture content as directed. Remove debris and any other foreign material 50 mm (2 inches) or larger in any dimension. Place stockpiled topsoil mixture to a depth of 150 mm ± 25 mm (6 inches ± 1 inch) measured in place after compaction.

Consolidate topsoil mixture and bond to soil surfaces using a sheepsfoot roller; and provide a firm, stable, rough textured surface. Compact areas not accessible to the sheepsfoot roller with a roller having a mass (weight) not over 180 kg/m (120 pounds per foot) width of roller or by other acceptable methods. Do not place topsoil mixture in a frozen or wet condition.

**(c) Unused Material.** Return unused topsoil or topsoil mixture to stockpiles and grade uniformly. Condition remaining stockpiles and stockpile areas as specified in Section 105.14.

**803.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

Measured in the hauling vehicle at the delivery point, as specified in Section 109.01(b).

# SECTION 804—SEEDING AND SOIL SUPPLEMENTS

**804.1 DESCRIPTION**—This work is furnishing and placing of seed and soil supplements of the type indicated, application of herbicides, and mowing.

**804.2 MATERIAL**—The Department may require pretesting reports from the Pennsylvania Department of Agriculture for verification of analysis and legality of labeling, in addition to control of materials, as specified in Section 106.

**(a) Soil Supplements.**

**1. Pulverized Agricultural Limestone.** Conforming to the requirements of the Agricultural Liming Materials Act of 1978, P.L. 15, No. 9, as amended; The Agricultural Liming Materials Rules and Regulations (Title 7-Part V); 7 PA Code, Chapter 108 for labeling requirements; and as follows:

- % Total oxides (total calcium oxide and magnesium oxide equivalent) (ASTM C 25) 50
- % Calcium carbonate equivalent (% by mass (weight)) (ASTM C 25) 89
- % Fineness (minimum % by mass (weight))

| | |
|---|---|
| material passing 850 µm (No. 20 sieve) | 95 |
| material passing 250 µm (No. 60 sieve) | 60 |
| material passing 150 µm (No. 100 sieve) | 50 |

Furnish material having an effective neutralizing value (ENV) of not less than 90 when calculated according to 7 PA Code Chapter 108 as follows:

- % by mass (weight) passing 20 mesh - % passing 60 mesh x 0.4 = (a)
  % by mass (weight) passing 60 mesh - % passing 100 mesh x 0.8 = (b)
  % by mass (weight) passing 100 mesh x 1.0 = (c)
- Minimum Calcium Carbonate Equivalent (CCE) = % by mass (weight) of calcium carbonate
- (a) + (b) + (c) x CCE divided by 100 = ENV

**2. Commercial Fertilizer.** Conforming to the requirements of the Pennsylvania Soil Conditioner and Plant Growth Substance Law, Act of December 1, 1977, P.L. 258, No. 86 (3P.S.68.2), as amended.

Use dry formulations of 10-20-20 analysis for seeded and sodded areas. Use dry formulations of 20-10-5 and 16-8-16 analysis controlled release for tree, shrub, and vine type planting operations. Use dry formulations of 19-6-12 analysis controlled release for herbaceous wetland planting operations. Use other analysis as indicated or specified in the proposal.

**3. Slow-Release Nitrogen Fertilizer.** Conforming to the requirements of the Pennsylvania Soil Conditioner and Plant Growth Substance Law, Act of December 1, 1977, P.L. 258, No. 86 (3P.S.68.2) as amended.

Use dry formulations of either 38-0-0 ureaform, 32-0-0 to 38-0-0 sulfur coated urea, 31-0-0 IBDU, or another analysis as indicated and conform to the following requirements:

- 38-0-0 ureaform

| | | |
|---|---|---|
| Total Nitrogen (TN) | — | 38.0% minimum |
| Cold Water Insoluble Nitrogen (WIN) | — | 25.0% minimum |
| Activity Index (AI) | — | 40.0% minimum |

| | | |
|---|---|---|
| Urea Nitrogen | — | 3.5% minimum |
| • 32-0-0 to 38-0-0 sulfur coated urea with a 7-day dissolution range of 20% to 30% | | |
| • 31-0-0 IBDU | — | Coarse grade (0.7 mm to 2.5 mm (28 mils to 98 mils)) |
| • Water Insoluble Nitrogen (WIN) | — | 27.0% minimum |

**(b) Seed.**

**1. General.** Conforming to the Pennsylvania Seed Act of 1965 (Act No. 187) and amendments, and regulations of the Pennsylvania Department of Agriculture, Bureau of Plant Industry.

Have the Pennsylvania Department of Agriculture, Bureau of Plant Industry, conduct purity and germination analysis, following the current Rules for Testing Seeds, of the Association of Official Seed Analysis.

Use Penngift certified Crownvetch, Kentucky Bluegrass, Perennial Ryegrass, Creeping Red Fescue, Chewings Fescue, Hard Fescue, and Birdsfoot Trefoil seed.

Use Crownvetch seed, pretested by the Pennsylvania Department of Agriculture, in 5.0 kg (10-pound) (net) waterproof bags, with a tag attached to each bag.

Use a premixed seed with an inspection tag, stamped, dated, and signed by the Department of Agriculture inspector sewn or stapled to the outside of each bag. Do not use seed from bags that are not sealed or that have been stored with herbicides.

Do not use seed unless it has been inspected and sampled, as specified, or sampled by individual species and lot number, and mixed on the project under Department supervision.

Do not use seed with a test date older than nine months.

**2. Seed Formulas.** See Table A.

**(c) Inoculant.** Standard acceptable commercial product, for treating leguminous seed. A product consisting of a suitable carrier, containing a culture of nitrogen-fixing bacteria specific for the seed to be inoculated.

Keep lids on containers when not in use to avoid contamination. Store containers at moderate temperature. Do not use inoculant after the expiration date shown on the container.

**(d) Herbicides.** Conforming to all applicable Federal and State pesticide acts and registration requirements and as specified in PCID No. 1094 – Herbicides (Weed and Brush Control) issued by the Pennsylvania Department of General Services, Bureau of Purchases, Quality Assurance Division, for the appropriate type.

Furnish herbicide in manufacturer's labeled container as follows:

**1. Selective Control in Seeded Areas.** In areas seeded with Formula B or D, use Type 1, Class C-2, 4-D Liquid Amine Salt Formulations (Dimethylamine) listed in PCID No. 1094, for controlling broadleaf weeds.

**(e) Mow-Line Delineator Stakes.** Not used.

**(f) Water.** Section 720.2

**TABLE A (Metric)**
**Seeding Requirements**

| Formula and Species | % By Mass | Minimum % | | Max. % Weed Seed | Seeding Rate kg/1000 $m^2$ |
|---|---|---|---|---|---|
| | | Purity | Germination | | |
| **Formula B** | | | | | **11.5 Total** |
| • Perennial Ryegrass mixture (Lolium perenne). A combination of improved certified varieties with no one variety exceeding 50% of the total Ryegrass component. | 18 | 98 | 90 | 0.15 | 2.0 |
| • Creeping Red Fescue or Chewings Fescue | 30 | 98 | 85 | 0.15 | 3.5 |
| • Kentucky Bluegrass mixture (Poa pratensis). A combination of improved certified varieties with no one variety exceeding 25% of the total Bluegrass component. | 52 | 98 | 80 | 0.20 | 6.0 |
| **Formula C** | | | | | **5.00 Total** |
| • Crownvetch (Coronilla varia) | 45 | 99 | 70 | 0.10 | 2.25 |
| • Annual Ryegrass (Lolium multiflorum) | 55 | 98 | 90 | 0.15 | 2.75 |
| **Formula D** | | | | | **11.5 Total** |
| • Tall Fescue (Festuca arundinacea var. Kentucky 31) | 70 | 98 | 85 | 0.15 | 8.0 |
| • Creeping Red Fescue or Chewings Fescue | 30 | 98 | 85 | 0.15 | 3.5 |
| **Formula E** | | | | | **5.5 Total** |
| • Annual Ryegrass (Lolium multiflorum) | 100 | 98 | 90 | 0.15 | 5.5 |
| **Formula L** | | | | | **13.00 Total** |
| • Hard Fescue mixture (Festuca longifolia). A combination of improved certified varieties with no one variety exceeding 50% of the total Hard Fescue component. | 54 | 98 | 85 | 0.15 | 7.00 |
| • Creeping Red Fescue | 36 | 98 | 85 | 0.15 | 4.75 |
| • Annual Ryegrass (Lolium Multiflorum) | 10 | 98 | 90 | 0.15 | 1.25 |
| **Formula W** | | | | | **5.5 Total** |
| • Tall Fescue (Festuca arundinacea var. Kentucky 31) | 73 | 98 | 85 | 0.15 | 4.0 |
| • Birdsfoot Trefoil mixture (Lotus corniculatus). A combination of varieties (Viking, Empire, Conec, Dawn, Leo, Bull, Maitland) with no one variety exceeding 50% of the total Trefoil component. | 18 | 98 | 80* | 0.10 | 1.0 |
| • Redtop (Agrostis alba) | 9 | 92 | 80 | 0.15 | 0.5 |

* Recommended 10% hardseed and 70% normal sprouts.

**TABLE A (English)**
**Seeding Requirements**

| Formula and Species | % By Weight | Minimum % | | Max % Weed Seed | Seeding Rate lb/1000 $yd^2$ |
|---|---|---|---|---|---|
| | | Purity | Germination | | |
| **Formula B** | | | | | **21.0 Total** |
| • Perennial Ryegrass mixture (Lolium perenne). A combination of improved certified varieties with No one variety exceeding 50% of the total Ryegrass component. | 20 | 98 | 90 | 0.15 | 4.0 |
| • Creeping Red Fescue or Chewings Fescue | 30 | 98 | 85 | 0.15 | 6.0 |
| • Kentucky Bluegrass mixture (Poa pratensis). A combination of improved certified varieties with no one variety exceeding 25% of the total Bluegrass component. | 50 | 98 | 80 | 0.20 | 11.0 |
| **Formula C** | | | | | **9.0 Total** |
| • Crownvetch (Coronilla varia) | 45 | 99 | 70 | 0.10 | 4.0 |
| • Annual Ryegrass (Lolium multiflorum) | 55 | 98 | 90 | 0.15 | 5.0 |
| **Formula D** | | | | | **21.0 Total** |
| • Tall Fescue (Festuca arundinacea var. Kentucky 31) | 70 | 98 | 85 | 0.15 | 15.0 |
| • Creeping Red Fescue or Chewings Fescue | 30 | 98 | 85 | 0.15 | 6.0 |
| **Formula E** | | | | | **10.0 Total** |
| • Annual Ryegrass (Lolium multiflorum) | 100 | 98 | 90 | 0.15 | 10.0 |
| **Formula L** | | | | | **24.0 Total** |
| • Hard Fescue mixture (Festuca longifolia). A combination of improved certified varieties with no one variety exceeding 50% of the total Hard Fescue component. | 55 | 98 | 85 | 0.15 | 13.0 |
| • Creeping Red Fescue | 35 | 98 | 85 | 0.15 | 8.5 |
| • Annual Ryegrass (Lolium Multiflorum) | 10 | 98 | 90 | 0.15 | 2.5 |
| **Formula W** | | | | | **10.5 Total** |
| • Tall Fescue (Festuca arundinacea var. Kentucky 31) | 70 | 98 | 85 | 0.15 | 7.5 |
| • Birdsfoot Trefoil mixture (Lotus corniculatus). A combination of varieties (Viking, Empire, Norcen, Dawn, Leo, Bull, Maitland) with no one variety exceeding 50% of the total Trefoil component. | 20 | 98 | 80* | 0.10 | 2.0 |
| • Redtop (Agrostis alba) | 10 | 92 | 80 | 0.15 | 1.0 |

* Recommended 10% hardseed and 70% normal sprouts.

## 804.3 CONSTRUCTION—

**(a) General.** Spread seeds where indicated and at the rates specified in Table A, or as otherwise indicated. Spread seeds within the following dates, or as otherwise indicated or directed.

- Formula B, D, and L — March 15 to June 1
  August 1 to October 15
- Formula C — Ryegrass Portion:
  March 1 to October 15

  Crownvetch Portion:
  Anytime except September and October
- Formula E — March 15 to October 15
- Formula W — April 1 to June 15
  August 16 to September 15

Extend seeding dates where project conditions warrant. Apply full treatment or apply only 50% of the permanent seeding and soil supplements and apply the remaining 50% within the next seeding dates, as directed in writing.

Use tillage and soil supplements before permanent seeding on topsoiled areas, where temporary seeding or mulching has been applied.

The Contractor may apply permanent seed and/or soil supplements without tilling on untopsoiled areas, where temporary seeding or mulching has been applied.

**(b) Tillage.** On topsoiled areas, 1:3 (3:1) and flatter, loosen the surface to a depth of at least 50 mm (2 inches) by disking, harrowing, or other acceptable methods until the tillage is satisfactory. On untopsoiled areas, 1:3 (3:1) and flatter, till only as directed. Also, till or scarify areas if the surface is glazed or crusted.

Correct surface irregularities by filling depressions and leveling rough or uneven areas. Remove metal objects, stones larger than 50 mm (2 inches) in any dimension, and other debris or objects deemed detrimental to maintenance operations.

**(c) Soil Supplements.** Prepare areas for seeding by uniformly applying supplements, except in areas that will receive Formula E seed. Document bulk delivery as specified in Section 804.2(a)2.

Blend the initial soil supplements into the soil at least 50 mm (2 inches), on topsoiled areas, by raking, disking, harrowing, or other acceptable methods. Blend the supplements into the soil during tillage operations.

Apply slow-release nitrogen fertilizer to the surface of Formula B, D, L, and W seeded areas before project completion. Do not apply slow-release nitrogen fertilizer supplement to Formula C seeded areas.

Apply soil supplements as follows, unless otherwise indicated:

- Pulverized Agricultural Limestone — 435 kg/1000 $m^2$
  (800 lb/1000 $yd^2$)
- 10-20-20 Analysis Commercial Fertilizer — 80 kg/1000 $m^2$
  (140 lb/1000 $yd^2$)
- 38-0-0 Ureaform Fertilizer — 30 kg/1000 $m^2$
  (50 lb/1000 $yd^2$)

  or
- 32-0-0 to 38-0-0 Sulfur Coated Urea Fertilizer — 35 kg/1000 $m^2$ to 30 kg/1000 $m^2$
  (59 lb/1000 $yd^2$ to 50 lb/1000 $yd^2$)
  as directed

  or
- 31-0-0 IBDU Fertilizer — 35 kg/1000 $m^2$
  (61 lb/1000 $yd^2$)

**(d) Inoculating Legumes.** Inoculate leguminous seed, such as Crownvetch and Birdsfoot Trefoil, with proper cultures, according to the manufacturer's directions. Protect inoculated seed from prolonged exposure to sunlight before sowing. Reinoculate seed not sown within 24 hours. If using hydraulic seeders, use inoculant four times the manufacturer's recommended rate.

If inoculated seed is held in a slurry with fertilizers for more than 1 hour, reinoculate or apply legumes separately.

**(e) Seeding.** At the rates specified in Table A, sow seeds uniformly on the prepared areas by the helicopter, hydraulic placement, broadcasting, drilling, or hand seeding methods. Inspect seeding equipment and adjust the equipment, if required, to ensure the specified application rates. Periodically perform a check on the rate and uniformity of application, as directed.

Prior to seed application of each designated seed formula, thoroughly clean-out seed tank by rinsing with clean water to prevent contamination from one seed formula to the next. Repeat rinsing cycle until tank is clean. Collect all non-applied seed derived from each clean-out event and remove as waste from the project.

**(f) Rolling.** After seeding, roll topsoiled areas that are to be mowed. Use a roller with a mass (weight) not more than 100 kg/m (65 pounds per foot). If soil is wet or frozen, roll only when directed.

**(g) Mow-Line Delineation.** Not used.

**(h) Herbicides.** Apply herbicides as directed, to areas that are to be mowed and where weed growth is prominent.

The Representative will designate existing plants or groups of plants to be saved within these areas before herbicide application. If directed, more than one application may be required to control undesirable growth.

Apply material with application personnel certified by the Department of Agriculture and with equipment specified in Section 108.05(c).

**(i) Liability.** Final acceptance of seeding and soil supplement materials will be subject to the results of official sampling and testing. If the purity or germination of any seed species does not meet the requirements of Table A, reseed with approved seed, not to exceed the original specified rate. If soil supplements do not meet the requirements, reapply with approved supplements not exceeding the original specified rates. Where directed, replace desirable vegetation damaged during mowing or herbicide application.

Redress and reapply designated seed and soil supplements to seeded areas exhibiting less than 70% coverage of the surface area with germinated grass stems after 90 days of growth. Calculate the germination and growth period from the date of the seeding operation when the seeding operations are performed within the normal specified dates. Perform this operation in the next applicable seeding date if necessary.

**(j) Maintenance.** Maintain grass and legume ground cover areas, within the grading limits, until the entire project has been completed. Mow as specified in Section 804.3(k).

Control any noxious weed growth found within the right of way, by herbicide spraying and cutting. These plants are defined by the Pennsylvania Weed Control Act of 1982, P.L. 228, No. 74 and as amended by further legislation. Submit, for approval, a schedule of work and list of herbicide material to be used before starting this operation.

If a slope failure occurs on a slope previously completed, and requires further excavation and redressing to reestablish the slope, reapply the seeding and soil supplement work as specified for the original slope.

**(k) Mowing.** Maintain turf grass areas within the grading limits, by mowing with approved equipment until the entire project has been completed.

Submit a proposed schedule of mowing operations that covers the length of the construction project for approval.

**1. Roadside Turf Areas.** Turf grass areas established with Formula D requires a different degree of mowing maintenance than areas established with Formulas B and L. Three mowing cycles per year, scheduled between April and October, are anticipated for mowing areas seeded with Formula D. The number of cycles may be adjusted based on the degree of turf establishment, project length, weather conditions, or other factors. Consult the District Roadside Manager for schedule, safety requirements, and mowing equipment approvals.

Schedule the first mowing cycle early in the growth flush period before all seed heads have emerged. Schedule the second mowing approximately 3 to 4 weeks after the first cut to remove the remaining seed heads. Schedule the last mowing cycle in the fall, as directed. Do not mow grass shorter than 100 mm (4 inches) to allow a low growing, competitive ground cover. Do not mow under the following conditions:

- When soil and grass blades are wet.
- During drought conditions, or during summer months when the temperatures are consistently over 32 ºC (90F), and when the grass exhibits dormancy.
- Within 7 days of any scheduled herbicide application or 7 days after a herbicide treatment.

**2. Lawn Turf Areas**. Maintain Formula B and L turf grass areas at a desired height of 50 mm (2 inches). Initiate mowing operations when grass seedlings reach a height of 75 mm (3 inches). Continue mowing operations during the active growing season throughout the length of the project. Follow the non-mow requirements indicated for Formula D grass. Mow at a normal frequency when the grass reaches the 75 mm (3-inch) height, unless directed otherwise.

## 804.4 MEASUREMENTS AND PAYMENT—

**(a) Seeding and Soil Supplements.** Kilogram (Pound)

Measured by the number of kilograms (pounds) of seed actually incorporated into the work for the seed formula and soil supplement applications specified in this specification.

The Department will pay for reseeding and reapplying soil supplements on failed slope areas, as specified in Section 804.3(j), at the contract unit price, in addition to the original accepted application of seeding and soil supplements.

**(b) Seeding.** Kilogram (Pound)

Measured by the number of kilograms (pounds) of seed actually incorporated into the work for the seed formula specified in this specification.

**(c) Herbicides.** 1000 Liters (1000 (M) Gallons)

For the type indicated.

**(d) Mowing.** Hectare (Acre)

# SECTION 805—MULCHING

**805.1 DESCRIPTION**—This work is the furnishing, placing, anchoring, and maintaining of mulch of the type indicated.

**805.2 MATERIAL—**

**(a) Mulches.** Free from foreign material, coarse stems, mold, substances toxic to plant growth, and mature seed bearing stalks or roots of prohibited and noxious weeds, as defined by law.

**1. Seeded Areas.** Either one or a combination of the following, as specified:

**1.a Hay.** Timothy hay, mixed clover and timothy hay, or other acceptable native or forage grasses, well-cured to less than 20% moisture content, by mass (weight).

**1.b Straw.** Either wheat or oat straw, reasonably free of viable seed, well cured to less than 20% moisture content, by mass (weight).

**1.c Wood Fiber.** Specially prepared, biodegradable, air-dried wood fibers manufactured from 100% wood chips or bark from lumber mill processing operations, tinted with nontoxic, green dye and containing an organic tackifier approved for use with wood fibers; manufactured to be applied with hydraulic seeding equipment; and conforming to the following requirements:

| | |
|---|---|
| • Moisture content | 15% maximum |
| • Organic matter (Oven-dried basis) | 95% minimum |
| • Water holding capacity (Grams of water per 100 grams of fiber) | 1000 minimum |
| • Tackifier content (By mass (weight)) | 2.5% to 3.5% |

Submit a certified physical analysis of the product for approval before application.

**1.d Pellet Mulch.** A biodegradable, water-absorbing, paper-based pellet that when wetted loses its pellet shape, breaks down and adheres to other pellets, forming a thin, protective mulch mat, and meeting the following requirements:

| | |
|---|---|
| • Paper content | 85% |
| • Fertilizer | 5% |
| • Polyacrylater | 2% to 5% |
| • Moisture content | 5% to 8% |
| • Dimensions | 3 mm (1/8-inch) diameter,<br>6 mm to 19 mm (1/4 inch to 3/4 inch) length |
| • Absorption potential | minimum, 3 times dry weight |

**1.e Bonded Fiber Matrix (BFM).** Specially prepared, water soluble, biodegradable, hydraulically applied system of long strand wood fibers held together by a bonding agent, which adheres to the soil surface and upon drying forms a continuous, insoluble, three dimensional, non-dispersible protective crust-like soil covering.

**1.e.1 Polymer or Hydrocolloid Binder Matrix.**

**1.e.1.a Wood Fiber.** Specially prepared, long strand (min. 25% 10 mm (3/8-inch) length), air-dried wood fibers (88% to 92% by mass (weight)) manufactured from wood chips, bark, or clean wood waste products, and conforming to the following requirements:

| | |
|---|---|
| Moisture content | 15% maximum |
| Water holding capacity | 1000 minimum<br>(Grams of water per 100 grams of fiber) |

**1.e.1.b Bonding Agent.** High-strength tackifier of powdered polysaccharide guar gum, blended hydrocolloid-based binder, hydrophyllic, or co-polymer material 5 to 12% by mass (weight).

**1.e.1.c Synthetic Fiber.** System may contain up to 5% by mass (weight) of crimped, polyester fibers or other synthetic fibers with wetting and dispersion agents manufactured for use in mulching applications.

**1.e.1.d Dye.** System may contain a nontoxic, water soluble, colored dye to aid in the visual application coverage of the matrix.

**1.e.1.e Activator.** System may contain up to 1% by mass (weight) of organic and mineral fertilizers.

**1.e.2 Gypsum Binder Matrix.**

**1.e.2.a Wood Fiber.** Specially prepared, long strand (min. 25% 10 mm (3/8-inch) length), air-dried wood fibers manufactured from wood chips, bark, or clean wood waste products, and conforming to the following requirements:

| | |
|---|---|
| Moisture content | 15% maximum |
| Water holding capacity | 1000 minimum<br>(Grams of water per 100 grams of fiber) |

**1.e.2.b Bonding Agent.** Naturally occurring, high purity, processed hemi-hydrate gypsum with manufacturer's system additives, which when combined with water will form a cementitious binder that will produce a crust-like soil covering within 4 to 8 hours after application. Material that has become partially air set, lumpy, or caked before use is not acceptable for use.

**1.e.2.c Synthetic Fiber.** Synthetic fibers manufactured for use in mulching applications, coated with wetting and dispersion agents.

**1.e.2.d Dye.** System may contain a nontoxic, water soluble, colored dye to aid in the visual application coverage of the matrix.

**2. Planting and Other Areas.** One of the following:

**2.a Tanbark.** Suitable fibrous shredded, ground or chunked, aged tanbark derived as a by-product of the tannin extraction process, free from insect life, not decomposed, and between 6 mm and 50 mm (1/4 inch and 2 inches) in any dimension.

**2.b Shredded Bark.** Suitable shredded, chunked, or ground pieces of predominantly aged, but not decomposed, hardwood or pinewood tree bark produced from lumber mill processing operations, free of excessively fine particles and having a general size range of 6 mm to 50 mm (1/4 inch to 2 inches) in any dimension.

**2.c Washed Gravel.** Uncrushed, washed, No. 57, as specified in Section 703.2(a)2.

**2.d Coarse Aggregate.** No. 67, Type C, as specified in Section 703.2(a)1.

**2.e Sewage Sludge Compost.** A blend of secondary dewatered sewage sludge and wood chips, aerobically composted at a DEP, Bureau of Waste Management permitted site for at least 21 days and cured for 30 to 60 days to ensure pathogen destruction. Free of foreign material and substances toxic to plant growth, nonburning, weed free, screened, and conforming to the following requirements:

- Minimum of 50% organic matter (oven dry basis)
- Minimum of 100% water holding capacity
- Particle Size—10 mm to 80 mm (3/8 inch to 3 inches)
- pH—6.0 minimum
- Heavy metals and toxic compounds (based on sewage sludge content)

| | **MAXIMUM PPM** |
|---|---|
| Cadmium | 25 |
| Chromium | 1000 |
| Copper | 1000 |
| Lead | 1000 |
| Mercury | 10 |
| Nickel | 200 |
| Zinc | 2500 |
| PCBs | 3 |

Submit a certified laboratory analysis with each shipment.

**2.f Wood Chips.** Suitable chipped or ground wood material produced from predominantly live or non-decayed trees, logs, brush including leaves or post-consumer lumber having a general size range of 15 mm to 50 mm (1/2 inch to 2 inches) in any dimension and free of excessively fine or stringy particles. Chips produced and stockpiled during clearing and grubbing operations or aged chips, at least 6 months old, from lumber mill operations of the desired size and free from foreign debris will also be accepted.

**2.g Spent Mushroom Soil Compost.** Organic substrate used in mushroom production that has been steam sterilized, then composted for a minimum of 90 days in well-managed windrows, and on a properly surfaced and protected composting pad and blended with ground brush (yard waste), recycled wood, and/or composted bark. Conforms to the requirements specified in Section 808.2(g)4 except as follows:

- Minimum Organic Matter (Oven Dry Basis)—40%
- Moisture Content—60% maximum
- Particle Size—10 mm to 80 mm (3/8 inch to 3 inches)
- Soluble Salt Concentration—20 dS maximum

**(b) Mulch Binders.** Other acceptable binder materials manufactured for this purpose or the following.

**1. Recycled Cellulose Fiber.** Specifically prepared, biodegradable, shredded paper particles, comprised of recycled newsprint or other recycled wood cellulose fiber, containing a surfactant and nontoxic, green dye; manufactured to be applied with hydraulic seeding equipment; and conforming to the following requirements:

- Moisture content — 17% maximum
- Organic matter — 80% minimum (Oven-dried basis)
- Water holding capacity (Grams of water per 100 grams of fiber) — 900 minimum

**2. Wood Fiber.** Section 805.2(a)1.c

**3. Nonasphaltic Emulsion.** Either water soluble natural vegetable gum blended with gelling and hardening agents or a water soluble blend of hydrophyllic polymers, viscosifiers, sticking aids, and gums.

**4. Polyvinyl Acetate.** Emulsion resin, containing 60% ± 1% total solids by mass (weight).

**5. Recycled Cellulose Fiber/Wood Fiber Mixture.** Specially prepared mixture of biodegradable, air-dried wood fiber, manufactured from wood chips or bark, and shredded paper particles, comprised of recycled newsprint or other recycled cellulose fiber combined with a surfactant and a nontoxic, green dye; manufactured to be applied with hydraulic seeding equipment; and conforming to the following requirements:

- Wood fiber — 45% to 55%
- Recycled cellulose fiber — 45% to 55%
- Moisture content — 21% maximum
- Organic matter (Oven-dried basis) — 97% minimum
- Water holding capacity (Grams of water per 100 grams of fiber) — 900 minimum

**(c) Mulch Control Netting.** One of the following:

**1. Plastic.** A uniformly extruded, rectangular, plastic mesh conforming to the following requirements:

- Mass (weight) — 7.8 g/m$^2$ (0.23 ounce per square yard), minimum
- Mesh opening — Nominal 19 mm x 19 mm (3/4-inch by 3/4-inch)

**2. Coconut Coir.** Undyed, biodegradable, coconut coir yarn woven into a mesh conforming to the following requirements:

- Mass (weight) — 200 g/m$^2$ (6 ounces per square yard), minimum
- Mesh opening — Nominal 50 mm x 50 mm (2-inch by 2-inch), maximum

**(d) Weed Barrier and Weed Control Mats.**

**1. Weed Barrier Mat.** Stable, evenly distributed, permeable, network of polymeric woven, non-woven or a woven/non-woven combination of polypropylene or polyester filaments or yarns manufactured for weed

barrier/soil separator use, inert to commonly encountered construction chemicals or substances and conforming to the following physical requirements:

| Type | MARV* | Property |
|---|---|---|
| Woven or combination<br>Non-woven fabric | 0.03 sec-1<br>1.3 sec-1 | Permittivity flow rate<br>ASTM D 4491 |
| Woven or combination<br>Non-woven fabric | 0.004 cm/sec<br>488 L/min/$m^2$<br>(12 gal/min/sq. ft.) | Permeability coefficient<br>Permeability flux<br>ASTM D 4491<br>Falling head test |
| All fabric | 175 N (40 lbs.) | Puncture strength<br>(5/16-inch flat head rod)<br>ASTM D 4833 |
| All fabric | 70% after 150 hours | Ultraviolet resistance<br>Strength retention<br>ASTM D 4355 |

* Minimum Average Roll Value (+95% of the fabric in a lot will meet or exceed the minimum requirements).

Certify as specified in Section 106.03(b).

**2. Weed Control Mat.** Stable, permeable network of spunbonded, long chain synthetic polyolefins (minimum 95% by mass (weight)) filaments or yarns with nodules of trifluralin, carbon black and polyethylene compounded together utilizing time-release characteristics permanently attached to the fabric on 38 mm (1 1/2-inch) centers and conforming to the following requirements.

| Physical Property | MARV* |
|---|---|
| Trifluralin (Nodule) | 20% |
| Puncture strength<br>(5/16-inch flat head rod)<br>ASTM D 4833 | 175 N (39 lbs.) |
| Permittivity<br>ASTM D 4491 | 0.7 sec-1 |
| Ultraviolet resistance<br>Strength retention<br>ASTM D 4355 | 70% after 500 hours |

* Minimum Average Roll Value (+95% of the fabric in a lot will meet or exceed the minimum requirement).

Certify as specified in Section 106.03(b).

**(e) Staples.** Section 806.2(e)1

**(f) Wood Stakes.** Section 806.2(e)3.

## 805.3 CONSTRUCTION—

**(a) Mulching Seeded Areas.** Place mulch, of the type indicated, immediately after seeding or within 48 hours after seeding is completed. Unless otherwise indicated, place only straw or wood fiber over topsoiled areas. Use hay, straw, or wood fiber in other areas, as indicated or specified.

Place hay or straw uniformly, in a continuous blanket, at a minimum rate of 650 kg/1000 $m^2$ (1,200 pounds per 1,000 square yards) or as otherwise indicated. If directed, increase the rate of application, depending upon the material used, season, soil conditions, or method of application. An acceptable mechanical blower may be used to apply mulch. Do not use machines that cut mulch into short pieces. Anchor mulch with specified mulch binders applied at the following rates:

- Recycled cellulose fiber—90 kg/1000 $m^2$ (160 pounds per 1,000 square yards)
- Wood fiber—90 kg/1000 $m^2$ (160 pounds per 1,000 square yards)
- Nonasphaltic emulsion—At manufacturer's recommended rate
- Polyvinyl acetate—At manufacturer's recommended rate
- Recycled cellulose fiber/wood fiber mixture—90 kg/1000 $m^2$ (160 pounds per 1,000 square yards)

The mulch binder application is incidental to the application of straw and hay mulch.

Apply wood fiber mulch hydraulically according to the manufacturer's tank-mixing instructions. It may be incorporated as an integral part of the slurry after the seed and soil supplements have been thoroughly mixed. Apply uniformly at the rate of 175 kg/1000 $m^2$ (320 pounds per 1,000 square yards) unless otherwise indicated.

Mulch temporary seeded areas with hay.

**1. Median Areas.** On slopes 1:6 (6:1) or flatter, place pellet mulch by hand or using a mechanical spreader immediately after seeding. Apply uniformly at application rate of 293 kg/1000 $m^2$ (540 pounds per 1,000 square yards). Thoroughly wet pellet mulch with water without dislodging mulch.

**(b) Mulch Control Netting.**

**1. Plastic.** Install netting over designated mulch surface. Staple upslope ends, edges, bottom, and overlaps at 600 mm (24-inch) intervals. Overlap adjacent fabric to outside edges. Secure remaining fabric areas by putting in approximately 1 staple per 1.0 $m^2$ (1 staple per 1 square yard) of area.

**2. Coconut Coir.** Install netting over designated mulch surface. Stretch fabric tightly and anchor with wood stakes along all edges at 2.2 m (7-foot) maximum interval. Overlap adjacent fabric widths by not less than 200 mm (8 inches).

**(c) Mulching Planted Areas.**

**1. Individual Plant Pits.** Uniformly apply a designated mulch specified in Section 805.2(a)2 to the entire plant pit to a loose depth of 75 mm (3 inches) and as shown on the Standard Drawing. Apply mulch within 48 hours after completion of the planting operation.

**2. Planting Beds.** Cover designated shrub beds with mulch or mulch and weed barrier mat or mulch and weed control mat as indicated. Cut mat around the plant stem to ensure mat will not extend above the mulch. Secure mat to the soil surface with staples or other approved anchoring devices at a maximum interval spacing of 1.0 m (3 feet) and along all edges and overlaps. Overlap mat edge with 50 mm (2-inch) minimum.

Uniformly apply a designated mulch specified in Section 805.2(a)2 over the entire bed area to a loose depth of 75 mm (3 inches). Redistribute excessive mulch depth. Taper mulch depth at plant pit as shown on the Standard Drawing. Apply mat and mulch within 48 hours after completion of the planting operation.

**(d) Maintenance.** Properly maintain mulched areas until the entire project has been completed. Promptly reapply mulch materials, which become dislodged or lost due to wind, rain, or other causes, at initial or modified rates, as directed.

After mulching work on a slope has been satisfactorily completed, if a slope failure occurs, one that requires redressing, excavation, or the establishment of a new slope, replace the mulch, as directed.

**(e) Bonded Fiber Matrix.**

**1. General.** Prepare surfaces as specified in Section 804.3(b). Scarify all slopes greater than 1:3 (3:1) to ensure a rough texture for lodging of seed and BFM. Apply seed at twice the rate specified in Section 804.2(b)2 Table A. Apply soil supplements as specified in Section 804.3(c).

**2. Application.** Apply bonded fiber matrix components hydraulically with hydromulching (hydroseed) equipment manufactured for this purpose. Follow manufacturer's mixing and application instructions.

The bonded fiber matrix components may be incorporated as an integral part of the seeding and soil supplement application if seeding and soil supplements are applied hydraulically.

Apply polymer binder or hydrocolloid binder matrixes at an application rate of 337.5 kg/1000 $m^2$ (3,000 pounds per acre) or as indicated to provide a uniform soil surface coverage thickness of 4 mm (0.16 inch) maximum after drying. Test application procedures to ensure a uniform application rate. Do not apply within 24 hours of anticipated rainfall.

Mix gypsum binder matrix components in a homogenous slurry in the following proportions for each 379 L (100 gallons) of water: gypsum binder—69 kg (150 pounds); wood fiber—18 kg (40 pounds); and synthetic fiber—0.3 kg (0.6 pounds). Apply gypsum binder matrix at an application rate of 675 kg/1000 $m^2$ (6,000 pounds per acre) or as indicated so that the soil surface is covered uniformly. Do not apply within 12 hours of anticipated rainfall.

Place BFM material at least 450 mm (18 inches) beyond the toe and top of all slopes. Apply material in at least two different directions to provide as much uniform coverage with no gaps or spaces greater than 1 mm (0.04 inch).

## 805.4 MEASUREMENT AND PAYMENT—

**(a) Seeded Areas.** Tonne (Ton)

For the type indicated. Measured by the number of tonnes (tons) of mulch actually incorporated into the work, at the specified rates.

**(b) Planted Areas.** Square Meter (Square Yard)

For the type indicated.

**(c) Mulch Replacement.** The Department will pay for replacing mulch on failed slope areas, as specified in Section 805.3(c), at the contract unit price, in addition to the original accepted mulch application.

**(d) Mulching and Weed Barrier Mat.** Square Meter (Square Yard)

For the type indicated.

**(e) Mulching and Weed Control Mat.** Square Meter (Square Yard)

For the type indicated.

**(f) Mulching - Bonded Fiber Matrix.** Square Meter (Square Yard)

**(g) Mulch Control Netting.** Square Meter (Square Yard)

# SECTION 806—WATER COURSE AND SLOPE EROSION PROTECTION

**806.1 DESCRIPTION**—This work is furnishing, placement, and maintenance of soil erosion control material.

**806.2 MATERIAL**—From a manufacturer listed in Bulletin 15 and conforming to the following requirements:

**(a) Erosion Control Mats (ECM) and Mulch Blankets (ECB).**

**1. Erosion Control Mat.** Undyed, flexible, non-treated biodegradable heavy jute, coconut coir, photodegradable polypropylene multifilament, and tape yarn or other yarns woven into a dimensionally stable uniform open plain weave mesh conforming to the physical properties of one of the following:

- Organic yarns—Mesh with approximately 15 mm to 25 mm (0.6-inch to 1-inch) square openings and having a mass (weight) not less than 470 g/m$^2$ (14 ounces per square yard).

- Synthetic fibers—Mesh with either nominal 4 mm x 4 mm (0.15-inch by 0.15-inch) or 2.5 mm x 3 mm (0.10-inch by 0.12-inch) (minimum average roll values) openings and having a mass (weight) not less than 55 g/m$^2$ (1.75 ounces per square yard).

**2. Erosion Control Mulch Blanket.** One of the following:

**2.a Organic Mulch Material.** A machine produced mat of organic, biodegradable mulch material such as straw, curled wood cellulose, coconut fiber, or combinations of material evenly distributed and attached on one side of a photodegradable polypropylene mesh with high-strength threads conforming to the following physical properties:

- Mass (weight) 270 g/m$^2$ (8 ounces per square yard), minimum

- Mat thickness Approximately 3 mm to 15 mm (0.125 inch to 0.6 inch)

**2.b Reprocessed Wood Fiber.** A flexible, non-woven, biodegradable water absorbing mat of mechanically defibrated wood fibers and synthetic fibers with a photodegradable polypropylene netting laminated to one side of the mat and conforming to the following physical properties:

- Mass (weight) 215 g/m$^2$ to 270 g/m$^2$ (6.4 ounces per square yard to 7.9 ounces per square yard)

- Mat thickness 2.6 mm (0.105 inch), minimum

**3. High Velocity Erosion Control Mulch Blanket.** Section 806.2(a)2.a, except mulch material is evenly distributed between two layers of photodegradable polypropylene mesh.

**(b) Turf Reinforcement Mat (TRM).** A machine-produced, three-dimensional, matrix web of mechanically or melt-bonded monofilaments or fibers processed to form a strong, entangled, and dimensionally stable rolled erosion control product. Matrix manufactured to have sufficient thickness, resiliency, and void space to fill with soil thereby providing erosion protection while facilitating vegetative establishment. The Contractor may supplement the matrix with polyethylene or polyolefin fibers, or degradable natural organic coconut fibers, stitched between biaxially oriented process synthetic netting with synthetic or natural threads. Matrix components, other than the supplemental fibers, stabilized against ultraviolet degradation, and conforming to the following physical properties:

| | |
|---|---|
| • Matrix bonding | Either polymer matrix welding, thermal or polymer matrix fusion, or fibers positioned between two high-strength biaxially oriented mesh nets bound securely together by parallel stitching with polyolefin, polypropylene, nylon, or polyester threads. |
| • Matrix fibers | Polyolefin, polypropylene, or natural coconut fiber |
| • Mat thickness | 13 mm (1/2-inch), Average Nominal Thickness (ASTM D 6525) |
| • Tensile strength | 1.75 kN/m x 1.4 kN/m* (10 pounds force per inch by 8 pounds force per inch*) (ASTM D 4595), or 1.36 kN/m x 0.79 kN/m* (7.8 pounds force per inch by 4.5 pounds force per inch*) (ASTM D 5035) |
| • Ultraviolet stability | 80% tensile strength retained (ASTM D 4355) |

* Minimum Average Roll Value

**(c) Erosion Control and Revegetation Mat (ECRM).** One of the following:

**1. Type A.** A flexible, machine produced, UV stabilized, three dimensional matrix web of mechanically or melt bonded nylon or polymer netting, monofilaments or fibers that are entangled to form a strong and dimensionally stable rolled erosion control product. Matrix to provide sufficient thickness to cover the ground and provide erosion protection while facilitating vegetation establishment and conforming to the following physical properties:

| | |
|---|---|
| • Matrix bonding | Either polymer welding, thermal or polymer fusion, or synthetic fibers positioned between two high-strength biaxially oriented nets bound securely together by parallel stitching with polyolefin, polypropylene, nylon, or polyester threads. |
| • Mat thickness | 3 mm (0.125-inch), Average Nominal Thickness (ASTM D 6525) |
| • Tensile strength | 1.59 kN/m x 0.86 kN/m* (9.1 pounds force per inch by 4.9 pounds force per inch*) (ASTM D 4595), or 1.45 kN/m x 0.70 kN/m* (8.3 pounds force per inch by 4 pounds force per inch*) (ASTM D 5035) |
| • Ultraviolet stability | 80% tensile strength retained (ASTM D 4355) |

* Minimum Average Roll Value

**2. Type B.** A flexible, randomly oriented polyvinylchloride monofilaments bonded together to form a stable three dimensional entangled, porous matrix resistant to natural soil and groundwater chemical degradation. Matrix to provide sufficient thickness and ground cover to provide erosion protection while facilitating vegetative establishment and conforming to the following physical properties:

| | |
|---|---|
| • Mat thickness | 2.5 mm (0.10 inches), Average Nominal Thickness (ASTM D 5199) |
| • Mass (weight) per unit area | 800 g/m$^2$* (24 ounces per square yard*) (ASTM D 5261) |

| | |
|---|---|
| • Wide width Tensile strength | 2.1 kN/m x 0.70 kN/m* (12 by 4 pounds force per inch*) (ASTM D 4595 or ASTM D 3776) |
| • Ultraviolet stability | 85% tensile strength retained (ASTM D 4355) |

* Minimum Average Roll Value

**(d) Anchoring Devices.**

**1. Staples.** 4 mm (No. 8 gauge) steel wire, bent U-shaped or square top with a throat width of 25 mm to 50 mm (1 inch to 2 inches), with an effective minimum driving depth of 200 mm (8 inches).

**2. Metal Pin.** Carbon steel pin, 5 mm (3/16-inch) shank diameter, 460 mm (18-inch) length with attached 38 mm (1 1/2-inch) minimum outside diameter steel washer head.

**3. Wood Stakes.** Sound, rough sawn, approved hardwood 25 mm x 100 mm (1-inch by 4-inch) nominal stake tapered to a point throughout, with a minimum length of 450 mm (18 inches).

**4. Substitutes.** Submit other anchoring devices, as recommended by the mat manufacturer, for review and approval.

**(e) Seeding and Soil Supplements.** Section 804

**(f) Mulch for Seeded Areas.** Section 805

**(g) Certification.** Section 106.03(b)3

**806.3 CONSTRUCTION—**

**(a) Erosion Control Mats and Mulch Blankets.**

**1. General.** Place erosion control materials after final grading and dressing slope, swale, or channel to define flow area and after applying designated soil supplements, seed, and mulch, as indicated. Install erosion control materials to conform to shape of soil surface.

Unroll, place, and anchor mat evenly and smoothly, without stretching, to maintain contact with mulch surface at all points. Use appropriate anchoring devices and follow installation directions of the mat manufacturer. If staples are used, drive staple flush with the top of the mat or the mulch blanket surface so that the staple does not extend above the mat or the mulch blanket. Click to view Video of ECM/ECB installation.

**2. Erosion Control Mulch Blanket and High Velocity Erosion Control Mulch Blanket.** Install blanket having mesh on only one side with mesh side on top. If erosion control blankets are installed, the mulch application normally associated with seeding operation is not required.

**(b) Turf Reinforcement Mat.**

**1. Site Preparation.** Prepare final graded and dressed soil surfaces to receive permanent seeding in accordance with Section 804.3. Soil surfaces to be free of rocks or other obstructions that prevent the mat from lying in direct contact with soil.

**2. Mat Installation.** Unroll, place, and anchor mat evenly and smoothly, without stretching, to conform to the shape of and be in uniform contact with the soil surface. Use appropriate anchoring devices and follow installation directions of mat manufacturer. Drive staples or anchoring pins flush with soil surface.

**3. Seeding.** After mat installation, broadcast designated seed formula mixture into mat matrix in accordance with Section 804.3.

**4. Topsoil Placement.** After seeding, uniformly place 13 mm to 20 mm (1/2 inch to ¾ inch) of approved topsoil on mat. Work soil into mat voids to completely fill mat matrix flush with top of mat. Remove excess topsoil.

**5. Mulching.** Mulch area with designated mulch as specified in Section 805.3.

**(c) Erosion Control and Revegetation Mat.**

**1. Site Preparation.** Prepare final graded and dressed soil surfaces to receive permanent seeding as specified in Section 804.3. Soil surfaces to be free of rocks or other obstructions that prevent mat from lying in direct contact with soil.

**2. Seeding.** Place designated seed formula mixture as specified in Section 804.3. Mulch application normally associated with seeding operation is not required for installation of mats.

**3. Mat Installation.** Unroll, place, and anchor mat evenly and smoothly without stretching. Use appropriate anchoring devices and follow installation directions of mat manufacturer. Drive staples or anchoring pins flush with soil surface.

**(d) Maintenance.** Properly maintain designated erosion control system until entire project is accepted. If a protected slope, swale, or other soil surface failure occurs after installation of work, redress affected soil areas and reinstall protection material as specified for original treatment, unless directed otherwise.

**806.4 MEASUREMENTS AND PAYMENT—**

**(a) Erosion Control Mat.** Square Meter (Square Yard)

**(b) Erosion Control Mulch Blanket.** Square Meter (Square Yard)

**(c) High-Velocity Erosion Control Mulch Blanket.** Square Meter (Square Yard)

**(d) Turf Reinforcement Mat.** Square Meter (Square Yard)

**(e) Erosion Control and Revegetation Mat.** Square Meter (Square Yard)

**(f) Seeding and Soil Supplements.** Section 804.4(a) for the type indicated.

**(g) Mulch.** Section 805.4(a) and (c) for the type indicated.

# SECTION 808—PLANTS, PLANTING, AND TRANSPLANTING

**808.1 DESCRIPTION**—This work is the furnishing, planting, and transplanting of trees, shrubs, vines, and other woody or herbaceous plants, and includes shrub-bed preparation.

**808.2 MATERIAL**—Conforming to the current edition of "American Standard for Nursery Stock" (ASNS), ANSI, Z60.1 of the American Nursery and Landscape Association (ANLA), and as follows:

**(a) Plant Stock.** Conforming to the following requirements.

- True to type and name, according to the current edition of Standardized Plant Names of the American Joint Committee on Horticulture Nomenclature;
- Each bundle or each plant, if not bundled, labeled with not less than the plant's common name and size;
- Typical of the species or variety indicated;
- Free from disease and injurious insects, according to State and Federal laws;
- Free from mechanical injuries, cutback leaders, broken branches, decay, or other defects;
- Unless otherwise designated, nursery-grown plants, acclimated to Pennsylvania soil and climatic conditions; and
- Dormant, other than those specified as container grown.

**1. Nursery Stock.** Grown in a licensed nursery for a period of at least one full-growing season. The use of mechanical digging equipment at the nursery will be allowed only when its use is not detrimental to nursery stock survival.

Pennsylvania is located within U.S. Department of Agriculture (USDA) Plant Hardiness Zones 5 and 6 with winter temperatures ranging from -20F to -10F for Zone 5 and -10F to 0F for Zone 6. Provide plants that have been grown for a period of at least 1 year in a nursery located within the same USDA Plant Hardiness Zone or colder Zone that exists at the location of the planting project.

Submit for approval a complete and detailed source of supply for each plant item indicated in the contract at least 90 days before the anticipated start of the planting operations. The Department reserves the right to reject plants from nurseries that do not qualify for the USDA Hardiness Zone growing requirement.

**2. Collected Plants.** Plants collected from native or previously established plantings that have not been re-established in a nursery row or grown under regular nursery cultural practices for at least two full-growing seasons. Designate collected plants as such.

**3. Balled and Burlapped (B&B) Plants.**

- Firmly balled with the original and undisturbed soil in which the plant was growing.
- Wrapped with untreated, biodegradable burlap or similar acceptable material, then tightly laced with biodegradable lacing to hold the ball firm and intact.
- Plants delivered to the planting site with balls broken, loose, or manufactured will be rejected.
- Acceptable nursery trade root protection devices will be allowed in lieu of burlap wrap, as approved.

**4. Container-Grown Plants.** Grown for at least one year, but not more than 2 years, in the same container so that the roots and soil ball held together and retained its shape when removed from the container. The Department will reject plants that exhibit a "pot-bound" condition with girdling and encircling primary roots. Only ground-cover, vine-type plants with roots exhibiting a "pot-bound" condition will be accepted.

**5. Herbaceous Plants.**

**5.a Rhizome.** Resilient, underground propagule collected during dormant condition and exhibiting light colored buds or shoots.

**5.b Bulb or Tuber.** Firm, underground propagule collected during dormant condition and exhibiting light colored buds or shoots.

**5.c Peat Pot.** Generally 44 mm to 58 mm (1 3/4-inch to 2 1/4-inch) square, commercial peat pot, filled with an approved potting soil mixture. Containing at least three nursery-grown plants, each with a minimum active top growth of at least 150 mm (6 inches) and having roots sufficiently developed through the peat pot surface so as to be firmly contained.

**5.d Plug (Grasses, Rushes, and Sedges).** Cubical or cylindrical plant extracts, minimum of 100 mm (4 inches) wide by 100 mm (4 inches) deep, cut from existing plant communities containing stems, roots, associated underground parts, and soil. Keep plug moist and viable for planting. Plug may also be provided in 50 mm (2 inches) square nursery pots or 50 mm (2 inch) wide by 150 mm (6 inch) deep pre-molded plastic tubes (tublings) manufactured to encourage deep root development. Minimum active top growth development of 100 mm (4 inches).

**5.e Starter Plant.** Bare root plants with developed root systems capable of being transplanted and generated from seed, rhizome, or rootstock. Starter plant may also be provided in 50 mm (2 inches) square nursery pots or 50 mm (2 inch) wide by 150 mm (6 inch) deep pre-molded plastic tubes (tublings) manufactured to encourage deep root development. Minimum active top growth development of 150 mm (6 inches).

**6. Bare Root (BR) Plants.** Plants that have been dug while dormant and have had the soil removed from the roots exhibiting a live, moist, and well-branched, fibrous root system characteristic of the species, free from rot, mold, and damage. Roots dipped into, and thoroughly covered with, a gel comprised of water and a superconcentrated, water-absorbent, nontoxic, neutral pH, starch graft/acrylate copolymer, insoluble material manufactured for this dipping purpose. Mix gel dip to manufacturer's recommended rate.

**7. Crownvetch Plants.**

**7.a Crowns.** No. 1, whole, field-grown crowns of certified variety at least one growing season old. Overall plant length of 150 mm to 230 mm (6 inches to 9 inches), including 15 mm (1/2 inch) of top growth. Measuring not less than 3 mm (1/8 inch) or more than 10 mm (3/8 inch) in caliper, at a point 25 mm (1 inch) below the root collar.

**7.b Potted Plants.** Certified variety, grown for a period of at least 100 days. In 58 mm (2 1/4-inch) or larger peat pots and "pot-bound," with a top growth of not less than 150 mm (6 inches).

**8. Storage, Packing, and Handling.** According to good nursery practice. Plants showing signs of improper storage, packing, or handling will be rejected.

**9. Inspection and Rejection.** Plant materials will be inspected at the project planting site prior to planting. Complete form CS 6104, Plant Material Inspection Report, for each shipment. When requested, provide certification as specified in Section 106.03(b)3. A state nursery inspection certificate is required with each shipment, invoice, or order of plants to verify inspection for pest control, as well as freedom from disease and insect pests, before removal from the nursery or place of growth.

Inspection at the project site is to ensure that plant stock is from an approved source, is in healthy and undamaged condition, and conforms to size, type, quantities, and appropriate ANSI Z60.1 Standards.

Plants exhibiting the following defects or damage may be rejected:

- Decayed tissue on plant trunk, branches, or twigs.
- Sunscald or sunburn resulting in cambium tissue or bark damage.
- Mechanical damage/bark abrasions resulting in damage to cambium tissue.
- Frost cracks appearing as splits in bark or wood.
- Disease resulting in abnormal growth of leaves, twigs, fruit, bark, discoloration of leaves and bark, or sap discharge.
- Insect damage appearing as borer holes into bark or wood or insect eggs or larvae.
- Other damage or injury such as branch and twig die-back, dry buds, or dead leaves.
- Improper pruning resulting in improper stubs left on trunk, branches, or twigs, removal of excessive branches that leaves the plant asymmetrical or non-uniform in plant density, and pruning wounds larger than 25 mm (1 inch) in diameter.
- Girdling roots appearing as roots growing in a damaging, encircling configuration.
- Non-standard growth patterns for single or multiple stem plants, non-typical for their plant genus, species, or varieties.
- Sheared evergreen trees or shrubs not representative of full-foliaged, natural-growth plants.
- Evidence of undue damage to root ball structure causing broken root balls and plants loosened in the soil ball.
- Evidence of insufficient roots throughout the entire soil ball and with fewer than five undamaged, viable, balanced, primary roots.
- Excessive top growth not in acceptable balance with the root system.

Plant materials will be accepted, subject to responsibility for latent defects, as specified in Section 107.16(b).

Plants damaged during planting operations will also be rejected and require replacement with appropriate indicated plants.

Segregate and remove rejected plants from the planting site within 48 hours or as directed.

**10. Substitutions.** No substitutions will be allowed without authorization, as provided in Form CS 616, Request for Plant Material Substitution.

**11. Shipment.** Carefully pack the roots of bare-rooted stock in spaghnum moss, moist straw, or other suitable material that will ensure the plant's arrival in acceptable condition. For material shipped in open vehicles, cover with securely fastened canvas, burlap, or other material to prevent wind burn or drying. Plant material that has heated or "sweated" by reason of tight packing or poor ventilation will be rejected. For plants approved to be shipped during the active growing season, treat plants with antidesiccant and/or antitranspirant material, applied by spraying or dipping, to prevent excessive transpiration. Comply with local, State, and Federal laws relative to plant material shipment.

**(b) Antidesiccant/Antitranspirant.** ASTM E 96 in liquid form.

**(c) Fertilizer.** 20-10-5 tablets (10 gram), 16-8-16 packets, and 19-6-12 fertilizers conforming to the requirements of Section 804.2(a)2. When using packets, use in 113 g (4-ounce), individual, heat-sealed, polyethylene envelopes. Application rates are as shown on the Standard Drawings or as directed.

**(d) Mulch.** Section 805.2(a)2

**(e) Backfill Mix for Planting or Transplanting.** A uniform mixture of one part peat or compost material, as specified in Section 808.2(f), and three parts soil by volume that was removed from the planting pit.

Where it is determined by the Representative that wet and poorly drained planting conditions exist, backfill with soil removed from the planting pit.

The ratio of peat to soil for plants requiring an acid soil is one part peat to two parts soil by volume.

**(f) Soil Amendments.**

**1. Peat.** Shredded reedsedge peat or spaghnum moss peat, or a combination of both, from fresh water sites. Do not use peat material in an advanced stage of decay. Provide peat material, conforming to the following requirements:

- Minimum of 80% organic matter.*
- Maximum of 15% ash content.*
- Minimum of 400% water holding capacity.*
- Maximum delivered density of 500 kg/m$^3$ (30 pounds per cubic foot).
- pH—4.5 to 6.0 (use laboratory analysis to indicate the liming required).

* Oven dry basis.

Submit a laboratory analysis of the peat intended for use. Do not ship peat material to the project until acceptance is received.

**2. Paper Mill Compost.** A blend of fibrous bark fines and wood-pulp fibers, composted, free of foreign material and substances toxic to plant growth, and conforming to the following requirements:

- Minimum of 70% organic matter.*
- Maximum of 25% ash content.*
- Minimum of 200% water holding capacity.*
- Particle size—13 mm (1/2 inch) maximum.
- Free of weeds.
- pH—7.0 ± 0.5.

* Oven dry basis.

Submit a certified laboratory analysis with each shipment.

**3. Sewage Sludge Compost.** A blend of composted sewage sludge and wood chips, conforming to the requirements specified in Section 805.2(a)2.e, except the maximum size particle is 10 mm (3/8 inch).

**4. Compost.** Decomposed product derived from agricultural, food and yard organic matter source. Composted at a DEP, Bureau of Waste Management permitted site under industry standards and U.S. EPA regulations, to provide a stable, weed free, nontoxic, soil amendment with a non-objectionable odor, and conforming to the following requirements:

- moisture content—35 to 55%
- trace elements and heavy metals—meet U.S. EPA Part 503 Exceptional Quality Concentration Limits
- particle size—pass 25 mm (1-inch) standard screen
- pH—5.5 to 8.0
- soluble salt concentration—3.0 dS maximum
- man-made foreign matter—less than 1% by mass (weight)

For plants requiring an acid soil, provide only compost that has not received the addition of liming agents or ash by-products and having a pH value ranging from 5.5 to 7.0.

**5. Water Absorbent Polymer.** A synthetic, nontoxic, granular polymer (polyacrylamide) product manufactured to increase the water holding capacity of the soil. Dry, free flowing granules capable of absorbing at least 200 times their mass (weight) in water, and conforming to the following requirements:

- Material—cross-linked modified acrylic polymer
- Granular size—1 mm to 4 mm (40 mils to 157 mils)
- Density—0.729 g/mL (45.5 lbs/$ft^3$)
- Time to achieve 100% absorption—56 minutes
- Absorption—minimum of 400 g/g (grams of water per gram of product)
- Deionized water—minimum of 200 g/g (grams of water per gram of product)
- Tap water—(rated 160 mg NaCl/liter of water)

**6. Mycorrhizal Inoculation.**

**6.a Trees.** Premeasured 85 g (3-ounce) packets containing live endo and ectomycorrhizal fungi, plant biostimulants, and water absorbent polymers conforming to the following typical requirements:

| | |
|---|---|
| • Endomycorrhizal fungi | Minimum 1000 live spores of Vesicular arbuscular (VA) fungi to include entrephospora columbiana, glomus etunicatum, glomus clarum, and glomus species |
| • Ectomycorrhizal fungi | Minimum 60 million live spores of pisolithus tinctorius |
| • Biostimulants | Dry soluble yucca extract (yucca schidigera); soluble sea kelp extract (ascophylum nodosum); and humic acid (leonardite humates) |

| | |
|---|---|
| • Water absorbent polymer | 0.7 mm to 1.5 mm particles of cross-linked polyacrylamide copolymer with certified free acrylamide monomer level of less than 0.05% |

**6.b BR Seedlings and Transplants.** Root dip material containing live endo and ectomycorrhizal fungi, plant biostimulants, and water absorbent polymers conforming to the following typical requirements:

| | |
|---|---|
| • Endomycorrhizal fungi | Minimum 50 000 live spores of VA fungi per 0.45 kg (pound) of product to include entrephospora columbiana, glomus etunicatum, glomus clarum and glomus species |
| • Ectomycorrhizal fungi | Minimum 140 million live spores of pisolithus tinctorius per 0.45 kg (pound) of product. |
| • Biostimulants | Dry soluble yucca extract (yucca schidigera); soluble sea kelp extract (ascophylum nodosum); and humic acids (natural humates) |
| • Water absorbent polymer | 0.2 to 0.8 mm sized particles of polyacrylamide copolymer |

**7. Spent Mushroom Soil Compost.** Organic substrate used in mushroom production that has been steam sterilized, then composted for a minimum of 90 days in well-managed windrows, and on a properly surfaced and protected composting pad. Conforms to the requirements specified in Section 808.2(f)4 except the soluable salt content is 20 dS maximum and the moisture content is 60% maximum.

**(g) Stakes and Collar Strap Attachments.** As shown on the Standard Drawings and conforming to the following requirements:

**1. Wood Stakes.** Rough-sawn, red or white cedar, southern yellow pine, or other acceptable hardwoods. Provide stakes free from knots, rot, or other defects that impair strength or render them unfit for the intended purpose.

**2. Steel Stakes.** Section 1103.08(a)

**3. Collar Strap Attachments.**

**3.a Rubber Collar Strap.** A wide, flexible rubber strip ranging in width from 40 mm to 75 mm (1 1/2 inches to 3 inches) with minimum length ranging from 350 mm to 480 mm (14 inches to 19 inches) made from recycled tire inner tube with a 13 mm (1/2-inch) minimum diameter brass plated grommet on each end.

**3.b Fiber Collar Strap.** High tenacity, flexible, non-stretch polypropylene or heavy-duty nylon fibers; or natural cotton fibers, woven into tubular or flat surfaced, soft edged, abrasion resistant straps with a minimum width of 20 mm (3/4 inch) manufactured for staking trees and conforming to the following requirements:

**1.** Straps made from a continuous roll of synthetic strap material cut to the appropriate length required to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

**2.** A manufactured, synthetic strap with #1 brass grommets positioned 25 mm (1 inch) from each end and of an appropriate length to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

**3.** A manufactured, synthetic strap with a 25 mm (1-inch) galvanized, ribbed nail within a

plastic retaining washer at one end of the strap and of an appropriate length to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

**4.** A manufactured natural cotton strap with #1 brass grommets positioned 25 mm (1 inch) from each end and of an appropriate length to encircle the tree trunk and attach to the stake as specified in Section 808.3(g)5.

**3.c Strap Tie.** All-purpose, biodegradable, 3 or 4-ply, non-stretch, cotton, hemp, jute, or sisal, natural fiber, twisted twine or rope that will pass through the grommet ends of the straps specified in Section 808.2(g)3.b.

**(h) Water.** Section 720.2

**(i) Time-Release Water.** A nontoxic, pH neutral, poly cellulose gel form of water in a biodegradable carton that slowly liquefies in contact with soil micro-organisms as its container decomposes, and conforming to the following requirements:

**1. Poly Cellulose Gel.**

- 98% water
- 2% vegetable gum and alum

**2. Carton.** Biodegradable, 0.95 L (1-quart) standard size.

**808.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) Plant Protection and Temporary Storage.** Untie and completely remove any binding materials from plants that were transported with bound branches.

Protect plants at all times. Plants will be rejected if left out of the ground, unprotected overnight; left with roots exposed to wind or sun; or left improperly protected during transit, unloading, storage, or during the planting operation.

Secure a suitable storage area near the planting site that is shaded, if possible, during the hottest times of the day.

Protect root systems from undue exposure to sun and wind during planting operations as follows:

**1. B&B and Container Plants.** Place the root balls and plant containers close together at the storage area without damaging the plants. Cover root systems with wet burlap, wet mulch, wood chips, straw, or other approved materials to keep the roots moist. Keep cover material moist.

**2. BR Plants.** Heel-in plants by digging a shallow trench and placing roots in the trench. Cover root systems with wet burlap, wet mulch, wood chips, straw, or other approved materials to keep the roots moist. Keep cover material moist.

**(b) Layout of Plantings.** Delineate the plant pit locations, plant bed, and planting area outlines as indicated. Identify the plants to be placed at the delineated location. Do not start excavation or cultivation until the locations and outlines are accepted. Use shrub bed preparation in all shrub beds.

If rocks or other obstructions prevent planting at indicated locations, the Representative will determine alternate locations or deletions.

**(c) Shrub Bed Preparation.** For all shrub bed areas, remove any existing sod or other vegetation growth from the bed areas. Add additional topsoil, if required, to re-establish grade.

Uniformly spread approved peat or compost material to an 80 mm (3-inch) depth, and thoroughly incorporate it into the soil to a depth of 150 mm (6 inches). Remove and dispose of undesirable material larger than 50 mm (2 inches) in any dimension as directed.

**(d) Preparation of Plant Pits.** Schedule digging operations, particularly on slopes, so that the actual planting operation occurs within 1 week of the digging, unless a delay is approved. Prepare planting pits to the size shown on the Standard Drawing and as follows:

**1. Trees.** Dig pits with tapered sides and flat bottom so that the pit is wider at the top than at the root mass depth and large enough to accommodate the roots without crowding. Allow for the placement of at least 300 mm (12 inches) of backfill mix around all sides at the bottom of the root mass. Scarify, loosen, or roughen the tapered pit sides for any glazed or hardened soil surfaces immediately before planting.

**2. Shrubs and Seedling Transplants.** Dig pits, except for slope plantings, with tapered sides and flat bottom so that the pit is wider at the top than at the root mass depth and large enough to accommodate the roots without crowding. Allow for the placement of at least 150 mm (6 inches) of backfill mix around all sides at the bottom of the root mass. Scarify, loosen, or roughen the tapered pit sides for any glazed or hardened soil surfaces immediately before planting. Dig pits for slope plantings with vertical sides and flat bottom.

**3. Vines.** Dig pits of appropriate size with tapered sides to accommodate the roots without crowding for vine plants such as periwinkle, pachysandra, and ivy. Provide at least 100 mm (4 inches) of backfill mix beneath and around all sides of the root system.

**(e) Pruning.**

**1. Branches.** Prune any dead, dying, broken, or undesirable branches not adequately pruned at the nursery or damaged during transport or installation. The removal of too many damaged branches that leaves an asymmetrical or non-uniform sided plant will be grounds for rejection of the plant. Prune according to best horticultural practice for the health of the plant and the natural or designed form and growth characteristics of the individual species.

**2. Roots.** Cut damaged or broken primary roots immediately above the damage with a clean, oblique cut.

**(f) Transplanting Existing Plants.** Relocate plant material designated for transplanting to areas indicated. Move plants while dormant unless otherwise approved.

Apply an approved antidesiccant/antitranspirant, according to the manufacturer's application recommendations, to all evergreen plant material and any deciduous trees or shrubs in leaf before digging.

Dig plants with root balls of sufficient diameter and depth to encompass enough fibrous and feeding roots for the full recovery of the plant. Root ball sizes and depths to correspond to the next largest size nursery grown stock listed in the ASNA Standard for deciduous and evergreen trees and shrubs. Dig root ball to have a flat bottom. Keep roots protected and moist at all times during transplanting procedures. Ball and burlap roots using tightly sewn, untreated, biodegradable burlap laced with heavy twine as specified in Section 808.2(a)3 and approved nursery industry practices.

Prune any damaged, broken, or diseased main roots as specified in Section 808.3(e)2.

Carefully transport plants to the transplant site within 24 hours after digging. Handle plants only by the root ball. Pad trunks and major branches to prevent damage.

Replant, prune, water, and maintain transplanted material in the same manner as new stock.

As specified in Section 808.3(a), locate and prepare an acceptable, secured, temporary site for heeling in or above ground storage of all plants that cannot be replanted within 24 hours at their designated transplant site due to construction sequencing. Keep all root balls moist during the storage period.

**(g) Planting.** Plant when soil and climatic conditions are favorable, according to the following schedule:

- Deciduous trees and shrubs: October 15 to November 30 and April 1 to May 15
- Evergreen trees and crownvetch plants: March 1 to May 15 and August 1 to September 15
- Seedlings and seedling transplants: March 1 to May 15

- Rhizomes, bulbs, tubers, and starter plants: March 1 to May 15
- Plugs and peat pots: March 1 to September 15

Where local conditions warrant, these dates may be extended, if directed in writing by the District Executive.

**1. Placing Plants.** Set plants plumb and at the required depth as shown on the Standard Drawings and conforming to the following requirements:

**1.a B&B.** Handle B&B plants by the ball or other root protective device, not by the stem or branches. Cut or untie the root ball lacing and lay back or cut off the burlap wrap from the top one-third of the root ball. Remove the top one-third of any root ball wire protective baskets.

**1.b BR.** Carefully handle BR plants by the main plant stem and any packaging material to avoid damage to the bark and roots. Form a raised soil mound in the planting pit of sufficient size to match the lateral spread of the root mass and to bring the plant up to the proper planting depth. Spread roots evenly over the mound before backfilling.

**1.c Container Grown.** Handle plants by the packing container, not by the stem or branches. Remove the container from the root mass formed by the container. Separate and spread any compacted roots outward in the planting pit before backfilling.

**2. Fertilizing and Backfilling.** Fertilize, according to the fertilizer schedule and as detailed. Mix the specified quantity of water absorbent granules into the backfill material spread around the plant roots in the bottom half of the planting hole. Use 15 g (0.5 ounce) of water absorbent polymer granules for each 100 mm (4-inch) width of root ball for shrubs and 60 g (2 ounces) for each 25 mm (1-inch) caliper of trees. Cultivate and completely tamp backfill mix around the ball or roots, in a manner that fills voids and eliminates air pockets. Avoid breaking or damaging roots during backfilling and tamping operations. When backfilling is two-thirds complete, lay back or cut off and remove the top one-third of the root ball wrapping material on B&B plants. Cut off and remove any wire root protection devices from the top one-third of the root ball. Thoroughly water the backfill material around the roots. Complete backfilling and broadcast mycorrhizal fungi around the perimeter of the root ball and incorporate into the top 250 mm (10 inches) of the backfill mix. Thoroughly water again after the initial watering has been completely absorbed. Firm backfill material around the top of the planting hole and plant stem. Fill in any surface irregularities of the planting hole and level soil. Apply one fungi packet of material for each 25 mm (1 inch) of tree caliper measured 150 mm (6 inches) above the top of the root ball. Fungi application is not required for shrub or ground cover plants.

Do not expose fungi packets to direct sunlight until ready to use at the planting pit.

Provide documentation of delivery to planting site of approved fertilizer(s) and fungi product. Certify that fertilizer and fungi requirements were installed as specified in the aforementioned paragraphs.

**3. Crownvetch Plants.** Plant crownvetch crowns or plants using Reforestation Method A. For areas planted with crownvetch plants, treat the soil before planting with lime and fertilizer at the rates specified in Section 804.3(c). Apply Formula E seed at the rate of 3.0 kg/m$^2$ (5 pounds per 1,000 square yards). Mulch with hay as specified in Section 805.

**4. Reforestation Methods.** Space and arrange plants as indicated or as directed. Puddle plants in a mud slurry immediately before planting.

**4.a Method A—Crownvetch Plants.** Make a vertical hole in the soil 150 mm to 200 mm (6 inches to 8 inches) deep, but do not excessively loosen the soil. Insert the root in a vertical position in the hole with the root collar resting at the same depth as it grew originally. Firmly tamp to close the hole and exclude air pockets without damaging the plant. Thoroughly water the planted area after installation.

**4.b Method B—Seedling Material and Seedling Transplants.** Prepare plant pits as specified in Section 808.3(d). Dig pits as large as necessary to accommodate plant root system and gel water carton.

Dip all BR seedling and transplant roots into the mycorrhizal fungi root dip inoculant gel immediately prior to planting. Thoroughly cover root surfaces.

Insert plant in a vertical position in the plant pit with the root collar positioned at the same depth as it grew originally. Place fertilizer tablet or fertilizer contact packet(s) and gel water carton(s) at, but not below, the root zone. Cut bottom of gel carton before installation to facilitate gel contact with the soil. Backfill the pit with excavation material from the plant pit. Thoroughly water the plant and firm soil around the plant root collar and gel carton to hold both in an upright position.

Use one gel carton for plants up to 300 mm (12 inches) in height; two cartons for plants from 300 mm to 600 mm (12 inches to 24 inches) in height; and three cartons for plants from 600 mm to 900 mm (24 inches to 36 inches) in height.

**5. Staking.** Stake trees using either rubber or fiber collar straps immediately after completion of the backfilling operation of the tree pit as shown on the Standard Drawing and as follows:

**5.a Rubber Collar Strap.** Use the size of collar strap shown on the Standard Drawings for the appropriate tree caliper size. Wrap straps around the tree trunk so that the rubber strap lies flat against the trunk. Securely fasten strap ends to stake with approved natural fiber twine or rope run through the grommet hole at each end of the strap and wrapped, tightened, and knotted around the stake.

**5.b Fiber Collar Strap.** Wrap collar strap around the tree trunk so that the fiber material lies flat against the trunk. Follow the strap manufacturer's attachment instructions for the type of collar strap used. Securely fasten the strap ends with either a tied knot; approved natural fiber twine or rope run through the grommet holes at each end of the strap and wrapped, tightened and knotted around the stake; or nailed to the stake. Use polypropylene straps with grommets for trees 75 mm (3-inch) caliper and smaller. Use heavy-duty nylon straps with grommets for trees over 75 mm (3-inch) caliper. Polypropylene straps without grommets can be used for all tree calipers 100 mm (4 inches) and smaller. Cotton straps can be used for trees 75 mm (3-inch) caliper and smaller.

**6. Period of Establishment.** Maintain all plants in a living, healthy condition until the entire project has been accepted. Plants are required to have been growing in place at least 60 days before project acceptance. During this period of establishment, perform the necessary watering, weeding, applying of acceptable insecticides or fungicides, cultivating, remulching to maintain a depth of 75 mm (3 inches), and adjusting stakes, all as directed.

**7. Watering.** Water during the period of establishment as directed. Perform watering promptly with sufficient personnel and equipment to complete the watering requirements within 5 calendar days after having been directed. Apply water using an open-end hose supplied by gravity or low-pressure pump rated less than 70 kPa (10 pounds per square inch). Allow water to thoroughly soak and percolate into the soil without run-off. Furnish measurements and capacities of water tanks used in this operation. Submit source of water and watering schedule for acceptance.

**8. Clean-Up.** Remove and dispose of any subsoil, rock, debris, and other undesirable planting excavation materials from the planting site. Leave planting sites with a clean and acceptable groundcover condition. An acceptable groundcover condition may include seeding bare soil or damaged ground areas with Formulas B, D, or L as directed and mulching with straw at rates typical for the affected areas.

**9. Plant Replacements.**

**9.a Nursery Stock.** Plants not alive or showing declining health and having died back beyond a normal recognize pruning point at the time of final inspection will be rejected and require replacement within the next specified planting dates. Replace the rejected plants with plants of the same species, size, and quality as originally indicated and specified unless plant substitutions have been approved for these plants. The Representative will determine plants that are not acceptable. Remove unacceptable plants from the project and replace with approved plants within 30 days of official notification in writing from the District Executive and before acceptance of the entire project. Make replacements at the beginning of the next planting season if directed, or if agreed upon in writing, the unacceptable material will be deleted from the contract. Only living, healthy plants are accepted at the time of final inspection.

**9.b Transplanted Material.** Replace any dead or unhealthy transplanted material with approved nursery grown plants of the same species and general size before final acceptance of the project. If directed, make replacements at the beginning of the next planting season.

**10. Mulching.** When indicated, mulch the entire individual plant pit or the entire planting bed as specified in Section 805.3(c). Use coarse aggregate mulch for all individual plant pits to be located in non-maintained, unmowed areas. In maintained, mowed areas, use shredded bark, tanbark, wood chips, or approved compost mulch for the individual plant pits.

**11. Herbaceous Plants.**

**11.a Peat Pots and Plugs.** Loosen soil to a depth of 150 mm (6 inches). Wet peat pot surfaces and root masses to saturation before planting. Plant pot or plug approximately 75 mm (3 inches) deep, in wet soil, leaving the growing stems above the surrounding soil. Firm soil by hand around each plant. Water thoroughly.

**11.b Tubers, Bulbs, and Rhizomes (Roots).** Loosen soil around each planting site to a depth of at least 100 mm (4 inches). Push roots 25 mm to 50 mm (1 inch to 2 inches) into the soil and firm soil around each root. When planting under standing water, add sufficient mass (weight), such as #8 penny nails held with rubber bands, or place several roots into a loose knit, biodegradable, mesh bag along with several small stones in order to submerge roots to bottom of planting site.

**11.c Fertilization.** Side dress each plant with 30 g (1 ounce) of 19-6-12 controlled release fertilizer at the time of planting. Apply fertilizer in furrow around each plant and cover with at least 25 mm (1 inch) of soil. Do not fertilize when planting under standing water.

**11.d Starter Plants.** Keep roots of plant moist during the planting operation. Loosen soil at planting site to a depth of at least 100 mm (4 inches). Make a vertical hole in the soil deep enough to accommodate the root depth. Insert roots in a vertical position with the root collar at the proper soil depth. Firmly tamp soil to close the hole and expel air pockets. Water thoroughly.

## 808.4 MEASUREMENT AND PAYMENT—

**(a) Plants, Planting and Transplanting.** Each
The Department will not pay for plants deleted from the contract by the Representative.

**(b) Shrub Bed Preparation.** Square Meter (Square Yard)

**(c) Mulching.**

1. **Individual Plant Pits.** Incidental to the planting operation.

2. **Planting Beds.** Section 805.4(b)

**(d) Watering.** Watering done at the time of planting or transplanting will be incidental to the planting or transplanting. Any subsequent watering indicated or directed, to keep the plants alive will be measured and paid for by the 1000 Liters (1,000 (M) Gallons).

# SECTION 809—SODDING

**809.1 DESCRIPTION**—This work is furnishing, placing, and maintaining cultivated sod on designated areas.

**809.2 MATERIAL—**

**(a) Sod.** Conforming to the current edition of the Turfgrass Producers International's Guideline Specifications to Turfgrass Sodding, and as follows:

- Certified sod cultivated of two or more approved Kentucky bluegrass varieties.
- Containing not more than 10% of other fine turf grass species.
- Entirely free from weeds, as defined in the Pennsylvania Seed Act of 1965 and amendments.
- Free from harmful insects, disease, and nematodes.
- Cultured in mineral soil.
- Certified by the Pennsylvania Department of Agriculture or the Department of Agriculture of the state from which sod is obtained.
- Rectangular machine sections 300 mm to 600 mm (12 inches to 24 inches) wide, 600 mm to 1800 mm (2 feet to 6 feet) long, with a uniform soil thickness of approximately 20 mm (3/4 inch) excluding top growth and thatch. Broken sections or sections having torn or uneven ends will not be accepted.
- Grass height, maximum 40 mm (1 1/2 inches).
- Well-moistened condition.
- Relatively free of thatch (up to 15 mm (1/2 inch) uncompressed thickness acceptable).

Net sod may be used after submitting a sample to obtain acceptance.

**(b) Lime.** Section 804.2(a)1

**(c) Fertilizer.** Section 804.2(a)2

**(d) Water.** Section 720.2

**809.3 CONSTRUCTION—**

**(a) Sod.** Place sod within 36 hours after having been cut.

**(b) Temporary Storage.** For sod in temporary storage, protect from drying due to sunlight or wind. Keep sod moist.

**(c) Site Preparation.** Before placing sod, complete soil preparation or topsoiling, as specified in Section 802.3. Provide a sod bed graded so that, after placing, the top of the sod is flush with the surrounding finished grade.

Apply soil supplements, as specified in Section 804.3(c), to areas to be sodded. Moisten soil before placing sod.

**(d) Placing Sod.** Place sod when soil moisture and temperature conditions are suitable. Do not cut or place sod if the temperature is lower than 0 ºC (32F). Do not place frozen sod.

Carefully place sod by hand, with tight joints, no overlap, and in straight lines with rows placed parallel to and tight against each other. Break or stagger transverse joints. Do not use pitchforks or other tools that may damage the sod. Do not dump sod from vehicles. Immediately after placing, saturate sod with water to its full depth. After the initial watering, tamp the sod to close joints and ensure close contact between the sod and sod bed. Tamp to obtain a smooth, even sod surface, free from bumps and depressions. If directed, use a roller having a mass (weight) not more than 100 kg/m (65 pounds per foot) of width to complete firming and smoothing the sod.

If placing sod in ditches, place the strip with the longer dimension perpendicular to the flow of water. At any point where water will start flowing over a sodded area, turn the upper edge of the sod strips into the soil, then place a layer of compacted earth over this juncture to conduct the water over the sod edge. On slopes, place sod with the long axis parallel to the contour, starting at the bottom of the slope. Stagger sod joints.

In ditches and on slope areas (1:3 (3:1) or greater), stake each strip of sod securely using at least one wood stake for each 0.2 $m^2$ (2 square feet) of sod. Use stakes 13 mm x 25 mm (1/2 inch by 1 inch) and with a length of 200 mm (8 inches) to 300 mm (8 inches to 12 inches). Drive stakes flush with the top of the sod, with the wide face parallel to the slope contour. Click to view Animation.

**(e) Maintenance.** Properly maintain sodded areas until the project has been accepted. This may include repeated watering, mowing, and repairs or replacement of sod in areas that fail to show a uniform growth of grass, or that are damaged in any way.

Do not mow sodded areas until sod is firmly rooted and secured in place. Maintain grass height at 40 mm (1 1/2 inches) unless otherwise directed.

## 809.4 MEASUREMENT AND PAYMENT—

**(a) Sodding.** Square Meter (Square Yard)

**(b) Watering and Mowing.** Initial watering and mowing at the time of sodding is incidental to sodding. The Department will measure and pay for subsequent watering, requested and required for grass survival, or as otherwise directed, by the 1000 liters (1,000 (M) gallons). The Department will measure and pay for subsequent directed mowing by the hectare (acre).

# SECTION 810—SELECTIVE TREE REMOVAL AND TRIMMING

**810.1 DESCRIPTION**—This work is the removal of selected trees and shrubs, the trimming of remaining trees and shrubs, the treatment of tree injuries, and the removal of stumps, debris, and undesirable vegetation within these areas.

**810.2 MATERIAL—**

- Stump or Basal Treatment Herbicide—Type 10, Class B or C, Triclopyr liquid formulations. Use either Class B – butoxyethyl ester of triclopyr and inerts or Class C – butoxyethyl ester of triclopyr in ready to use form as specified in PCID No. 1094 Herbicides (Weed and Brush Control) issued by the Pennsylvania Department of General Services, Bureau of Purchases, Quality Assurance Division. Conform to all current Federal and State pesticide acts and registration requirements. Furnish herbicides in the manufacturer's labeled container.

**810.3 CONSTRUCTION—**

**(a) Tree and Shrub Removal.** Living trees and shrubs to be removed or trimmed will be designated either by separate marking, marking in sample areas, or as otherwise identified. Where sample marking is adopted, do not disturb these sample areas until other areas are complete.

For designated live or dead trees and shrubs, stumps and undesirable vegetation, cut to the ground line or to a height of not more than 100 mm (4 inches), as directed. Fell trees and remove in a manner preventing injury to remaining vegetation. In areas where felling is not permitted, due to possible damage for any reason, remove trees in sections.

**(b) Herbicide Treatment.** Treat live stumps of cut trees and shrubs with herbicide on the day of cutting. Apply herbicides according to the manufacturer's recommendation. Repeat the herbicide treatment, as directed, if suckers or sprouts develop at any time before final inspection.

**(c) Tree Trimming.** Remove living branches to a maximum height of 6 m (20 feet), if directed. Remove dead and dying limbs and branches 25 mm (1 inch) or more in diameter. Remove branches to the branch bark ridge.

Provide skilled workmen to perform cutting and trimming, according to accepted arboricultural practices. Use acceptable tools and methods to perform the work. Do not use climbing spurs or spikes.

Treat work-related injuries to remaining trees and shrubs, regardless of species, according to accepted arboricultural practices.

**(d) Clean-up.** Chip, burn, or dispose of brush and debris resulting from work. Burn, as specified in Section 201.3. Do not burn within 12 m (40 feet) of vegetation designated to remain.

As directed, dispose of rubbish, broken concrete, litter, and other objectionable material.

**(e) Maintenance.** Until the project is completed, properly maintain selective tree removal and trimming, including retreatment of sucker growth, the removal of wind-thrown trees and plants or parts of plants, which die from any cause.

**810.4 MEASUREMENT AND PAYMENT**—Lump Sum, Hectare (Acre), or Each

When work is measured and paid for by Hectare (Acre) or Each, computations for completed work will be recorded daily on Form M-609.

If measured by the Hectare (Acre), measure to the overhanging dripline of the trees.

# SECTION 811—TEMPORARY PROTECTIVE FENCE FOR EXISTING PLANT MATERIAL

**811.1 DESCRIPTION**—This work is furnishing, installing, and maintaining temporary protective fencing for existing trees or shrubs within the project limits, as indicated.

**811.2 MATERIAL—**

**(a) Fence.** Acceptable, undamaged, standard picket snow fence or other acceptable, highly visible, weather resistant, easily maintained fencing that provides a substantial barrier.

**(b) Posts.** High carbon channel bar steel, 2.1 m (7 feet) in length. Designed to drive satisfactorily into the ground and with at least ten fence-holding lugs of the rivet type. The Representative may accept other posts.

**811.3 CONSTRUCTION**—Fence desirable wooded areas, individual trees, and shrubs designated for protection, before beginning other general project work. Where directed, fence other areas to be protected. Do not stockpile materials under, or within, protected vegetation areas. Prohibit construction traffic within protected areas. Place the fence at the dripline of trees or plants, but avoid causing root damage when driving posts. Replace damaged fence in kind within 24 hours of damage, as directed. Remove temporary protection, when directed.

**811.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 845—UNFORESEEN WATER POLLUTION CONTROL

**845.1 DESCRIPTION**—This work is construction of temporary or permanent control measures, as ordered during the contract life, to control unforeseen pollution of surface water and groundwater.

**845.2 MATERIAL—**

- As specified in applicable parts of Sections 804, 805, and 806.
- Erosion and sediment pollution control devices—as shown on the Standard Drawings.
- Other water pollution control measures and devices as directed.

**845.3 CONSTRUCTION**—As directed during construction, provide water pollution control measures to prevent or abate unforeseen pollution of surface water and groundwater resources. These measures are separate from those temporary and permanent water pollution control features designed for the project.

Coordinate control measures with the Erosion and Sediment Control Plan and permanent features to ensure economical, effective, and continuous pollution control throughout the construction and post-construction periods. Also comply with the requirements specified in Section 107.28.

If directed, place pollution control measures for authorized construction areas outside the right of way.

Comply with all applicable Federal, State, and local laws, rules, or regulations.

**845.4 MEASUREMENT AND PAYMENT**— Dollar

The proposal will include an item and a predetermined amount of money for Unforeseen Water Pollution Control. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Unforeseen Water Pollution Control item as follows:

**(a) Contract Items.** The Department will pay for performance of work, identified as having similar items listed in the contract, at the contract unit price.

**(b) Non-Contract Items.** The Department will pay for items of work not identified in the contract as follows:

**1. Negotiated Price.** At price agreed upon with the Department before before performing the work. If applicable, agreement is also required with FHWA.

**2. Force Account Basis.** Section 110.03(d)

# SECTION 850—ROCK LINING

**850.1 DESCRIPTION**—This work is construction of rock lining of the class indicated.

**850.2 MATERIAL—**

**(a) Rock.**

**1. General.** Acceptable quality; sound; free from structural defects and foreign substances, such as soil, shale, and organic materials. Unless the rock comes from material providing an approved Type A aggregate, submit samples to the MTD for petrographic examination for durability before use.

Use rock conforming to the following requirements:

- No shale seams.
- Hard and angular shaped rock with neither width nor thickness less than one-third its length.
- Minimum specific gravity of 2.5, as determined according to AASHTO T 85, bulk-saturated, but surface-dry basis.
- Each load of rock well-graded, from the smallest to the largest size.

**2. Size and Gradation.**

| Percent Passing (Square Openings) | | | | | | |
|---|---|---|---|---|---|---|
| **Class, Size No. (NCSA)** | **R-8**** | **R-7**** | **R-6** | **R-5** | **R-4** | **R-3** |
| **Rock Size, millimeters (inches)** | | | | | | |
| 1070 (42) | 100* | | | | | |
| 760 (30) | | 100* | | | | |
| 610 (24) | 15-50 | | 100* | | | |
| 460 (18) | | 15-50 | | 100* | | |
| 380 (15) | 0-15 | | | | | |
| 300 (12) | | 0-15 | 15-50 | | 100* | |
| 230 (9) | | | | 15-50 | | |
| 150 (6) | | | 0-15 | | 15-50 | 100* |
| 100 (4) | | | | 0-15 | | |
| 75 (3) | | | | | 0-15 | 15-50 |
| 50 (2) | | | | | | 0-15 |
| **Nominal Placement Thickness, millimeters (inches)** | 1220 (48) | 915 (36) | 800 (30) | 610 (24) | 460 (18) | 305 (12) |

* Maximum allowable rock size.
** Use Class 2, Type A geotextile

Acceptance of gradation will be based upon visual inspection and certification. Provide two samples of rock, at least 4.5 tonnes (5 tons) each or each one-half the total project quantity, whichever is smaller. Provide one sample in place at the construction site and provide the other sample at the quarry. The construction site sample may be incorporated into the work. These samples will be used as a reference for judging the size and gradation of the rock supplied and placed. Certify as to gradation, as specified in Section 106.03(b)3.

**(b) Geotextiles.** Class 2, for the type required. Section 735.

**850.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Prepare the area required for placing the geotextile and rock.

This preparation may include, but not be limited to excavating, removing unsuitable material, backfilling, placing embankment, and clearing and grubbing, as specified in Section 201.3. Place the geotextiles, as specified in Section 212.3(c).

Carefully place the rock on the geotextiles to produce an even distribution of pieces, with a minimum of voids and without tearing the geotextile. Place the full course thickness in one operation in a manner to prevent segregation and to avoid displacement of the underlying material. Do not placing rock in layers, by dumping into chutes, or by similar methods likely to cause segregation or geotextile damage. Rearrange individual rocks, if necessary, to ensure uniform distribution.

**850.4 MEASUREMENT AND PAYMENT—**

**(a) Rock.** Square Meter (Square Yard) or Cubic Meter (Cubic Yard)

**(b) Geotextile.** Square Meter (Square Yard)
Section 212.4(b).

**(c) Excavation.** Cubic Meter (Cubic Yard)
Section 203.4 or 204.4, for the class indicated.

# SECTION 851—ROCK ENERGY DISSIPATOR

**851.1 DESCRIPTION**—This work is construction of a rock energy dissipator of the class indicated.

**851.2 MATERIAL**—

- Rock, Class as required—Section 850.2(a)
- Geotextiles, Class 2, for the type required—Section 735
- Grout—Section 601.2(c)

**851.3 CONSTRUCTION**—As shown on the Standard Drawings, as specified in Section 850.3, and as follows:

If required, after rock is in place, saturate the rock with water, then completely fill the voids between pieces with grout, for at least the top 150 mm (6 inches), and sweep the surface with a stiff broom. Do not place grout if the air temperature is below freezing. In hot, dry weather, protect grouted rock from excessive heat and keep moist for at least 3 days after grouting, using saturated burlap.

**851.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 852—PAVED ENERGY DISSIPATOR

**852.1 DESCRIPTION**—This work is construction of a reinforced cement concrete channel, with embedded stones or solid precast blocks.

**852.2 MATERIAL—**

- Class A Cement Concrete—Section 704
- Reinforcement—Section 709.3
- Precast Concrete Blocks—Section 713.2(a)
- Joint Sealing Material—Section 705.4(b) or (c)
- Premolded Expansion Joint Filler—Section 705.1
- Bituminous Paper—Section 727
- Stones—acceptable quality

**852.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Excavate to the required paving depth. Remove unsuitable material below the bottom of the paving and then replace with suitable material. Thoroughly compact and finish the entire foundation area to a firm, even surface.

Mix, place, finish, and cure the concrete, as specified in the applicable parts of Section 1001.3. Hold the reinforcement firmly in position during the placing of concrete.

Pave in uniform 3 m (10-foot) lengths or sections except where shorter sections are necessary for closures or curves. Place premolded expansion joint filler, 13 mm (1/2 inch) thick, cut to conform to the paving cross section at the ends of curved sections, at intervals of not more than 30 m (100 feet), at the end of a day's work, and where paving is adjacent to a rigid structure. Use joint filler with a depth of 13 mm (1/2 inch) less than the paving depth and press firmly against the adjacent concrete. Seal the joint top with joint-sealing material. Form intermediate joints between sections, with two thicknesses of one-ply bituminous paper cut neatly to the paving cross section.

Protect paving from the elements, flowing water, or other disturbances until curing is completed.

**852.4 MEASUREMENT AND PAYMENT—**

**(a) Paved Energy Dissipator.** Cubic Meter (Cubic Yard)

**(b) Excavation.** Cubic Meter (Cubic Yard)
For removal of unsuitable material of the same class of excavation for the ditch or channel above the paving.

# SECTION 853—ROCK BASIN

**853.1 DESCRIPTION**—This work is construction of a rock basin.

**853.2 MATERIAL**—

- Rock, Class R-7—Section 850.2(a), except petrographic examination by the MTD is not required.
- Geotextiles, Class 2, Type A—Section 735
- Grout—Section 601.2(c)

**853.3 CONSTRUCTION**—Section 851.3

**853.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 854—TEMPORARY SLOPE PIPE DRAIN

**854.1 DESCRIPTION**—This work is construction of a temporary slope drainage facility.

**854.2 MATERIAL—**

- Metal End Section—Section 616.2(b)
- Pipe (Inlet and Outlet)—Section 601.2(a)4
- Fill Slope Pipe—Plastic, metal, or flexible rubber pipe of acceptable quality.
- Geotextiles, Class 2, Type B—Section 735

**854.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Construct the berms of suitable compacted embankment material, as specified in Section 206.3. Construct the inlet end to channel water into the temporary drain. Use a slope pipe that can easily be moved, with the length varying, as necessary, to reach a suitable discharge area. Place the discharge end so the outlet water does not cause erosion. Place geotextiles, Class 2, Type B, at the discharge end of the pipe; if necessary, use rock, to prevent erosion. Place fabric, as specified in Section 212.3(c).

Remove and satisfactorily dispose of pipes and end sections if they are no longer required.

**854.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 855—DEWATERING BASIN

**855.1 DESCRIPTION**—This work is construction of a basin for removing sediment from pumped water.

**855.2 MATERIAL—**

**(a) Rock.** Class R-3, Section 850.2(a), except petrographic examination by the MTD is not required.

**(b) Aggregate.** AASHTO No. 67, Section 703.2.

**(c) Other Material.** As follows:

- Embankment—Section 206.2
- Seeding and Soil Supplements—Section 804.2
- Mulch—Section 805.2

**855.3 CONSTRUCTION**—As shown on the Standard Drawings, at the location indicated or directed, and as follows:

Clear and grub the site as specified in Section 201.3. Construct the basin by excavating as specified in Section 203.3, forming embankments as specified in Section 206.3, and placing rock and aggregate at the outlet end as indicated. If required, obtain borrow excavation for the formation of the embankment as specified in Section 205. Apply seeding and soil supplements as specified in Section 804.3. Mulch, if required, as specified in Section 805.3.

If the dewatering basin is no longer required, or if otherwise directed, recondition the site by filling in excavated areas; removing embankment, rock, and aggregate; and restoring the area as specified in Section 105.14.

**855.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 856—ROCK BARRIER

**856.1 DESCRIPTION**—This work is construction of a rock barrier and filter blanket.

**856.2 MATERIAL—**

- Rock, Class R-4—Section 850.2(a), except petrographic examination by the MTD is not required.
- Coarse Aggregate, No. 67—Section 703.2

**856.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Determine the length required for the ditch or depression slope. Produce an even distribution of rock pieces with minimum voids. Construct coarse aggregate filter blanket as shown.

**856.4 MEASUREMENT AND PAYMENT—**

**(a) Rock.** Section 850.4(a)

**(b) Coarse Aggregate.** Cubic Meter (Cubic Yard)

# SECTION 857—CONCRETE BLOCK REVETMENT SYSTEMS

**857.1 DESCRIPTION**—This work is construction of an articulating system of interlocking precast concrete blocks or cable-connected precast concrete block mats for erosion protection of slopes and channels.

**857.2 MATERIAL—**

**(a) Blocks**. Precast, Section 714, or if machine-made, Section 713 and having 28-day compressive strength of 28 MPa (4,000 pounds per square inch) and an absorption of 6% or less when tested according to ASTM C 140 and a minimum durability factor of 80 when tested according to ASTM C 666 (Procedure A, freezing and thawing in water).

**(b) Stainless Steel Cable.** For connected block systems, ASTM A 368 or MIL-W-87161.

**(c) Geotextile.** As specified by the system manufacturer, and from a manufacturer listed in Bulletin 15.

**(d) Soil Anchors.** Conforming to the manufacturer's recommendations.

**(e) Other Material.** Backfill.

1. **Aggregate.** Section 703

2. **Topsoil.** Section 802

- Seeding and Soil Supplements—Section 804
- Mulching—Section 805
- Erosion Control Mulch Blanket—Section 806.2(a)2

**(f) Hydraulic Performance Requirements.** Provide documented evidence that the system being furnished meets hydraulic performance characteristics, derived from tests conducted under controlled flow conditions and conforming to U.S. Federal Highway Administration and U.S. Bureau of Reclamation Testing protocol, as documented in "Hydraulic Stability of Articulating Concrete Block Revetment Systems During Overtopping Flow," Report No. FHWA-RD-89-199.

**(g) Certification.** Section 106.03(b)3

**(h) Delivery, Storage, and Handling.** Transport blocks in a manner that minimizes damage during shipping. Store and handle in a manner that protects them from damage by construction activities or traffic.

**857.3. CONSTRUCTION**—Excavate to allow placement of the geotextile and concrete blocks as indicated or directed. Remove obstructions such as tree roots, projecting stones, or other foreign matter to a depth of 0.16 m (6 inches) below subgrade. Grade the slope to a smooth surface. Backfill voids or soft areas with suitable material and compact to non-movement. Fine grade the area and hand dress, where necessary, before placing the geotextile. Place geotextile as specified in Section 212.3(c).

Place concrete blocks over a geotextile, according to the system manufacturer's instructions. Submit field samples to MTD to verify that the manufacturer's prescribed geotextile is installed. Secure cable connected concrete block systems to the slope with soil anchors as indicated or directed. Do not use unsound or damaged blocks. Minor cracks, incidental to the usual methods of manufacturer, or minor chipping resulting from shipment and delivery are not grounds for rejection unless the Representative determines the material unacceptable. After placing blocks, backfill the open areas of the block with topsoil or aggregate, as indicated, to the top of the blocks. Complete backfilling within 7 days of placing the geotextile. If using aggregate, size aggregate according to the

manufacturer's recommendation. If using topsoil, seed the backfill area as specified in Section 804 and mulch as specified in Section 805. Use an erosion control mulch blanket (ECB), as specified in Section 806.2(a)2, to establish vegetation in a wet weather channel as directed.

**857.4 MEASUREMENT AND PAYMENT—**

**(a) Concrete Block Revetment System.** Square Meter (Square Yard)
Aggregate backfill, if used, is incidental to the work.

**(b) Seeding and Soil Supplements.** Section 804.4(a) as indicated.

**(c) Mulching.** Section 805.4 as indicated.

**(d) Erosion Control Mulch Blanket.** Section 806.4(b)

**(e) Topsoil.** Section 802.4 as indicated.

# SECTION 858—GEOCELL CONFINEMENT SYSTEM

**858.1 DESCRIPTION—**This work is furnishing, placement, and maintenance of a geocell confinement system for slope erosion protection.

**858.2 MATERIAL—**Use geocell as specified in Section 737

**(a) Stakes.** Conforming to manufacturer's recommendations and as indicated.

**(b) Fasteners.** Heavy-duty 9.5 mm (3/8-inch) steel wire staples clinched on the reverse side or No. 1 hog rings.

**(c) Backfill.**

**1. Topsoil.** Section 802

**2. Coarse Aggregate.** Section 703.2. AASHTO No. 67 or No. 2A, as indicated.

**(d) Seeding and Soil Supplement.** Section 804.2

**(e) Mulching.** Section 805.2

**(f) Geotextile, Class 2, Type B, Non-Woven.** Section 735

**858.3 CONSTRUCTION—**Construct as indicated and as follows:

**(a) Geotextile.** Place geotextile as specified in Section 212.3(a) and (c).

**(b) Geocell Confinement System.** Store and transport geocell confinement sections in an unexpanded configuration until ready to install. Place and expand the geocell sections on the geotextile with the longer dimension up and down (parallel with the slope direction) the side slope. Place geocell section flush or slightly lower than the adjacent terrain or final grade. Anchor as indicated. Mechanically fasten adjacent sections using wire staples or hog rings as shown on the shop drawings. Align abutting external cells at contact points and keep top edges flush before fastening. Place backfill material flush with the top of cells, as indicated. Do not operate equipment on finished subgrade, geotextile, unfilled geocell sections, or uncompacted backfill, except compaction equipment.

**(c) Seeding and Mulching.** As indicated and as follows:

**1. Seeding and Soil Supplements.** Section 804.3

**2. Mulching.** Section 805.3.

**(d) Maintenance.** Properly maintain slope erosion protection systems until the entire project has been completed. Maintenance includes regrading of washed-out areas and replacing fill material, reseeding, and mulching, as directed as specified in Section 105.13.

**858.4 MEASUREMENT AND PAYMENT—**

**(a) Geocell Confinement System.** Square Meter (Square Yard)
The unit price includes backfill as indicated.

**(b) Seeding and Soil Supplements.** Section 804.4(a)

**(c) Mulching**. Section 805.4

**(d) Geotextile.** Class 2, Type B, non-woven, Section 212.4 (b).

# SECTION 859—SEDIMENTATION POND

**859.1 DESCRIPTION**—This work is construction of a dam to impound water in a storage area.

**859.2 MATERIAL—**

**(a) Rock Basin.** Section 853.2

**(b) Other Material.** As shown on the Standard Drawings and as follows:

- Embankment—Section 206.2
- Seeding and Soil Supplements—Section 804.2
- Mulch—Section 805.2
- Class A Cement Concrete—Section 704
- Corrugated Metal Pipe—Section 601.2(a)4.b or 4.c
- Reinforcement—Section 709.1
- Steel Plate—Section 1105.02
- Welding Material—Section 1105.02(t)

**859.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

As specified in Section 201.3, clear and grub the storage area and embankment foundation area site. Excavate the key trench for the full length of the dam. Excavate the emergency spillway in natural ground. Install the pipe spillway, with the anti-seep collar attached, at the location indicated. Construct the concrete footing for the riser pipe, as specified in the applicable parts of Section 1001.3. Construction of the embankment and trench before placing the pipe is not required. Do not use coarse aggregate as backfill material around the pipe. Backfill the pipe with suitable embankment material to prevent dam leakage along the pipe. Construct rock basin at outlet end of pipe, as specified in Section 853.3. Place the embankment material, as specified in Section 206.3. If required, obtain borrow excavation for the formation of the embankment, as specified in Section 205. Apply seeding and soil supplements, as specified in Section 804.3. Mulch, if required, as specified in Section 805.3.

When the sedimentation dam is no longer required, or if otherwise directed, satisfactorily recondition the site by filling in excavated areas, and by removing embankments, riser pipe assemblies, corrugated metal pipe, and anti-seep collars. Restore the areas as specified in Section 105.14. Satisfactorily dispose of removed materials.

**859.4 MEASUREMENT AND PAYMENT—**

**(a) Class 1 Excavation.** Cubic Meter (Cubic Yard)
Section 203.4.

**(b) Riser Pipe Assembly.** Lump Sum

**(c) Corrugated Metal Pipe.** Meter (Linear Foot)
Section 601.4(a).

**(d) Anti-Seep Collar.** Each

**(e) Embankment.** Section 206.4

**(f) Borrow Excavation.** Cubic Meter (Cubic Yard)
Section 205.4.

**(g) Seeding and Soils Supplements.** Section 804.4 for the type indicated.

**(h) Mulch.** Section 805.4 for the type indicated.

**(i) Rock Basin.** Section 853.4

# SECTION 860—SEDIMENT TRAP

**860.1 DESCRIPTION**—This work is construction of a sediment-collecting trap.

**860.2 MATERIAL—**

**(a) Aggregates.** AASHTO No. 1 and No. 57, Section 703.2.

**(b) Rock.** Class R-3, Section 850.2(a), except petrographic examination by the MTD is not required.

**(c) Other Material.** As follows:

- Geotextiles, Class 3, Type B—Section 735
- Embankment—Section 206.2
- Seeding and Soil Supplements—Section 804.2
- Mulch—Section 805.2

**860.3 CONSTRUCTION**—Construct, as shown on the Standard Drawings, at the location indicated or directed, as follows:

Clear and grub the site, as specified in Section 201.3. Construct the trap by excavating as specified in Section 203.3, forming embankments as specified in Section 206.3, and placing aggregate or rock at the outlet as indicated. Place geotextiles, Class 3, Type B as specified in Section 212.3(c). If required, obtain borrow excavation for the formation of the embankment, as specified in Section 205. Apply seeding and soils supplements, as specified in Section 804.3. Mulch, if required, as specified in Section 805.3.

When the sediment trap is no longer required, or if otherwise directed, recondition the site by filling in excavated areas, by removing embankments and aggregate and by restoring the area, as specified in Section 105.14.

**860.4 MEASUREMENT AND PAYMENT—**

**(a) Class 1 Excavation.** Cubic Meter (Cubic Yard)
Section 203.4.

**(b) Embankment.** Section 206.4

**(c) Aggregate.** Cubic Meter (Cubic Yard)

**(d) Borrow Excavation.** Cubic Meter (Cubic Yard)
Section 205.4.

**(e) Seeding and Soil Supplements.** Section 804.4 for the type indicated.

**(f) Mulch.** Section 805.4 for the type indicated.

**(g) Rock.** Cubic Meter (Cubic Yard)
Section 850.4(a).

**(h) Geotextile.** Meter (Linear Foot)
Section 212.4(c).

# SECTION 861—CLEANING SEDIMENTATION STRUCTURES

**861.1 DESCRIPTION**—This work is removal and disposal of sediment deposited in erosion and sedimentation control structures and/or devices.

**861.3 CONSTRUCTION**—When sediment accumulation has reached a point one-third the depth of the sediment structure or device, remove and dispose of the sediment so it does not erode into the construction areas and/or natural waterways. Do not damage the structure or device.

**861.4 MEASUREMENT AND PAYMENT**—Cubic Meter (Cubic Yard)

The sediment removed will normally be measured by the number of full loads hauled multiplied by the rated capacity of the hauling equipment, in cubic meters (cubic yards). Cross-sectional measurements will be used for large quantities and when not using hauling equipment.

# SECTION 862—STANDBOXES

**862.1 DESCRIPTION**—This work is construction of wooden standboxes for the pipe size indicated.

**862.2 MATERIAL**—Acceptable exterior grade plywood and steel hardware, as shown on the Standard Drawings, and geotextiles, Class 3, Type B, as specified in Section 735.

**862.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Remove the standbox, when directed, then satisfactorily patch or repair the end wall.

**862.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 864—DIVERSION DITCH

**864.1 DESCRIPTION**—This work is construction of a ditch, at the indicated locations, to divert surface run-off water.

**864.2 MATERIAL**—

- Seeding and Soil Supplements—Section 804.2
- Mulch—Section 805.2

**864.3 CONSTRUCTION**—Windrow the excavated material on the low side of the ditch, then satisfactorily compact with a heavy wheel load or other acceptable method. On the entire ditch area, apply soil supplements and sow Formula D seed as specified in Section 804.3. Mulch with hay as specified in Section 805.3.

**864.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

# SECTION 865—SILT BARRIER FENCE

**865.1 DESCRIPTION**—This work is construction of silt barrier fences of the height indicated.

**865.2 MATERIAL—**

**(a) Geotextiles, Class 3, Type A or B**—Section 735

**(b) Mesh Support.** Metallic coated steel, 2.0 mm (14.5 gage) wire mesh, arranged in a maximum grid of 150 mm x 150 mm (6 inches by 6 inches), or an acceptable, equivalent plastic mesh.

**(c) Posts.** Of sufficient length for 460 mm (18-inch) embedment in the ground. Either wood, nominal 51 mm (2.0 inches) square; or steel, 31.8 mm x 25.4 mm (1.25-inch by 1.00-inch) T-section or equivalent; or acceptable plastic, with an equivalent section.

**(d) Fasteners.** No. 9 staples, 38 mm (1.5 inches) long, or tie wires, 1.37 mm (17 gage) steel, of appropriate length, acceptably metallic coated.

**(e) Ground Anchors.** Install for ditch or swale condition, as directed.

**(f) Guy Wires.** 3.30 $mm^2$ (No. 12 gage), galvanized, according to ASTM A 392, Class II. Install for ditch or swale condition, as directed.

**(g) Wood Strips.** Of sufficient length and measuring 50 mm x 50 mm (2 inches by 2 inches) in size. Place around the silt barrier fence for inlet protection, as shown on the Standard Drawings.

**865.3 CONSTRUCTION**—As shown on the Standard Drawings, with or without mesh support fencing, and as follows:

Install posts and excavate the trench. Fasten the geotextile fabric securely to the top of the mesh, at a maximum spacing of 760 mm (30 inches), and to the posts, ensuring that sag is kept to a minimum. Extend the geotextile fabric a minimum of 150 mm (6 inches) into the excavated trench, backfill the trench with the excavated soil, and compact.

After installation, satisfactorily maintain the barrier fence. The fence fabric may require periodic cleaning by tapping the dry fabric from the downstream side. If directed, remove and replace barrier fence not functioning due to clogging, damage, or deterioration.

When the barrier fence is no longer needed, remove the fence and restore the area as specified in Section 105.14.

**865.4 MEASUREMENT AND PAYMENT—**

**(a) Silt Barrier Fence.** Meter (Linear Foot)

**(b) Silt Barrier Fence Replacement.** If silt barrier fence is required to be replaced, the Department will pay for it at the contract unit price for Silt Barrier Fence.

# SECTION 866—COMPOST FILTERSOCK

**866.1 DESCRIPTION**—This work is furnishing, placement, and maintenance of an organic compost, water permeable, erosion and sedimentation pollution control system.

**866.2 MATERIAL—**

**(a) Compost.** Well-decomposed, stable, weed-free, organic compost meeting AASHTO MP-9, Standard Specification for Compost for Erosion/Sediment Control (Filter Berms) derived from a variety of feedstocks including agricultural, forestry, food, or industrial residuals; bio-solids (treated sewage sludge); leaf and yard trimmings; manure; or tree wood with no objectionable odors or substances toxic to plants. Material aerobically composted at a DEP, Bureau of Waste Management permitted site and conforming to CFR 503. Test in accordance with U.S. Composting Council's Test Methods for Examining of Composting and Compost (TMECC). Provide compost with the U.S. Composting Council's Seal of Testing Assurance Program (STA) certification and STA product label. Compost having the following physical properties:

TMECC Test Methodologies —

- Moisture content, dry mass (weight) basis — 30% - 60%
- pH — 5.5 to 8.5
- Soluble salt concentration (electrical conductivity) maximum — 5.0 dS/m
- Man-made inert contaminants, dry mass, (weight) basis — Less than 1%
- Organic matter content, dry mass (weight) basis (compost to be seeded) — 25%-65%
- Organic matter content, dry mass (weight) basis (compost that will not be seeded) — 25%-80%
- Particle size, % passing mesh size, dry mass (weight) basis:
  material passing 75 mm (3 inches) 100
  material passing 50 mm (2 inches) 99
  material passing 9.5 mm (3/8 inch) 30 minimum – 75 maximum
  acceptable general particle sizes of 13 mm – 50 mm (1/2 inch – 2 inches)
  150 mm (6 inches) maximum particle length

**(b) Filtersock (Sock).** High density polyethylene (HDPE) expandable, tubular, biodegradable or photodegradable, 3 mil to 5 mil, 9.5 mm (3/8 inch) knitted mesh netting fabric sock of 300 mm (12 inches) and 450 mm (18 inches) diameters.

**(c) Compost Enhancing Additive (Optional).** Organic sucrose, hydrophilic powder from natural sources, and cotton seed meal from the plant genus Gossypium blended into a product that provides compost stabilization and soil bonding properties. This material provides long-term nutrient resources for the propagation of specific hydrocarbon degrading bacteria and structurally enhancing fungi and actinomycetes.

**866.3 CONSTRUCTION—**

**(a) Installation.** Fill sock with approved compost at the designated erosion control area or fill and transport to the project site. Fill sock with compost using pneumatic blower equipment designed to blow compost/bark. Tie off ends of the sock. Create filled compost filtersocks to the lengths required. Optional installation technique, inject approved compost enhancing additive into the compost stream during sock filling at the rate of at least 0.45 kg per 3 m (1.0 pound per 10 linear feet) of sock length. Verify calibration of injection system to ensure proper additive rate and integration.

Place filtersock on level contour or surface as indicated. Position the filtersock around the structure or surface to be protected to create a complete physical barrier to intercept any sheet flow of drainage water and allowing sediment to collect on the outside of the sock. Ensure a minimal overlap of at least 300 mm (12 inches) on either side of the area to be protected. Anchor filtersock with approved stakes or other devices capable of holding the sock in place.

For bottom of slope installations, position filtersock parallel to the base of the slope to be protected in order to intercept sheet flow of drainage water. Place filtersock at least 1.5 m (5 feet) distance from the toe of slope if possible. Do not place the sock where it will concentrate drainage runoff or channel water to another location. Position each closed end of the sock pointing upslope so that the ends are at a higher elevation than the overall filtersock body.

**(b) Maintenance.** Maintain compost filtersock until the project has been completed. Routinely inspect filtersock installation for damage that would make the filtersock non-functioning. Repair or replace damaged areas as directed. Remove built-up sediment retained by the filtersock when the sediment reaches 1/3 of the exposed height of the sock. Dispose of sediment as directed.

At completion of project, remove filtersock or when directed, leave compost filtersock in place. If directed to leave the sock in place, slit open the sock to expose the compost material.

**866.4 MEASUREMENT AND PAYMENT—** Meter (Linear Foot) for the specified filtersock diameter.

# SECTION 867—COMPOST BLANKET AND COMPOST FILTER BERM

**867.1 DESCRIPTION**—This work is furnishing, placement, and maintenance of organic compost, water permeable, erosion and sedimentation pollution control systems.

**867.2 MATERIAL—**

**(a) Compost.** Well-decomposed, stable, weed-free, organic compost meeting AASHTO MP-9, Standard Specification for Compost for Erosion/Sediment Control (Filter Berms) and AASHTO MP-10, Standard Specification for Compost for Erosion/Sediment Control (Compost Blankets) derived from a variety of feedstocks including agricultural, forestry, food, or industrial residuals; bio-solids (treated sewage sludge); leaf and yard trimmings; manure; or tree wood with no objectionable odors or substances toxic to plants. Material aerobically composted at a DEP, Bureau of Waste Management permitted site and conforming to CFR 503. Test in accordance with U.S. Composting Council's Test Methods for Examining of Composting and Compost (TMECC). Provide compost with the U.S. Composting Council's Seal of Testing Assurance Program (STA) certification and STA product label. Compost having the following physical properties:

TMECC Test Methodologies —

| | |
|---|---|
| • Moisture content, dry mass (weight) basis | 30% - 60% |
| • pH | 5.5 to 8.5 |
| • Soluble salt concentration (electrical conductivity) maximum | 5.0 dS/m |
| • Man-made inert contaminants, dry mass, (weight) basis | Less than 1% |
| • Organic matter content, dry mass (weight) basis (compost to be seeded) | 25%-65% |
| • Organic matter content, dry mass (weight) basis (compost that will not be seeded) | 25%-80% |

1. **Compost Blanket Material.**

Particle size, % passing mesh size, dry mass (weight) basis:

| | |
|---|---|
| material passing 75 mm (3 inches) | 100 |
| material passing 25 mm (1 inch) | 90 to 100 |
| material passing 19 mm (3/4 inch) | 65 to 100 |
| material passing 6.4 mm (1/4 inch) | 0 to 75 |

150 mm (6 inches) maximum particle length

2. **Compost Filter Berm Material.**

Particle size, % passing mesh size, dry mass (weight) basis:

| | |
|---|---|
| material passing 75 mm (3 inches) | 100 |
| material passing 50 mm (2 inches) | 99 |
| material passing 9.5 mm (3/8 inch) | 30 minimum – 75 maximum |

acceptable general particle sizes of 13 mm – 50 mm (1/2 inch – 2 inches)
150 mm (6 inches) maximum particle length

**(b) Compost Enhancing Additive (Optional).** Organic sucrose, hydrophilic powder from natural sources, and cotton seed meal from the plant genus Gossypium blended into a product that provides compost stabilization and soil bonding properties. This material provides long-term nutrient resources for the propagation of specific hydrocarbon degrading bacteria and structurally enhancing fungi and actinomycetes.

**(c) Seed.** Section 804 for the designated seed formula. Soil supplements are not required with these compost systems.

## 867.3 CONSTRUCTION—

**(a) Compost Blanket.**

**1. Soil Preparation.** Roughen/scarify soil surface with appropriate equipment. Remove and dispose of large unworkable soil clumps, debris, large rocks, and undesirable woody matter such as stumps. Track soil surface before compost application with equipment capable of working perpendicular to the slope gradient in order to create soil indentations that will hold compost. Avoid excessive soil compaction during this operation so that the loosened soil surface remains less than the 97% of dry mass (dry weight) density specified in Section 206.3(b)1 for embankment compaction.

**2. Compost Application.** Uniformly apply compost to the specified depth with approved pneumatic (blower) units, or other appropriate equipment designed to handle and distribute compost material. Do not apply compost in direct-flow drainage channels such as ditches or the centerline of swales.

Apply compost approximately 1 m (3 feet) beyond and overlapping all edges of the bare soil surfaces designated to receive the compost.

**2.a Application Rate.**

- Surfaces to be seeded up to 1:2 (2:1) slope – 510 cubic meters/hectare (270 cubic yards/acre) or 50 mm (2 inches) depth with ± 12.6 mm (1/2 inch) tolerance.

- Surfaces not to be seeded up to 1:2 (2:1) slope – 1020 cubic meters/hectare (540 cubic yards/acre) or 100 mm (4 inches) depth with ± 12.6 mm (1/2 inch) tolerance.

**3. Seeding Designated Areas.** Apply seed by injection of the appropriate seed formula into the compost flow stream during the compost application, or apply the seed in a separate surface applied operation. Apply seed at twice the seeding rate indicated in Section 804.2(b)2, Table A, for the designated seed formula. Test and verify the specified application rates for the equipment used.

Soil supplements and mulch are not used in this operation. The compost acts as the mulch in this operation and a separate mulch application is not required.

**4. Maintenance.** Maintain compost blanket depth until the project has been completed or directed otherwise. Routinely inspect blanket for any material dislodgement. Replace and redress any dislodged material and reseed if necessary. Control any noxious weeds with approved herbicides meeting the applicable requirements of Section 804.3(j).

Leave compost blanket in place upon completion of the project unless directed otherwise.

**(b) Compost Filter Berm.**

**1. Installation.** Apply approved compost using specially designed pneumatic (blower)

equipment and a berm forming/shaping device, or other appropriate equipment designed to handle compost and form berms. If blower is used, blow compost directly at the soil surface to help settle, compact, and shape the berm. Optional installation technique, inject or add approved compost enhancing additive into the filter berm compost during berm construction at the rate of at least 1.0 kg per 3 m (2.25 pounds per 10 linear feet) of berm. Verify calibration of injection system to ensure proper integration and integration rate of the additive.

Construct a trapezoidal shaped compost filter berm 600 mm high with 1200 mm wide (2 feet high by 4 feet wide) base with 1:2 (2:1) side slopes. Position the berm around the designated disturbed soil areas and parallel to the slope base. Construct berm ends pointing upslope so that the ends are at a higher elevation than the berm body to prevent drainage water from flowing around the ends of the berm.

**2. Maintenance.** Maintain filter berm in a functional condition. Routinely inspect berm and replace any dislodged compost or reshape any collapsed berm areas. Compost can be replaced by hand and tamped into place. Remove built-up sediment retained by the berm when the sediment reaches 1/3 of the exposed height of the berm. Dispose of sediment as directed. Replace any compost dislodged by this operation. At completion of project or when directed, leave compost in place by pushing over the berm and spreading the compost material over the adjacent ground.

## 867.4 MEASUREMENT AND PAYMENT—

**(a) Compost Blanket, Seeded.** Square Meter (Square Yard) for the designated seed formula.

**(b) Compost Blanket, Unseeded.** Square Meter (Square Yard)

**(c) Compost Filter Berm –** Meter (Linear Foot)

# SECTION 900
# TRAFFIC ACCOMMODATION AND CONTROL

## SECTION 901—MAINTENANCE AND PROTECTION OF TRAFFIC DURING CONSTRUCTION

**901.1 DESCRIPTION**—This work is the furnishing, installing, maintaining, and relocating of traffic control devices. This work may include flagging and pilot car operation for guidance of traffic through the temporary traffic control zone and dust control. All work shall be done as specified in these Specifications, the Publication 212, Publication 213, and the MUTCD, the Special Provisions, Standard Drawings, the approved Traffic Control Plans (TCP), and as directed.

**901.2 MATERIAL**—Furnish material and traffic control devices necessary for maintenance and protection of traffic, and conforming to the TCP, Publication 212, Publication 213, and the MUTCD, and as follows:

- Temporary Concrete Barrier—Section 627.2
- Temporary Impact Attenuating Devices—Section 696.2
- Reset Temporary Concrete Barrier—Section 628.2
- Reset Temporary Impact Attenuating Devices—Section 697.2
- Painting Traffic Lines and Markings—Section 962.2
- Bituminous Tack Coat—Section 460.2
- Bituminous Wearing Course ID-2—Section 420.2
- Bituminous Wearing Course FJ-1—Section 422.2
- Flat Sheet Signs (for Post Mounted Signs, Types B, C, and F: and Distance Marker(s)) - Section 1103.04

When traffic line paint and glass beads or pavement marking tape are provided according to the requirements of Section 901.3(k), furnish certification, as specified in Section 106.03(b)3, that these materials meet specifications.

All temporary traffic control devices must be listed in Bulletin 15 as NCHRP-350 compliant. Temporary Type III barricades must comply with Standard Drawing TC-8716 or be listed in Bulletin 15 as NCHRP-350 compliant.

**901.3 CONSTRUCTION—**

**(a) General.** Comply with Publication 212, Publication 213, and the MUTCD.

Install and maintain traffic control devices as indicated on the TCP, or an approved alternate plan submitted at the preconstruction conference. The Representative may revise the TCP in writing during construction. If unforeseen conditions arise or if revisions are made to the TCP by the Representative, install and maintain additional warning lights and traffic control signs on necessary mounting devices according to Publication 212, Publication 213, and the MUTCD, and at locations designated in writing by the Representative. Use Department approved channelizing devices only. Reflectorize channelizing devices according to Publication 212, Publication 213, and the MUTCD. Provide safety for general public and work crew, and protection of work. Schedule construction operations to allow movement of traffic through various phases of construction with minimum interference. If traffic interruptions become too frequent, cease operations in the area concerned, as directed. Take remedial action to correct situation before continuing operations. Remove or cover existing traffic control devices that conflict with the TCP. When conflict no longer exists, erect or uncover them.

Install and maintain reduced regulatory speed limit signs in work areas, as indicated on the TCP, approved alternate plan, or as directed

Temporarily remove or cover reduced regulatory speed limit signs when workers are not present, except as otherwise indicated on the TCP, approved alternate plan, or as directed.

Install temporary bituminous rumble strips according to locations, patterns, and configurations indicated.

Maintain rumble strips in place for the period indicated or as directed, and remove them immediately thereafter. Restore the surface after removal and obtain acceptance.

Open any substantially completed section of roadway for the use and convenience of traffic, as directed, and as specified in Section 107.15. When work is completed, immediately remove temporary traffic control devices.

Construct and erect all devices in a workmanlike manner. Maintain, clean, and properly operate the devices during the entire time they are in use. Remove all devices when no longer required. Where operations are performed in stages, only the necessary devices that apply to the present stage of construction shall remain in operation.

Cover or remove from service signs that do not apply to the existing conditions. Cover with rubber roofing material (EPDM) having a thickness of 1.1 mm (0.045 inch) or any other approved material, to cover the entire sign. Stabilize and fasten this material to the sign with either plastic or wood to prevent any movement. Do not apply tape to face of sign. Do not deface or damage the sign face using this procedure.

Do not allow weeds, brush, trees, construction equipment, materials, and the like to obscure any traffic control device.

**(b) Maintenance of Roadway and/or Structures.** Treat existing earth roads or improved roads that have been graded, with calcium chloride or by other approved dust control palliatives, as specified in the proposal or as directed.

The Department reserves the right to enter upon a project and, at its own expense, maintain the existing roadway and/or structures. This maintenance will be during the life of the project, but will not include those items that are the contractor's responsibility as specified in Section 105.13 for the contract items of work and Section 901.3(e) for the accommodation of local traffic. The Department does not assume responsibility in any way for maintenance of traffic as a consequence of performing this roadway and/or structure maintenance.

If the Department does not exercise its right to enter upon a project, then the Contractor is to perform routine maintenance of the existing roadway and/or structures that are open to traffic at no additional cost to the Department.

**(c) Snow Removal and Anti-Skid Material.** The Department reserves the right to enter upon a project and, at its own expense, remove snow and/or place anti-skid material, considered necessary for traffic protection. The Department does not assume responsibility in any way for maintenance of traffic as a consequence of removing snow or placing anti-skid material.

Remove the anti-skid material when necessary.

**(d) Detours.** For indicated detours, furnish, erect, maintain, and remove the detour signs, unless otherwise directed. Also, temporarily cover, revise, or remove existing permanent guide signs, in the vicinity of the construction site and along the detour route, if the messages on the guide signs conflict with the detour signs. Erect, maintain, and remove the detour signs and the modification of directional signs, as indicated, and as necessary for construction conditions. Restore original signs to their original state upon removal of the detour.

**(e) Local Traffic Maintenance and Safety.** Proceed with the work to ensure safety and the least inconvenience to local traffic. Maintain local traffic ingress and egress by use of existing or new roadways.

Provide and maintain local access to and from the nearest intersecting public road or street, unless otherwise directed. As directed, provide temporary approaches for local vehicular and pedestrian access to and from commuter service, residential, business, industrial, and other public and private facilities.

Also, provide and maintain adequate bridging over base and surface courses, trenches, or other construction, when directed.

**(f) Equipment and Material Storage.** According to Publication 212, Publication 213, and the MUTCD.

**(g) Tubular Markers.** When indicated, furnish and install tubular markers according to Publication 212, Publication 213, and the MUTCD.

When directed, replace the complete tubular marker or the tubular marker post only, as the case may be.

Remove all tubular markers when no longer necessary for traffic control or as directed.

**(h) Existing Department Signs.** Remove existing warning, regulatory, guide, and directional signs as required to accommodate construction operations. Do not remove Stop or Yield signs unless an alternate type of traffic control is provided, such as flaggers, temporary traffic signals, etc. Continue the alternate traffic control until the Stop or Yield signs are replaced. Stake or mark sign locations or locate signs on construction drawings before removing any signs. Reinstall existing warning signs at appropriate locations within 4 hours of their removal. With the exception of Stop or Yield signs as herein noted, reinstall existing regulatory, guide and directional signs at appropriate locations within 24 hours of their removal.

Remove existing State Route and Segment markers that are likely to be damaged or disturbed as a result of construction operations. Provide survey ties for all such markers, before the removal, to facilitate replacement.

Replace all State Route and Segment markers that were removed, at their exact longitudinal locations, upon completion of the work.

**(i) Barricades.** When indicated, furnish and install barricades according to Publication 212, Publication 213, and the MUTCD.

**(j) Dropoffs.** The following conditions and treatments apply only to dropoffs created by construction, maintenance, or permit/utility operations.

Drainage ditches are not to be considered as dropoffs.

If channelizing devices are used for a dropoff condition, a minimum of two devices are required.

Space all channelizing devices at a maximum distance in meters (feet), equal to 0.55 (2) times the posted speed limit in miles per hour, or closer as directed.

If a dropoff is greater than 150 mm (6 inches) and the distance from the dropoff to the edge of the travel lane is such that channelizing devices must be placed below grade, position the devices on a stable platform so that the bottoms are at grade.

Temporary concrete median barrier may be used at the discretion of the Representative.

Pavement courses or compacted earthen embankments tapered at 1:3 (3:1) or flatter are not considered dropoffs.

**1. Dropoffs Between Travel Lanes.** If a dropoff less than or equal to 50 mm (2 inches) exists between travel lanes, channelizing devices are not necessary. If a dropoff greater than 50 mm (2 inches) exists between travel lanes, provide the following:

- On multilane highways, close one or more lanes to prevent vehicles from crossing over the dropoff.
- On two-way, two-lane roadways, install “Do Not Pass” signs (R4-1) in each direction, at intervals not exceeding 800 m (1/2 mile) throughout the dropoff condition and install two-direction no passing zone, standard pavement markings according to Publication 212, Publication 213, and the MUTCD.

Use uneven pavement signs at intervals not exceeding 800 m (1/2 mile) throughout the dropoff condition, if traffic is allowed to cross the dropoff.

**Dropoffs from the Edge of the Travel Lane.**

| Distance from Edge of Travel Lane | Dropoff Height | | | |
|---|---|---|---|---|
| | **≤ 50 mm (2 inches)** | **> 50 mm (2 inches) to ≤ 100 mm (4 inches)** | **> 100 mm (4 inches) to ≤ 600 mm (2 feet)** | **> 600 mm (2 feet)** |
| **≤ 1.2 m (4 feet)** | No channelizing devices required. | Install a 1:1 or flatter bituminous wedge. (1), (2), (3) | • Place suitable material to grade and compact to non-movement.<br>OR<br>• Install a 1:3 (3:1) slope with suitable material and compact to non-movement. (1), (2), (3)<br>OR<br>• Install temporary barrier. | • Install temporary barrier.<br>OR<br>• Place suitable material to grade and compact to non-movement.<br>OR<br>• Install a 1:3 (3:1) slope with suitable material and compact to non-movement. (1), (2), (3) |
| **> 1.2 m (4 feet) to ≤ 3.7 m (12 feet)** | No channelizing devices required. | Install a 1:1 or flatter bituminous wedge. (2), (3) | • Place suitable material to grade and compact to non-movement.<br>OR<br>• Install a 1:3 (3:1) slope with suitable material and compact to non-movement. (2), (3) | • Install temporary barrier.<br>OR<br>• Place suitable material to grade and compact to non-movement.<br>OR<br>• Install a 1:3 (3:1) slope with suitable material and compact to non-movement. (2), (3) |
| **> 3.7 m (12 feet) to ≤ 4.5 m (15 feet)** | No channelizing devices required. | Use channelizing devices throughout dropoff condition. (3) | Use channelizing devices throughout dropoff condition. (3) | Use channelizing devices throughout dropoff condition. (3) |

Footnotes:

(1) Install low shoulder signs at intervals not to exceed 800 m (1/2 mile) throughout the dropoff condition.

(2) Use channelizing devices throughout the dropoff condition.

(3) No channelizing devices are needed if the dropoff is:

- outside right-of-way; OR
- behind guiderail, barrier, or curb; OR
- greater than 4.6 meters (15 feet) from edge of roadway.

**(k) Work Area Pavement Markings.** Unless otherwise indicated in the TCP, furnish all material and install reflectorized pavement markings in work areas for all base course, flexible pavement, and rigid pavement construction operations as follows:

- **All Operations Except Seal Coat/Surface Treatment (Oil & Chip), Skin Patching, Slurry Seal, Heat Scarification, and Microresurfacing Operations.** Before terminating work each day, replace all lane lines and centerlines covered or destroyed during the day's operations with applicable standard pavement marking pattern, shown in Publication 212, Publication 213, and MUTCD.

- **Seal Coat/Surface Treatment (Oil & Chip) and Skin Patching Operations.** If lane lines or centerlines are covered or destroyed during the day's operations, install "No Pavement Markings" signs (W21-16) throughout the affected area, at the beginning and at intervals not exceeding 800 m (1/2 mile), before terminating work each day. In not less than 7 days or more than 14 days after completion of the operation, remove signs and replace all lane lines and centerlines covered or destroyed during the operation with the applicable standard pavement marking pattern shown in Publication 212, Publication 213, and the MUTCD.

- **Slurry Seal, Heat Scarification, and Microresurfacing Operations.** If lane lines or centerlines are covered or destroyed during the day's operations, install "No Pavement Markings" signs (W21-16) throughout the affected area, at the beginning and at intervals not exceeding 800 m (1/2 mile), before terminating work each day. In not less than 3 days or more than 7 days after completion of the operation, remove signs and replace all lane lines and centerlines covered or destroyed during the operation with applicable standard pavement marking pattern shown in Publication 212, Publication 213, and the MUTCD.

For seal coat/surface treatment, skin patching, slurry seal, heat scarification, and microresurfacing operations,, the Representative may waive the curing period specified in the above bulleted item for the bituminous paving material due to traffic conditions or special circumstances. In these cases, install the applicable standard pavement marking pattern before terminating work each day and eliminate the requirement for installation of "No Pavement Markings" signs.

Apply work area pavement markings as specified in Section 962. Pavement markings to consist of 100 mm (4-inch) wide lines; except, lane lines for all multilane roadways are to be 150 mm (6 inches) wide. As an alternate to paint and glass beads, provide standard pavement markings consisting of temporary pavement marking tape or use nonplowable raised pavement markers, when directed, except for final markings. Use traffic line paint and glass beads for pavement markings meeting requirements in Publication 212, Publication 213, and the MUTCD, or temporary pavement marking tape from a manufacturer listed in Bulletin 15.

Place standard pavement markings in the same location as covered or destroyed pavement markings, unless otherwise indicated in the TCP or directed.

Remove any pavement markings improperly placed and install in the correct location at no additional cost to the Department.

If the roadway is to be closed to traffic until completion of the project, and standard pavement markings will be in place when the roadway is opened to traffic, then work area pavement markings, as specified above, are not required.

**(m) Lateral Lane Restrictions.** Provide, at the preconstruction conference, a written notification of construction activities that will create a physical lateral restriction to roadway width due to temporary concrete barriers, barricades, drums, etc. Include a written schedule indicating the proposed times and widths of restrictions for the various phases of construction.

All restrictions are subject to Department approval.

Notify the Representative, in writing, at least 14 days before implementing or changing any lateral lane restriction, which provides less than 4.9 m (16 feet) of pavement and shoulder in each direction for oversize vehicles. Notify the Representative, in writing, at least 7 days before removing the restriction.

**(n) Temporary Highway Lighting.** Provide temporary highway lighting as indicated on the TCP. Comply with local government, electric utility, and state codes or requirements; the electrical regulations of the Department of Labor and Industry; and applicable construction requirements of the NEC, NESC, and NBFU. Cooperate with electric utility company or agency furnishing power to the system and meet necessary service requirements.

Do not locate lighting fixtures to produce distracting or blinding glare for the driver.

Perform the Highway Illumination Test (Conv.) and record test data on Department Test Form CS-4225D. Correct any defects. Perform the test in the presence of an authorized representative of the Department.

Provide guide rail, crash cushions, or other devices, as indicated or directed, to protect vehicles from hitting poles or other temporary highway lighting appurtenances.

**(p) Surveillance and Review of Traffic Control.** Designate personnel to be responsible for and to be on-call continuously over traffic control operations. This designee shall always be available to respond to calls involving damage to temporary traffic control devices from causes such as vandalism, traffic accident, or weather. Provide to the Representative during the preconstruction conference the name and phone number of the designee providing the surveillance.

The Representative and the Contractor's designee shall conduct periodic reviews of the traffic control devices throughout the duration of the project to ensure continuous compliance with the approved TCP. Conduct reviews during the day and night, adverse weather conditions, and active and inactive construction operations, as directed .

**(q) Temporary Concrete Barrier.** Blunt ends of temporary concrete barrier or glare screen will not be allowed. Protect blunt ends by burying them in a cut slope or using an appropriate end treatment according to the pertinent parts of the following: Design Manual, Part Two, Section 696, and the Standard Drawings.

Provide, install, and maintain top-mounted and side-mounted delineators on temporary concrete barriers, glare screen and bridge barrier as indicated on the TCP.

Clean or replace all delineators once per month or as directed. Clean in an approved method.

**(r) Removal of Conflicting Traffic Lines and Markings.** Remove conflicting pavement markings during any phase of construction and relocate as indicated. Remove as specified in Section 963.3. Do not remove traffic lines and markings without a paint truck present on the project site if repainting is required.

**(s) Lifting of Construction Materials.** Stop traffic during the placement or removal of any construction materials that are above open lanes of traffic, such as, but not limited to, lifting equipment, bridge components, signs, and overhead sign structure components as directed.

**(t) Non-Compliance of Maintenance and Protection of Traffic.** Work zone liquidated damages will be assessed in the event of non-compliance with Maintenance and Protection of Traffic requirements. These work zone liquidated damages will be assessed when the Contractor neglects or refuses to correct a situation or condition of non-compliance to the TCP, Publication 212, Publication 213, and the MUTCD, or other contract traffic control requirements after being notified by the Representative in writing.

The amount of work zone liquidated damages assessed per 24 hour period will be one of the following, whichever is greatest:

1. The amount bid for Maintenance and Protection of Traffic divided by the number of calendar days between the Notice to Proceed date and the date of completion as specified in the contract documents.
2. The amount bid for the specific line item that is in non-compliance divided by the number of calendar days of use for that particular item.
3. $1,000.00

For long-term Maintenance and Protection of Traffic operations with duration of 24 hours or greater, the assessment will begin 24 hours after notification of necessary corrective action and continue daily for subsequent periods of time that such action has not been taken.

For short-term Maintenance and Protection of Traffic operations with duration less than 24 hours, 10% of the above-described amount will be assessed per hour as work zone liquidated damages. The assessment will begin 8 hours after notification of necessary corrective action and continue hourly for subsequent periods of time that such action has not been completed.

For long-term operations of 24 hours or greater, if no action is taken to correct a deficiency after 1 week following assessment of work zone liquidated damages, then the amount of daily work zone liquidated damages will be increased by $1,000.00 each week until action is taken to correct the deficiency. For short-term operations of less than 24 hours, if no action is taken to correct a deficiency after 8 hours, then the amount of hourly work zone liquidated damages will be increased by $100.00 each hour until action is taken to correct the deficiency.

Any extension of time will not be included in the number of calendar days. If the Contractor remains in violation of the Maintenance and Protection of Traffic requirements, the District Executive will direct Department forces to correct the deficiencies and charge the Contractor for labor, equipment, and material costs incurred by the Department or suspend work in accordance with Section 105.01(b) until the deficiencies are corrected.

**(u) Temporary Nonplowable Raised Pavement Markers.** Nonplowable markers are to be attachable to the roadway surface by use of a pressure sensitive adhesive as recommended by the manufacturer; they may be attached by epoxy when the marker does not have to be removed at a later date.

## 901.4 MEASUREMENT AND PAYMENT—

**(a) Maintenance and Protection of Traffic During Construction.** Lump Sum
The Department will measure and pay for this item in a proportionate manner based on current estimates.
With the exception of the separate pay items specified in Section 901.4(b), if an item or device is required for maintenance and protection of traffic, the cost of the item or device is incidental to Item 2901-0001 (Item 0901-0001).

**(b) Separate Pay Items.** The Department will separately measure and pay for the following items or devices, when indicated or required for maintenance and protection of traffic during construction:

- Arrow Panel—Each
- Tubular Markers—Each
- Changeable Message Sign—Each
- Temporary Traffic Signals—Each
- Floodlights—Each
- Temporary Concrete Barrier—Section 627.4
- Reset Temporary Concrete Barrier—Section 628.4
- Painting Traffic Lines and Markings—Section 962
- Pavement Marking Removal—Section 963.4
- Temporary Nonplowable Raised Pavement Markers—Each
- Temporary Bituminous Rumble Strips—Square Meter (Square Yard)
- Temporary Impact Attenuating Devices—Section 696.4
- Reset Temporary Impact Attenuating Devices—Section 697.4
- Standard Pavement Markings, Paint & Beads—Meter (Linear Foot)
- Standard Pavement Markings, Tape—Meter (Linear Foot)
- Additional Warning Lights—Day
  For the type indicated.
  Payment will be based on an accumulation of 24 hours when in place for one unit.

- Additional Traffic Control Signs—Square Meter (Square Foot)
  Payment will be based on the minimum size sign for the necessary application as defined in Publication 212, Publication 213, and the MUTCD unless otherwise directed.

- Temporary Highway Lighting—Lump Sum or Each
  As indicated.

# SECTION 902—MAINTENANCE AND PROTECTION DURING TEMPORARY SUSPENSION OF WORK

**902.1 DESCRIPTION**—This work is maintenance and protection of traffic on the project and the maintenance and protection of the project during a temporary work suspension.

**902.2 MATERIAL**—Section 901.2

**902.3 CONSTRUCTION**—Maintain and protect the project during suspension, as specified in Section 105.13(b), as directed, and as follows:

- Shape and maintain the existing roadway if existing roadway pavements are broken up and removed in advance of a reasonable paving schedule.
- Surface roadways, as directed, with acceptable commercial material or with acceptable local material secured beyond the project limits. If necessary, remove this material when project operation resumes.
- Apply a calcium chloride dust control solution or other approved dust control palliative in the manner and at the rate of application directed. If necessary, remove this material when project operations resume.
- Remove all protective signs and devices previously installed on the project.

If necessary, remove material placed by Department forces when operations resume.

Maintain and protect traffic during suspension, as specified in Section 901. The Department reserves the right to maintain traffic through the entire project or portions of the project and to perform necessary maintenance of traffic work. This Department work will be performed if agreement, as specified below, cannot be made upon a price, or if the Department work performed is in the interest of the State.

**902.4 MEASUREMENT AND PAYMENT—**

**(a) Lump Sum Basis.** Section 901.4

If this item is extra work, then the Department will pay for this item at a negotiated price as specified in Section 110.03(c).

**(b) Acceptable Commercial and/or Local Material.** Cubic Meter (Cubic Yard) or Tonne (Ton)

If this material is extra work, then the Department will make payment as specified in Section 110.03(c).

**(c) Calcium Chloride or Other Dust-Control Palliatives.** Liter (Gallon) or Tonne (Ton)

If these materials are extra work, then the Department will make payment as specified in Section 110.03(c).

**(d) Removal of Material Placed by Department Forces.** Cubic Meter (Cubic Yard)

The Department will pay for this work as Class 1 Excavation.

# SECTION 903—TEMPORARY BRIDGE AND APPROACHES

**903.1 DESCRIPTION**—This work is the design, furnishing, placement, maintenance, and removal of a temporary bridge and approaches of the type and method indicated, including required maintenance and protection of traffic.

**903.2 MATERIAL**—As indicated or as shown on the accepted detailed drawings.

**903.3 CONSTRUCTION—**

**(a) Two-Lane Construction.** If not otherwise indicated, design a temporary bridge and approaches to accommodate two lanes of traffic on a Department right of way or easement. Submit detailed drawings of the proposed bridge and approaches for the Representative's review and acceptance. Design the proposed temporary bridge for PHL-93 at the operating level, with a roadway width as indicated between curbs, guide rails, and with sidewalks, when directed. Conform to the alignment and grades indicated. If not indicated, submit a plan of a proposed alignment and grade.

Upon acceptance of the detailed drawings, construct the temporary bridge and grade, drain, and pave the approaches. Provide sidewalks and sidewalk protection when indicated.

If indicated, move the existing structure and use it as the temporary bridge. The method of moving, placing, and maintaining the structure will be subject to the Representative's review and acceptance.

When the temporary bridge and approaches are no longer needed, remove and dispose of them as directed. Grade and restore the entire disturbed area, as specified in Section 105.14.

**(b) One-Lane Construction.** Construct, as specified in Section 903.3(a), except:

Construct a one-lane temporary bridge having a roadway width between curbs of not less than 3.6 m (12 feet). Grade the one-lane approaches for a total width of not less than 5.4 m (18 feet) and surface for a width of not less than 3.6 m (12 feet).

**(c) Maintenance and Protection of Traffic.** As specified in Section 901, maintain and protect traffic in the temporary area.

**903.4 MEASUREMENT AND PAYMENT—**

**(a) Method 1.** Lump Sum

**(b) Method 2.** Separate items, as follows:

- **Temporary Bridge and Approaches (Two-Lane or One-Lane).** Lump Sum
- **Maintenance and Protection of Traffic on Temporary Bridge and Approaches.** Lump Sum
- **Removal of Temporary Bridge and Approaches.** Lump Sum

# SECTION 910—HIGHWAY LIGHTING

**910.1 DESCRIPTION**—This work is the furnishing, installation, erection, and wiring of the complete highway lighting system, including the electrical power supply and distribution system.

**910.2 MATERIAL—**

**(a) Highway Lighting Material.** Section 1101. Submit for approval, before purchase and at no cost to the Department, catalog cuts, drawings, and manufacturer's specifications for all lighting material including lighting poles, luminaires, junction boxes, conduits, cables, and power supply components proposed for the project. Refer to the Project Office Manual for material information requirements.

**(b) Other Material.**

- Fine Aggregate, Type A or B—Section 703.1
- Coarse Aggregate, Type A or C—Section 703.2
- Class A Cement Concrete—Section 704
- Expansion Joint Filler—Section 705.1
- Reinforcement Bars—Section 709.1
- Nonshrink Epoxy Grout—An acceptable type.
- Nonshrink Mortar—Section 1001.2(e)
- Caulking Compound—Section 705.8
- Precast Concrete Products—Section 714

**(c) Certification and Warranties.** Secure warranties or guarantees from the manufacturers for electrical and mechanical equipment. Submit these warranties or guarantees to the Department at project completion.

Submit material certification, as specified in Section 106.03(b)3.

For poles, submit a signed warranty from the manufacturer stating that specifications have been met.

**910.3 CONSTRUCTION**—As shown on the Standard Drawings, as indicated, and as follows:

**(a) General.** Comply with local government, electric utility company, and State codes or requirements; the electrical regulations of the Department of Labor and Industry; and the construction requirements of the NEC and NESC. Cooperate with the electric utility company or agency furnishing power to the system and meet the necessary service requirements. Acquire permits as specified in Section 107.02. Furnish certificates of approval from appropriate agencies when required. Upon work completion, submit to the Department five copies of "as-built" drawings, as directed, showing the date, any changes from the indicated system made during construction, and any revised circuit diagrams. Upon receipt, "as-built" drawing copies will be supplied to the agency maintaining the system. The acceptance of drawings will not relieve Contractor responsibility for erroneous or inconsistent dimensions, notations, or omissions or for the proper installation and operation of the electrical systems.

**(b) Excavation for Pole Foundations.** Before placing forms, each foundation excavation will be inspected for the actual soil conditions encountered. Do not proceed with work until the foundation excavation is accepted. The foundation design may need to be revised based on the actual conditions encountered as determined by the Representative.

Obtain approval of the completed foundation forms before concrete placement. Remove water from the foundation holes before concrete placement.

**(c) Trench Excavation and Backfill.** Remove and store topsoil encountered in the excavation. Excavate trenches for conduit runs parallel to the roadway, or as indicated. The preferred location is off of the shoulder. Backfill the same day if possible. Remove rock within the excavation unless an alternate layout is authorized. Remove and dispose unsuitable material and excess excavation as directed.

Place plastic marking tape within the last layer of backfill material for the entire length of the trench.

Provide bedding soil for conduits as specified in Section 206.2(a)1.a. Backfill the remaining portion of the trenches with suitable on-site material to match existing conditions as shown on the Standard Drawings. Do not use course aggregate, except within the subbase area or as directed. Compact trench material as specified in Section 601.3(f) or Section 206.3(b)1.

Stake trench alignments for inspection and acceptance before excavating when they deviate from the indicated location. Submit the layout for review and acceptance before proceeding if the alignments extend the overall indicated circuit length by more than 5%.

**(d) Pole Foundations.** Construct of Class A cement concrete, as specified in the applicable parts of Section 1001.3.

Before erection of high mast poles, mix, cure, and test samples of the foundation concrete according to Department procedures.

Provide and place anchor bolts perpendicular to the top plane of the foundation. Use suitable templates or forms to hold the anchor bolts in position while placing concrete.

Clean the exposed portion of anchor bolts and associated hardware.

Install individual electrical grounds for pole foundations. Install additional ground rods as required if the resistance between the pole and ground is greater than 25 ohms. Attach the ground wire to the ground rod with an exothermic weld or bronze connector. Test before placing concrete.

**(e) Lighting Poles and Accessories.** Install poles plumb. For other than high-mast, use aluminum shims with aluminum bases; and use stainless steel shims with other bases. Place shims under no more than three bolts of any base. Orient the handhole in the direction of traffic, unless otherwise indicated.

Plumb high-mast poles, using the leveling nuts supplied with the anchor bolts.

Unless otherwise indicated, install bracket arms at right angles to the pavement edge with arms securely fastened to the pole shafts. Install luminaires and ballasts according to the manufacturer's instructions or as indicated.

Fasten an identification plate to the roadway side of the pole 2.5 m (8 feet) above the foundation or as directed.

Select one or more poles for the static load test, as specified in Section 1101.02 before erecting the remainder of the poles.

Use similar pole types and similar materials within the same general area.

Field-assemble two-piece pole shafts by overlapping bolted sections.

Do not field weld poles or accessories.

**(f) Supervision (High-Mast Installations).** Ensure that a manufacturer's representative is on site to assist in supervising the field assembly and erection of high-mast poles and to instruct Department personnel in the proper procedures for raising and lowering the luminaire ring and in the recommended maintenance care of the poles.

Check the pole section mating and alignment before the erection of the pole.

Request the electric utility company to be present during erection of poles within 60 m (200 feet) of their aerial electric lines.

**(g) Conduits.** Support conduits firmly and rigidly in place in a manner to prevent dislodging, while placing concrete or while performing other operations. If possible, install conduits under roadways before placing the pavement. If this is not possible, install a 80 mm (3-inch) diameter rigid steel conduit for a sleeve. Jack, auger, or bore under pavements, shoulders, sidewalks, railway tracks, and other indicated areas. Do not water bore. Extend this sleeve under the roadway approximately 600 mm (24 inches) beyond the outside paved edge. Place the lighting conduit through this sleeve.

Grind the cut ends of metallic conduit to remove rough edges. Do not use defective conduit. Thread steel conduit for couplings and fittings. Coat the threads as specified in Section 910.3(r).

Weld plastic conduit joints with solvent, according to the conduit manufacturer's recommendations.

Make conduit bends and offsets, either in the shop or in the field. Do not damage the protective coating when making bends and offsets. Do not reduce the interior diameter of the bend. Form the bend on a radius at least twelve times the conduit diameter, but not less than 460 mm (18 inches). Use manufactured sweep bends whenever possible.

Seal the ends of partially installed conduit runs if conduit work is temporarily suspended. If it is necessary to open the ends for cleaning or testing, reseal them upon completion. Seal the conduits in control cabinets.

Install conduit expansion and deflection joint fittings at each structure expansion joint as shown on Bridge Standard Drawings.

Ground steel conduit and provide electrical continuity on structures, as specified in Section 910.3(q), as soon as possible after installation, and before energizing the system. Connect fittings, junction boxes, and other appurtenances to the conduit on a structure so electrical continuity is maintained. Provide conduit expansion joints with an external bonding jumper.

Coat underground steel galvanized conduit with bituminous paint or other approved coating if placed in a corrosive area. Use hot-dipped galvanized coating for other areas.

Clean conduit runs after installation by pulling a stiff wire brush, the size of the conduit, through the conduit. Then test the conduit by pulling a ball mandrel that has a diameter of at least 85% of the inside diameter of the conduit, through each conduit run. Where the mandrel fails to pass, either clean the conduit without injury to the conduit walls or replace the conduit.

Fasten conduits to electrical equipment using code-approved devices. Use watertight conduit fittings to connect to watertight enclosures.

Attach conduit to wood poles with 3 mm (1/8-inch) thick hot-dipped galvanized steel straps and galvanized lag screws. Provide 1.5 m (5 feet) maximum spacing between straps.

Do not install pull wires in the conduit, unless indicated.

Provide a 50 mm (2-inch) minimum direct burial conduit for underground circuits.

**(h) Cable Installation.** Do not damage the cable insulation. Manually remove the cable from the drum or reel. Notify the Representative when cable is to be placed. Do not proceed without the Representative being present.

Use cable grips to install the cable in the conduit. Simultaneously pull cables within a single conduit, but do not damage the cable by overpulling. Use a dynamometer if pulling other than by hand. Use pulling lubricant of a type recommended by the cable manufacturer if necessary. Use extreme care when pulling cable through handholes in pole shafts. Place a pad of firm rubber or other similar material around the bottom edges of the opening to protect the cables.

Clearly locate underground conduits with aboveground markers if guide rail or other surface features are to be constructed in the immediate area.

Provide enough slack cable in junction boxes and light pole bases to allow exterior splicing. Neatly arrange the spliced cables or coil in junction box or pole base.

Prevent the entry of moisture into the cable at all times during installation. Seal the ends of cable until final splices are made.

Make splices with pre-molded disconnectable connector kits rated for 600 V. Provide splices with a minimum watertight or splash proof seal using weatherproof boots and tape as required by the manufacturer; and when placed in junction boxes or other potentially wet areas, provide splices that are waterproof and submersible. For in-ground junction boxes use non-fusible splices, unless indicated otherwise. Use only breakaway type connectors for connections where breakaway bases are used. Line splice only at pole bases or junction boxes. Do not splice cables inside conduits.

Use seven-strand 5.26 $mm^2$ (No. 10 AWG) insulated wire for the line taps from the feeder cable to the ballast for the phase and neutral wires. Provide taps to the feeder cables as specified for line splicing. Do not use wire nuts for cable taps. Provide adequate size connectors for the wire sizes involved. Provide individual fusing for all conventional lighting. Fuse the tap with a 6A to 10A fuse, midget size, 250 V rating. Fuse the phase wire only. Connect the neutral wire to the ground wire at the pole base with a split bolt connector and coat the connection with an approved corrosion inhibitor. Attach the cable to the J hook at the pole top with a cable grip that supports the weight of the cable.

Furnish and install circuit-identifying tags on control and distribution circuit cables where they connect to equipment located in service cabinets and vaults and on cables in junction boxes and pole shafts. Use fiber or other acceptable nonconducting tags, not less than 20 mm (3/4 inch) in diameter, and not less than 0.8 mm (1/32 inch) thick. Legibly stamp identification markings on the tags using small tool dies or permanent, waterproof marker. Securely tie each tag to the proper conductor, using plastic or nylon cord.

Use underground cable in direct burial conduit for all underground installations. The minimum underground wire size is 8.38 $mm^2$ (No. 8 AWG) copper cable.

**(i) Cable Duct.** Use only if indicated. Install similar to conduits as specified in Section 910.3(g), and according to the manufacturer's instructions.

**(j) Luminaires.** Check the luminaires for the proper lamp socket position, according to the lamp distribution indicated, before placing on the pole top or arms. Uniformly adjust and level luminaires.

Immediately before the illumination test, and after the other work has been completed, clean the light control surfaces according to the luminaire manufacturer's recommendations using a cleaner recommended by the manufacturer.

Provide luminaires with a weather resistant decal that shows the lamp wattage. Provide a decal that is visible from the ground.

**(k) Service Pole Installation.** Position the service pole inside the right of way, and where indicated. Mount a meter base on the pole according to the utility company's requirements. Coordinate the meter installation with the utility company.

Install poles, according to the current specifications and standards of NELA, EEI, and NESC. The minimum depth of holes for setting wood poles 9 m to 12 m (30 feet to 40 feet) in length is 1.8 m (6 feet), measured from the low side on sloping ground. Dig holes with vertical sides and with a diameter large enough to permit use of a mechanical tamper around the pole. Ensure that each pole is inspected and accepted before backfilling. Deposit acceptable backfilling material around the poles and mechanically tamp, in layers of not over 100 mm (4 inches). Place backfill material around the pole to drain water away.

Guy service poles, if necessary. Install cone anchors 2.1 m (7 feet) below ground level. After placing the anchor, backfill the hole with coarse aggregate for a depth of 600 mm (24 inches) above the anchor, then tamp during backfilling. Backfill the remaining hole with the excavated material, then thoroughly tamp. Obtain approval for the guys before the conductors are strung. Install a guy guard if the guy is adjacent to the roadway.

**(m) Photoelectric Control Device.** Use a plug-in device, for ease of replacement. Install the device with its detector area facing north.

**(n) Enclosure Installation.** Mount enclosures for housing the control equipment. Padlock the enclosures. Key as directed. Provide enclosure ID tags as specified for pole ID tags. Provide the power supply number and the system voltage on the tags.

**(p) Junction Boxes.** Obtain acceptance of any change in box location before installation.

Excavate, then construct or install the box. Backfill around the box and dispose of excess or unsuitable material. Ground the junction box as required.

If using precast junction boxes with knockouts, remove the knockouts, then tightly grout the conduit or conduit sleeves in place with nonshrink mortar.

Ground exposed metal parts of junction boxes with a minimum 21.15 $mm^2$ (No. 4 AWG) ground wire and a minimum 12 mm x 2.5 m (1/2-inch by 8-foot) ground rod. Connect the ground wire to the ground rod with either an exothermic weld or with a bronze connector clamp. Connection to an adjacent system ground rod is allowable.

**(q) Grounding.**

**1. General.** Install individual ground rods. Install additional ground rods as required if the resistance to ground is greater than 25 ohms. Attach the ground rod to the ground wire with an exothermic weld or a bronze connector. Coat bronze connection with approved corrosion inhibitor.

**2. Grounding on Structures.** Ground lighting poles, underpass luminaires, and metal junction boxes on structures by connecting to the structure mounted steel conduit. If using structure mounted non-metallic conduit, use a continuous grounding conductor in the conduit.

Do not connect the neutral to the ground on structures.

Provide one ground rod for structures up to 150 m (500 feet) in length. Provide one ground rod at each end of structures over 150 m (500 feet) in length. Ground structure mounted steel conduit with a 21.15 $mm^2$ (No. 4 AWG) uninsulated copper ground conductor. Provide a separate insulated or uninsulated continuous ground conductor of the same size and material as the circuit conductors for structures using non-metallic conduit. Install the ground conductor with the circuit conductors. Connect the ground conductor to the ground rod(s).

**(r) Galvanize Repair.** Repair field damage to any galvanized finishes by painting with two coats of Zinc Dust-Zinc Oxide Paint, according to ASTM A 780, or with an acceptable equal.

**(s) Power Supplies.** Make arrangements with the local electric utility company for electrical service for the lighting system.

Furnish and install the specified number of wooden poles for the power supplies with the necessary auxiliary equipment (crossarms, brackets, meter base, transformers, cutouts, lightning arresters, conduit, insulators, switches, fuses, circuit breakers, contractors, photoelectric controls, enclosures, weatherheads, service wire, guywire, and grounding) to provide complete electrical service for the entire lighting system.

**(t) Buried Cable and Conduit Markers.** Set the markers flush with the ground and directly over the trench. Place the marker directly under the guide rail when trench and guide rail cross.

**(u) Tests.** Perform the following tests as applicable and record the test data on the test forms. Provide the electrical energy and furnish personnel and equipment to complete the tests. Correct any defects disclosed by the tests and then retest the corrections. Perform the tests in the presence of an authorized representative of the Department.

| Form | Title |
|---|---|
| CS-4225A | Ground Rod Test |
| CS-4225B | Conductor Insulation Resistance Test |
| CS-4225C | Circuit Performance Test |
| CS-4225D | Highway Illumination Test (Conventional) |
| CS-4225E | Sign Illumination Test |
| CS-4225F | High Mast Lighting Test |
| CS-4225G | Static Load Test (Conventional) |

Satisfactorily demonstrate that circuits are continuous and free from short circuits and from unspecified grounds. Provide a resistance to earth-ground, for each ground rod installed, of not more than 25 ohms. Supply and install additional ground rods until this requirement is met or as directed.

The resistance to ground of conductors for direct buried cable is to be as shown in Table A at 15.6 ºC (60F), when measured with a 1000 V megger:

**TABLE A (Metric)**
**Insulation Resistance (Megaohms- minimum, based on 305 m)**
**Wire Size ($mm^2$)**

| Cable Type | 5.23-13.3 | 21.1-42.5 | 53.4-67.5 |
|---|---|---|---|
| Cross-Linked Polyethylene RHW, RHH, USE | 2000 | 1500 | 1300 |
| Cross-Linked Polyethylene XHHW | 1600 | 1100 | 900 |
| Rubber-Neoprene RHW | 500 | 350 | 300 |
| PVC THW | 140 | 120 | 100 |

**TABLE A (English)**
**Insulation Resistance (Megohms- minimum, based on 1,000 feet)**
**Wire Size (AWG)**

| Cable Type | 10-6 | 4-1 | 1/0-2/0 |
|---|---|---|---|
| Cross-Linked Polyethylene RHW, RHH, USE | 2,000 | 1,500 | 1,300 |
| Cross-Linked Polyethylene XHHW | 1,600 | 1,100 | 900 |
| Rubber-Neoprene RHW | 500 | 350 | 300 |
| PVC THW | 140 | 120 | 100 |

Take voltage readings, with load and without load, at the power supply side of the control cabinet main breaker. The readings with load must be within ±5% of nominal voltage (typically either 120 V or 240 V). Take voltage readings at the last light of each circuit. A voltage reading is acceptable if it is within 5% of the reading with load at the supply point.

Take current (ampere) readings with a full lighting load on the load side of each distribution breaker in the control cabinet. A current reading is acceptable if it does not exceed 75% of the breaker rating.

Energize and operate the lighting system, including automatic control(s), for 168 consecutive hours. At each control cabinet, supply a service voltage graphic record covering the test period, with the installed electrical equipment in normal operation (lights on at night and off in daytime).

After the lights have been energized for at least 100 hours burning time, and after dark, take horizontal lux (footcandle) readings at road level with the light meter leveled. Use a light meter conforming to the following:

- Lowest full scale not exceeding 21.5 lux (2.0 footcandles) or equivalent sensitivity.
- Calibrated by a recognized testing laboratory within the past year and bearing the certification of calibration.

Take lux (footcandle) readings, where directed. Give particular attention to points where low illumination is most likely to occur, usually midway between luminaires.

Complete the static load tests specified in Section 1101.02(a)1.

Lower and raise the ring assembly of all high mast poles to ensure proper operation.

**(v) Guarantee.** Guarantee the in-service operation of all mechanical and electrical equipment, and related components of the entire lighting system including lamps, for a period of 180 days. The guarantee begins the day after the lighting system is fully operational, as determined by the Representative, after completion of all lighting system related work and completion of the 168-hour performance test specified in Section 910.3(u).

The energizing cost during the guarantee period will be borne by others. Perform the following at the onset of and during the guarantee period:

- Execute the in-service guarantee notification Form CS-4225H, provided by the Department.
- Commence repairs within one calendar day following notification to the person designated on Form CS-4225H.
- Guarantee all repairs and material replacements for the balance of the guarantee period, or 30 days, whichever is the longer period.
- Repair work not performed within the guarantee period, or any extension periods, will be considered latent defects as specified in Section 107.16(b).

Repairs that are the direct result of external causes will be performed by others. Examples of external causes are lightning strikes, vehicular impact, objects driven through the underground circuit, trenching through installed circuits, etc.

Issuance of certificate of acceptance or final settlement of the contract is not consequential to the in-service guarantee period described herein. The guarantee period is not a part of the contract time.

## 910.4 MEASUREMENT AND PAYMENT—

**(a) Junction Boxes.** Each, for the type indicated.
The price includes the ground wire, ground rod, ground clamp, and necessary excavation and backfill.

**(b) Poles (Conventional).** Each, for the type and height indicated.
The price includes either frangible or breakaway base (when indicated) and arm.

**(c) Poles (High-Mast).** Each, for the height indicated.
The price includes the lowering device and wiring from the line splice to the luminaire ring.
The winch drive unit is incidental to the total number of poles constructed.

**(d) Arms.** Each, for the length indicated.
The price includes complete installation.

**(e) Luminaires (Conventional).** Each, for the wattage and mounting indicated.
The price includes complete wiring from luminaire ballast to line splice.

**(f) Luminaires (High-Mast).** Each, for the wattage indicated.
The price includes complete wiring from the luminaire-ring terminal board to the luminaire ballast.

**(g) Luminaires (Underpass).** Each, for the wattage and mounting indicated.
The price includes complete wiring, conduit, and necessary mounting provisions from the line splice at the junction box to the luminaire.

**(h) Ballast.** Each, for the wattage indicated.
The price includes mounting and wiring, as directed.

**(i) Pole Foundations.** Each, for the type indicated.
The price includes excavation, concrete, anchor bolt assemblies, reinforcement bars, conduit, ground rod, ground rod clamp, grounding conductor, backfilling, and satisfactory disposal of surplus material.

**(j) Cable and Conduit Markers.** Each
The price includes excavation, concrete, backfilling, and satisfactory disposal of surplus material.

**(k) Conduit.** Meter (Linear Foot)
The price includes fittings, expansion/deflection fittings, joints, bends, grounds, protective coatings, and appurtenances. Does not include conduit in pole foundations.

Unless otherwise authorized, no allowance will be made for additional conduit lengths as a result of deviation from the indicated conduit location.

**(m) Cable.** Meter (Linear Foot)
No allowance will be made for coiling or looping cable slack lengths inside pole bases or junction boxes, when additional lengths of cable are necessary for splicing. An allowance will be made for cable entry into each pole base from the trench to the handhole.

Unless otherwise authorized, no allowance will be made for additional cable lengths, or cable size, as a result of deviation from the indicated cable location.

The ground wire and ground rods specified for structures are incidental to the circuit cables. Splices and fuses are incidental to the circuit cables.

**(n) Trenches.** Meter (Linear Foot)

The price includes excavation, backfilling, temporary and permanent plastic trench markers, and surplus material disposal. No allowance will be made for rock excavation or for any other subsurface condition encountered.

Unless otherwise authorized, no allowance will be made for additional trench lengths as a result of deviation from the indicated trench locations.

**(p) Pull Wire.** Meter (Linear Foot)

When indicated.

**(q) Complete Power Supply System.** Each

The price includes service pole and all necessary power supply equipment.

**(r) Testing of Entire Lighting System.** Lump Sum

The price includes furnishing personnel, equipment, and electrical energy necessary for tests.

**(s) Conduit Sleeve.** Meter (Linear Foot)

The price includes all work necessary to install the conduit sleeve as specified in Section 910.3(g). The price does not include circuit conduit passing through the sleeve.

# SECTION 920—SIGN LIGHTING

**920.1 DESCRIPTION**—This work is the furnishing and installation of a complete electrical distribution, control, and lighting system for the illumination of indicated signs.

**920.2 MATERIAL**—Section 1102. Certification and warranties, as specified in Section 910.2(c).

**920.3 CONSTRUCTION**—As shown on the Standard Drawings, as indicated, and as follows:

**(a) General.** Section 910.3(a) and as follows:
Do not alter sign structure members to attach electrical items, unless indicated. When necessary, drill during structural fabrication.

**(b) Trench Excavation and Backfill.** Section 910.3(c)

**(c) Service Pole Installation.** Section 910.3(k)

**(d) Photoelectric Control Device.** Section 910.3(m)

**(e) Enclosure Installation.** Section 910.3(n)

**(f) Luminaires.** Attach the luminaires to the supports. Install a lamp in each luminaire. Clean the luminaires as specified in Section 910.3(j). If the luminaire is provided with a remote ballast, mount the remote ballast over the shoulder. Submit mounting method and materials for approval.

**(g) Junction Boxes.** Section 910.3(p)

**(h) Conduit Installation.** Section 910.3(g) and as follows:
Unless another method is specified, attach exposed conduits to sign structures using galvanized or stainless steel supports and U-bolts or two-hole straps with spacers and expansion bolts, and attach the conduit to sign columns and shafts with clamping bands and bolts.

**(i) Cable Installation.** Section 910.3(h)
Deviation from the indicated layout may be allowed if it is necessary to overcome obstacles during construction, provided that drawings showing the deviations are submitted for approval.
Extend cables from the breakers of each sign structure mounted lighting panel to each ballast and sign lighting fixture.
Attach exposed cable runs to the structures using 13 mm (1/2-inch) stainless steel straps or black plastic tie straps, as directed, at intervals not exceeding 1 m (3 feet).

**(j) Cable and Conduit Markers.** Section 910.3(t)

**(k) Grounding.** Install grounding wire, ground rods, connectors, and necessary devices to ground the entire electrical system and sign structure.
Connect the 13.3 $mm^2$ (No. 6 AWG) ground wire to the breaker panel ground bus and to the ground rod at the service pole.
Install a 13.3 $mm^2$ (No. 6 AWG) ground wire at sign structures through the sign column shaft and attach to the grounding lug accessible from the handhole. Connect the ground wire to the ground rod with a bronze clamp. Ground the system neutral conductor and enclosure using a connection on the grounding lug in the column shaft. Drive the ground rod vertically into the ground a horizontal distance of 300 mm (12 inches) from the foundation and opposite the roadway side of the shaft.

**(m) Tests.** Section 910.3(u), except as follows:

**1. Circuit Tests.** Make voltage readings at the power supply side of the service pole equipment or at the supply side of the highway sign lighting circuit, and make readings at ballasts. Provide a voltage drop not exceeding 5% of the rated voltage at the service point when under full load at the lamp ballast.

Take current readings on the load side of each main breaker and neutral circuit. Take current readings at nighttime and at daytime with the lighting systems in normal operation.

**2. Performance Test.** As directed, take lux (footcandle) readings at several points on each sign face.

**(n) Guarantee.** Section 910.3(v)

**920.4 MEASUREMENT AND PAYMENT**—Lump Sum

The price includes furnishing personnel, equipment, and the costs of electrical energy for the tests.

# SECTION 930—POST MOUNTED SIGNS, TYPE A

**930.1 DESCRIPTION**—This work is furnishing and installation of fabricated aluminum signs of the type indicated on steel S or W beam posts and breakaway system.

**930.2 MATERIAL**—As shown on the Standard Drawings and as follows:

**(a) Extruded Aluminum Channel Signs, Posts, and Miscellaneous Material.**

- Extruded Aluminum Channel Signs—Section 1103.02
- Steel S or W Beam Posts and Breakaway System—Section 1103.07
- Galvanized Steel Bolts, Nuts, Lock-Nuts, Lock-Washers, Aluminum Post-Clips, Auxiliary Supports for Exit Panels, 3.2 mm (1/8-inch) Rivets; Aluminum or Nylon Washers—Section 1103.11

**(b) Flat Sheet Aluminum Signs with Stiffeners, Posts, and Miscellaneous Material.**

- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Steel S or W Beam Posts and Breakaway System—Section 1103.07
- 3.2 mm and 4.8 mm (1/8-inch and 3/16-inch) Aluminum Rivets; Stainless Steel Bolts, Nuts, Washers, Post-Clips; Twist-In Toggle and Buckle Straps; Butting Plates; Auxiliary Supports for Exit Panels—Section 1103.11

**(c) Foundations.**

**1. Cast-In-Place Foundation.**

- Class A Cement Concrete—Section 704
- Reinforcement Bars—Section 709.1

**2. Steel Finned-Pipe Foundation.** From a manufacturer listed in Bulletin 15.

**930.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Erect posts plumb using a method that does not twist, bend, or otherwise deform the posts. Before erection, correct twisted, bent, or deformed posts. Erect signs by a method that does not twist, bend, or otherwise deform the signs. Level, correctly align, and then center signs on the posts and properly fasten. Exercise extreme care when using hoisting cables on the sign to avoid damage to the reflective sheeting. Repair or replace damaged posts and signs.

Fasten the signs to the posts with the necessary hardware as detailed in TC 8700 Standard Series.

**(b) Location.** The indicated location of sign installations is approximate with the exact location established at the site. Mark longitudinal and lateral location by stakes or paint marks with an identifying symbol.

On tangent sections of roadway, locate and erect posts to allow signs to face away from roadway at an angle of 93 degrees from the pavement edge. On curves, locate and erect the posts perpendicular to the sight line, where the sight line is an imaginary line connecting the center of the near traffic lane. The length in meters (feet) from the sign to the center of the near traffic lane is equal to 0.6 times the letter height of the smallest legend in millimeters (40 times the letter height of the smallest legend in inches), but not less than 90 m (300 feet). For example: 0.6 mm x 300 mm (50-inch x 12-inch) letter equals a 180 m (600-foot) sight line.

**(c) Removal of Existing Signs.** Remove existing signs or sign installations as indicated. Existing signs or sign installations that are permanently removed shall become the property of the Contractor unless indicated otherwise. Remove foundations to a minimum 300 mm (12 inches) below final grade.

**(d) Clearing and Grubbing.** When directed, and as specified in Section 201.3, remove material, brush, trees, or branches, which obstruct the clear view of signs being placed.

**(e) Restoration of Site.** Restore the site to its original condition, including the disposal of excess or unsuitable materials.

**(f) Motorist Service Signs.** Provide and install symbols, legends, and borders, with the exception of business logo signs, as indicated.

**(g) Posts and Foundations.**

**1. Posts.** Submit a sketch for acceptance for each plan location before post fabrication, showing the following:

- location of sign by plan station;
- lateral offset from pavement edge to sign edge;
- sign size (width and height);
- exit panel sign size (width and height);
- number of post supports and sections;
- post heights, measured from bottom of post base plate to post top;
- measured distance from reference line elevation at pavement edge to foundation top;
- steel finned pipe foundation design; or
- footing base type design and reinforcing steel; and
- bracket identification number and quantity.

Replace galvanized parts or members damaged in transition or erection with new material having properly galvanized surfaces. Repair damage to galvanized surfaces that does not exceed 2% per meter (linear foot) of the total surface area according to ASTM A 780 and as specified in Section 910.3(r).

**2. Foundations.**

**2.a Cast-in-Place Foundations.** Excavate for the foundation, then position the posts and connections with the post flange faces aligned in the same plane. Place concrete against undisturbed earth, as specified in the applicable parts of Section 1001.3. Form the top 300 mm (12 inches) of foundations.

**2.b Steel Finned-Pipe Foundations.** Install foundation and provide installation report prepared by Technical Assistant, according to the drawing and manufacturer's recommendations.

- **Technical Assistant.** Provide a certified designer/installer to be present at the project site to assist the Contractor and Representative in the event that unusual problems or special circumstances arise. Furnish evidence of the designer/installer's certification from the steel finned-pipe foundation supplier to the Representative before the start of work.

**(h) Erection.** Install lock-nuts on post clips with a torque wrench for extruded aluminum channels. Apply 25.4 N•m (225 inch-pounds) of torque to each galvanized locknut with the threads dry, clean, and unlubricated.

Attach the sign to posts with twist-in toggle and buckle straps or stainless steel post-clips for flat sheet aluminum. Apply 25.4 N•m (225 inch-pounds) of torque to each stainless steel lock-nut with the threads dry, clean, and unlubricated.

Clean signs after erection, removing any accumulation of oil, grease, dirt, or foreign material.

Brace the panel with one or more auxiliary supports if exit panels cannot be supported by two sign posts.

## 930.4 MEASUREMENT AND PAYMENT—

**(a) Post Mounted Signs, Type A.** Square Meter (Square Foot) of sign

The unit price includes removal of existing signs and erection of posts, but not furnishing and galvanizing posts.

**(b) Steel S or W Beam Posts.** Kilogram (Pound)

**(c) Breakaway System.** Each

The price includes all breakaway hardware for a single post and all necessary machining.

# SECTION 931—POST MOUNTED SIGNS, TYPE B

**931.1 DESCRIPTION**—This work is furnishing and installation of flat sheet signs on breakaway steel posts.

**931.2 MATERIAL**—As shown on the Standard Drawings and as follows:

- Flat Sheet Signs—Section 1103.04
- Breakaway Steel Posts—From a manufacturer listed in Bulletin 15, and as specified in Section 1103.08.
- Aluminum Bolts, Nuts, Lock-Washers; Nylon Washers; Anti-Theft Hardware—Section 1103.11
- Packaged Dry Concrete—Section 624.2(b)

**931.3 CONSTRUCTION**—As shown on the Standard Drawings, as specified in Sections 930.3(a), (b), (d), and (e) and as follows:

**(a) General.** Drive anchors into undisturbed earth with anchor top a maximum of 100 mm (4 inches) above lower slope side.

Drill concrete if posts are to be located in concrete areas.

Drive square anchor into undisturbed earth and place concrete if square steel posts are used in concrete. Complete installation after concrete is cured a minimum of 72 hours.

Fasten STOP and YIELD signs, and other signs if indicated, to posts with anti-theft hardware.

Permanently scribe 25 mm (1-inch) numerals on back of sign indicating the month/day/year of installation.

**(b) Removal of Existing Signs.** Remove existing signs or sign installations, only when indicated or directed.

Return aluminum and steel removed from existing sign installations to the Department unless indicated otherwise. Sort and band removed items by type of material onto separate wooden pallets. Prevent additional damage or deterioration of the sign materials, particularly aluminum sign blanks, during storage, bundling, and delivery. Give 3 working days notice to arrange delivery to the Department as indicated.

**931.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot) of sign

The unit price includes removal of existing signs.

# SECTION 932—POST MOUNTED SIGNS, TYPE C

**932.1 DESCRIPTION**—This work is the furnishing and installation of flat sheet signs on wood posts.

**932.2 MATERIAL**—As shown on the Standard Drawings and as follows:

**(a) Signs, Posts, Supports, and Miscellaneous Material.**

- Flat Sheet Signs—Section 1103.04
- Treated Wood Posts—Section 1103.09
- Aluminum Bolts, Nuts, Lock-Washers; Aluminum or Nylon Washers; Lag Screws—Section 1103.11
- Shims and Bars—Section 1105.02(a)2
- Brackets—Section 1105.02(f)2

**(b) Foundations.**

- Class A Cement Concrete—Section 704
- Sleeves—Section 1105.02(j)1

**932.3 CONSTRUCTION**—As shown on the Standard Drawings, as specified in Sections 930.3(a), (b), (d), and (e), Section 931.3(b), and as follows:

Excavate for the post foundation. Place the post, with shim plates and bars attached, in the sleeve in the excavated foundation. Carefully set the sleeve, using the temporary framing to ensure proper location.

Place foundation concrete, as specified in the applicable parts of Section 1001.3, against undisturbed earth. Finish the foundation tops flush and in the same plane as the adjacent ground, except trowel the concrete surface and shape to prevent water standing against the posts.

Drill or form the hole if posts are to be located in concrete such as divisors or islands.

Limit field cutting of posts to a minimum. Field treat the cut area with the original post preservative.

Where multiple sign assemblies on the same installation require larger posts than shown on the Standard Drawings, refer to the Standard Drawings for post mounted signs, Type E.

Permanently scribe 25 mm (1-inch) numerals on back of sign indicating the month and year of installation.

**932.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot) of sign

The price includes removal of existing signs.

# SECTION 933—POST MOUNTED SIGNS, TYPE D

**933.1 DESCRIPTION**—This work is the furnishing and installation of flat sheet aluminum signs with stiffeners on steel pipe supports, fastened to fabricated structural steel mounting brackets.

**933.2 MATERIAL**—As shown on the Standard Drawings and as follows:

- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Twist-In Toggles and Buckle Straps; Anchors—Section 1103.11
- Steel Brackets, Bars, Pipes, Shapes, and Plates (Supports)—Section 1103.12

**933.3 CONSTRUCTION**—As shown on the Standard Drawings and as specified in Sections 930.3(a) and (b), and Section 931.3(b), except insert the word "support" for the word "post."

Permanently scribe 25 mm (1-inch) numerals on back of sign indicating the month and year of installation.

**933.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot) of sign

The unit price does not include furnishing and erecting fabricated structural steel mounting brackets.

# SECTION 934—POST MOUNTED SIGNS, TYPE E

**934.1 DESCRIPTION**—This work is the furnishing and installation of fabricated aluminum signs of type indicated on wood posts or composite posts.

**934.2 MATERIAL**—As shown on the Standard Drawings, and as follows:

**(a) Extruded Aluminum Channel Signs, Posts, Supports, and Miscellaneous Material.**

- Extruded Aluminum Channel Signs—Section 1103.02
- Treated Wood Posts—Section 1103.09(a)
- Composite Posts—Section 1103.09(b)
- Galvanized Steel Bolts, Nuts, Lock-Washers, Lock-Nuts; Aluminum Postclips, Auxiliary Supports for Exit Panels, Rivets; Aluminum or Nylon Washers—Section 1103.11
- Angles (Supports)—Section 1103.12(g)
- Shim Bars and Plates (Supports)—Section 1105.02(a)2

**(b) Flat Sheet Aluminum Signs with Stiffeners, Posts, and Miscellaneous Material.**

- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Treated Wood Posts—Section 1103.09(a)
- Composite Posts—Section 1103.09(b)
- Rivets—Section 1103.11(g)
- Stainless Steel Bolts, Nuts, Washers, Post-Clips; Twist-In Toggles and Buckle Straps; Butting Plates; Auxiliary Supports for Exit Panels—Section 1103.11
- Angles (Support)—Section 1103.12(g)
- Shim Bars and Plates (Supports)—Section 1105.02(a)2

**(c) Foundations.**

- Class A Cement Concrete—Section 704
- Sleeves—Section 1105.02(j)1
- Steel Pipe—Section 1103.12(e)

**934.3 CONSTRUCTION**—

**(a) Wood Posts.** Section 932.3

**(b) Composite Posts.** As shown on the Standard Drawings, as specified in Sections 930.3(a), (b), and (e), Section 931.3(b), and as follows:

Excavate for the post foundation. Place the post in the sleeve in the excavated foundation. Set the sleeve, using the temporary framing to ensure proper location.

Place foundation concrete against undisturbed earth, as specified in the applicable parts of Section 1001.3. Finish the foundation tops flush and in the same plane as the adjacent ground, except trowel the concrete surface and shape to prevent water standing against the posts.

Drill or form the hole if posts are to be located in concrete such as divisors or islands.

Place protective plastic cap over top end of post.

Permanently scribe 25 mm (1-inch) numerals on back of sign indicating the month and year of installation.

**934.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot) of sign

The unit price includes removal of existing signs.

# SECTION 935—POST MOUNTED SIGNS, TYPE F

**935.1 DESCRIPTION**—This work is the furnishing and installation of signs of the type indicated on existing posts or posts installed for other purposes.

**935.2 MATERIAL**—As shown on the Standard Drawing for the corresponding type post and as follows:

- Flat Sheet Signs—Section 1103.04
- Aluminum Bolts, Nuts, Lock-Washers; Brackets and Bars (Supports); Lag Screws; Anti-Theft Sign Hardware; Banding—Section 1103.11
- Extruded Aluminum Channel Signs—Section 1103.02
- Flat Sheet Aluminum Signs with Stiffeners—Section 1103.03
- Galvanized Steel Bolts, Nuts, Lock-Nuts; Lock-Washers; Aluminum Post-Clips; Rivets; Aluminum or Nylon Washers—Section 1103.11

**935.3 CONSTRUCTION**—Attach signs to supports, as shown on the Standard Drawings for post mounted signs, Type A, B, C, D, or E, as appropriate.

Band signs or brackets to signal poles, mast arm columns, or luminaire supports.

When mounting as a secondary sign below another sign, install sign at a minimum height of 1.5 m (5 feet) on conventional highways in rural areas; at 2.1 m (7 feet) on conventional highways, on business, commercial, and residential streets where parking or pedestrian movements are likely to occur, or where other obstructions exist; and at 1.5 m (5 feet) on expressways and freeways. Height is measured as the difference in elevation between near roadway edge surface and sign bottom.

Erect the sign in a level position, correctly aligned on the posts, and firmly attached with the necessary mounting hardware.

Permanently scribe 25 mm (1-inch) numerals on the back of sign indicating the month and year of installation.

**935.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot) of sign

The unit price includes removal of existing sign(s), as necessary.

# SECTION 936—STRUCTURE MOUNTED SIGNS

**936.1 DESCRIPTION**—This work is the furnishing and installation of signs of the type indicated, mounted on overhead structures.

**936.2 MATERIAL**—As shown on the Standard Drawings and as follows:

- Extruded Channel Signs and Miscellaneous Material—Section 930.2(a)
- Flat Sheet Aluminum Signs with Stiffeners and Miscellaneous Material—Section 930.2(b)
- Flat Sheet Signs—Section 1103.04
- Other Miscellaneous Material:
  Angles—Section 1103.12(g)
  Angles—Section 1105.02(a)2, galvanized as specified in Section 1105.02(s).

**936.3 CONSTRUCTION**—Section 930.3(h), as shown on the Standard Drawings, and as follows:

Remove existing signs only if indicated. Signs that are removed become property of Contractor unless otherwise indicated.

Erect signs level, position correctly on sign brackets, and attach firmly with the necessary mounting hardware as shown in the Standard Drawings.

Erect signs by a method that does not twist, bend, or otherwise deform the signs. Repair or replace damaged signs.

**936.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Foot) of sign

The unit price includes removal of existing signs and mounting hardware.

# SECTION 937—DELINEATION DEVICES

**937.1 DESCRIPTION**—This work is the furnishing and installation of delineation devices of the type and color indicated.

**937.2 MATERIAL**—Provide delineation devices of the type and color indicated in the TC-8604 Standard Drawings and as listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(a) Barrier Mount.** Provide delineation devices with an anchoring system of pressure-sensitive or epoxy adhesive as recommended by the manufacturer for anchoring the delineation device to the top or side of the barrier.

**(b) Guide Rail Mount.** Provide delineation devices with an anchoring system as recommended by the manufacturer for anchoring to the face or top of the strong or weak post guide rail.

**(c) Post Mount.** Provide delineation devices mounted on flexible posts meeting NCHRP 350 crash test criteria.

**1. Ground Mount.** Provide a ground mount anchoring system for installing flexible delineator posts in the ground or in proposed pavement, median or island.

**2. Surface Mount.** Provide a surface mount anchoring system for installing flexible delineator posts to existing pavements.

**937.3 CONSTRUCTION—**

**(a) General.** Locate delineation devices as indicated, by type and color. Install devices as shown on the Standard Drawings. Verify that the reflective surface of all delineation devices is visible to approaching traffic.

**(b) Barrier Mount.** Install barrier-mount delineators with a pressure-sensitive adhesive or epoxy as recommended by the manufacturer on a section of barrier that is clean and dry.

**(c) Guide Rail Mount.** Install guide rail mounted delineators as indicated for the particular type. Be certain the delineators are securely attached to the face of the guide rail or the top of the guide rail post as recommended by the manufacturer.

**(d) Post Mounts.** Check each post to be certain it is plumb.

**1. Ground Mount.** Drive flexible delineator post soil anchors until the top is flush with the ground. Place soil anchors in proposed pavement, median or island for in-pavement mount. Insert post and secure as recommended by the manufacturer.

**2. Surface Mount.** Install surface mount base anchors on the existing pavement and insert post and secure as recommended by the manufacturer.

**937.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 938—DISTANCE MARKERS

**938.1 DESCRIPTION**—This work is furnishing and installation of distance markers on breakaway steel posts or distance marker supports.

**938.2 MATERIAL**—As shown on the Standard Drawings and as follows:

- Aluminum Blanks—Section 1103.04(a)
- Breakaway Steel Posts—Section 1103.08
- Anti-Theft Hardware—Section 1103.11(m)
- Brackets, Bars, Clamps, Straps and Gussett Plates (Supports)—Section 1103.12(i)

**938.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

The location of an initial marker will be established by the Representative.

Locate the markers in order along both main roadway sides, beginning as directed. Measure to accurately establish the marker locations, in 1.6 km (1-mile) increments, along the outside pavement edge of the northbound or eastbound roadway only. Locate markers on the southbound or westbound roadway, opposite the marker locations established on the northbound or eastbound roadway.

Drive posts or erect supports, , and mount markers. After mounting markers, tighten anti-theft nuts and bolts to ensure a snug fit.

Erect markers facing traffic on distance marker brackets if a marker location is on a structure.

**938.4 MEASUREMENT AND PAYMENT**—Each

The price includes posts and supports.

# SECTION 948—STEEL SIGN STRUCTURE

**948.1 DESCRIPTION**—This work is the construction of overhead steel sign structures of the type indicated.

**948.2 MATERIAL—**

**(a) Cantilever, Centermount, or Span with Single Plane Truss.**

**1. Columns, Struts, and Truss Chords—**

**1.a.** ASTM A 53/A 53M, Grade B, Type E or S

**1.b.** API 5L, Grade B, PSL2 (columns-610mm (24-inches) and greater only), with the following characteristics:

- No jointers permitted
- Process of manufacture: seamless, electric resistance welded, or longitudinal seam, submerged arc welded.
- $f_y$ = 450 MPa (65,000 pounds per square inch), maximum

**2. Truss Webs and Truss Verticals**—ASTM A 53/A 53M, Grade B, Type E or S for tubular members; or Section 1105.02(a)2 for structural shapes.

**3. Steel Angle, Shapes and Plates**—Section 1105.02(a)2

**(b) Span with Tri-Chord or Box-Shaped Truss.** As specified in Sections 948.2(a)1 and 948.2(a)2.

**(c) Tapered Tube Structures.**

- Chord and Column Members—Section 1105.02(a)2
- Steel Angles, Shapes, and Plates—Section 1105.02(a)2

**(d) Fabricated Structural Steel.** Section 1105, except identify on the shop drawings weld locations, type, size, process, and nondestructive testing. Shielded metal arc welding (SMAW), submerged arc welding (SAW), gas metal arc welding (GMAW), and gas-shielded flux cored arc welding (FCAW) are approved. Galvanize as specified in Section 1105.02(s). If necessary, repair base connection welds one time. If more than one repair is necessary, obtain approval. Column base plates must meet a Class C flatness tolerance, as specified in Section 1111, for structures erected directly on a pre-finished concrete foundation using bridge shoe bedding material.

**1.** Perform the following minimum ultrasonic testing of Complete Joint Penetration (CJP) groove welds:

**1.a** 25% of the length of CJP groove welds connecting each flange splice plate to the truss chords, each base plate to the tower columns, each connection plate to the chords or columns, each CJP weld on truss seat plates, and each CJP longitudinal seam weld on cantilever and center-mount sleeves.

- If a rejectable defect is found, then test 100% of the weld on that plate or sleeve.

**1.b** 100% of the groove weld length on at least 25% of the number of similar type connections of web members to the truss chords.

- If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

**2.** Perform the following minimum magnetic particle inspection (MT) of fillet welds and Partial Joint Penetration (PJP) groove welds.

**2.a** Intermediate member connections: MT 100% of the weldment length on at least 25% of the total number of connections on trusses and towers, respectively.

- If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

**2.b** Welds on truss seat plates, base plates, and cantilever and center-mount sleeves, and fillet welds connecting backing rings to base plates and flange splice plates: MT a minimum of 25% of the total length of each weld.

- If a rejectable defect is found, then test 100% of the weld on that element.

**2.c** Welds attaching handhole frames to columns: MT 100% of the length of each weld..

**2.d** All other connections: MT 100% of the weldments on at least 10% of the total number of connections

- If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

**3.** Perform 100% radiographic inspection of complete penetration longitudinal seam welds on tapered tube structures.

**4.** The Department's plant inspector will select weld locations and weldments to be tested.

**5.** Backing rings for full penetration welds must be continuous or butt welded with a full penetration weld. Perform 100% ultrasonic inspection (UI) of butt welds in rings 8 mm (5/16-inch) and thicker. Perform 100% MT on rings less than 8 mm (5/16-inch) thick. Test to AWS D1.5-2002 tension criteria.

**(e) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)3, except anchor bolts shall conform to Grade 379 (Grade 55) only.

**(f) Class A Cement Concrete.** Section 704

**(g) Mortar.** Section 1001.2(d), with a 1-day compressive strength equal to or greater than 26 MPa (3,750 pounds per square inch).

**(h) Reinforcement Bars.** Section 709.1

**(i) Stainless Steel U-Bolts and Washers.** ASTM A 276, Type 304

**(j) Stainless Steel Nuts.** ASTM A 276, Type 303

**(k) High Strength Bolts.** Section 1105.02(d)

- Furnish bolts, nuts, and washers for testing purposes and test as specified in Section 1050.3(c)7.b.

- U-bolts, other than stainless steel, shall conform to ASTM A 449.

**(m) Bedding Material for Bridge Shoes.** Section 1113.03(h)

**(n) Pre-Assembly of Field Connections.** Before galvanizing, preassemble field connections of chord trusses and chord sections to verify geometry and camber. If distortion occurs after galvanizing, re-verify.

**(o) Certification.** Section 106.03(b)3

**948.3 CONSTRUCTION**—As indicated, as shown on the Standard Drawings, and as follows:

**(a) General.** Submit detailed shop drawings for review and acceptance. Material and workmanship not previously inspected will be inspected on the work site. Remove rejected material from the work site. Restore the site to its original condition, including the disposal of excess or unsuitable material.

**(b) Foundations.** Excavate and construct the foundations of Class A cement concrete, as specified in the applicable parts of Section 1001.3.

Use steel templates provided by the fabricator to accurately set tower base anchor bolts to the correct elevation and alignment. Securely brace the bolts against displacement before concrete is placed. Provide conduit sweeps when required.

After constructing the concrete foundations, backfill the excavation around the foundation using acceptable material, in uniform loose layers, not exceeding 100 mm (4 inches) in depth. Compact to the necessary density by means of mechanical tampers.

**(c) Bearing Areas.** Construct the column base bearing areas of concrete pedestals, in a true and level position. Provide full bearing under bases. Place bedding material for bridge shoes, if indicated.

**(d) Cantilever and Centermount Structures.** Adjust cantilever and centermount structures, after the sign panels and lighting are installed, to make the signs level.

**(e) Column and Anchor Bolt Installation.** Clean threads of anchor bolts and nuts before column installation and lubricate as necessary.

Clean, to the satisfaction of the Representative, the top of the concrete pedestals or caissons to ensure that they are free of dirt or other foreign materials.

Install the leveling nut to proper elevation.

Clean top and bottom surfaces of column base plates. Remove any burrs that would prevent proper seating of the connected parts in the snug tight condition.

Install column. Column must fit freely over anchor bolts and be seated on all leveling nuts. Do not force column onto anchor bolts. Adjust leveling nuts to align column in proper position.

Install washers and nuts on top of the column base plate. Apply beeswax or equivalent to all of the top nut bearing surfaces and internal threads.

Bring all nuts into contact with the column base plate. For cantilever structures bring all nuts in to contact with column base plate after column is in final upright position. Tighten top nut to a snug tight condition by sequentially tightening the nuts by initiating and progressing the tightening of the bolts in a pattern whereby a 180-degree opposite side repetition is maintained. Snug tight as specified in Section 1050.3(c)7.d.

Fully tighten the bolts by turning the nuts an additional 30 degrees to 45 degrees. Progress by sequentially tightening the nuts on opposite sides of the base plate (180 degrees apart). Install locking nuts and burr threads of bolts.

Place non-shrink grout.

**(f) Expansion.** Provide a 31 3/4 mm (1 1/4-inch) clearance for expansion of structures mounted between concrete walls. Hand-tighten the nuts on the U-bolts at expansion points on such structures, and then install jam nuts.

**(g) Connections Using High-Strength Bolts.** Section 1050.3(c)7

**948.4 MEASUREMENT AND PAYMENT—**

**(a) Steel Sign Structures.** Lump Sum

The price includes removal of existing signs.

**(b) Class 3 Excavation.** Cubic Meter (Cubic Yard)

**(c) Class A Cement Concrete.** Cubic Meter (Cubic Yard)

**(d) Reinforcement Bars.** Kilogram (Pound)

# SECTION 950—TRAFFIC SIGNALS - GENERAL

**950.1 DESCRIPTION**—These specifications are the general requirements pertaining to the work of furnishing and installing operational traffic signals; including controller assemblies, traffic signal supports, electrical distribution, traffic signal heads, detectors, communications, and systems.

NEMA TS 2 specifications do not supersede NEMA TS 1 specifications, and are to be used separately, as indicated. Comply with current NEMA TS 1 or NEMA TS 2, as specified, unless superseded in part or whole by specific items in these Specifications or special provisions. Words and phrases peculiar to traffic signals that are not defined in these specifications or in the regulations, are to be defined as in NEMA TS 1 or NEMA TS 2.

**950.2 MATERIAL—**

**(a) Materials Acceptance.** Before the submission of a bid proposal, verify that Certificates of Approval, Sale or Provisional, have been issued by the Department, for traffic signal equipment, as provided in 67 PA Code, Chapter 211.

Within three weeks after the Notice to Proceed, submit to the Department, for review and acceptance, a tabulation of all project traffic signal materials. Include the type of material, manufacturer's name, model number, and the Department's Certificate of Approval number for each item to be supplied. Provide catalog cuts for further clarification of the material, when requested. As applicable, tabulate the following:

- Controller Units
- Flasher Units
- Signal Heads
- Detector Amplifiers
- Auxiliary Equipment
- Electrically Operated Signs

**(b) Wiring Diagrams and Timing Plans.** Provide three copies of the cabinet wiring diagram and manufacturer's timing plan for each controller assembly. Place a clear protective envelope in the controller assembly cabinet that contains one copy of the manufacturer's instruction manual for each controller unit, time clock, coordination unit, software programming manuals, time setting charts, wiring diagrams, and parts list. If there are any changes to the timing patterns during the 30-day test, then provide three new copies of a revised timing plan.

**(c) Certification.** As specified in Section 106.03(b)3. Certify that all signal supports satisfy the Department's criteria and are adequate to support the loads indicated. This certification shall include the signature and seal of a Professional Engineer registered in the State. Certify the structural adequacy of all sign and signal brackets.

**(d) Warranties, Instruction Manuals and Guarantees.** Furnish, as specified in Section 1104.01.

**(e) Shop Testing.** Submit results from shop tests to the Representative, as specified in Section 1104.01.

**950.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Perform work according to applicable codes, regulations, and standards.

Existing signals are to remain in operation, as is, until the new traffic signal equipment and devices are in place and operable.

Complete installation of the new system at the earliest possible date. If it becomes necessary to turn off the existing system of signalization, obtain approval and provide flaggers to direct traffic within the intersection during periods when the signals are not operating.

Place temporary poles to support existing signals, as indicated or directed. Provide certification to the Department that such poles have sufficient strength to support the traffic signals.

Make revisions to the existing system of signalization, as indicated or directed.

Before any excavation for placement of traffic signal or sign support poles, mark proposed locations in the field. Field review pole locations with the Representative and adjust pole locations as necessary.

Remove all existing traffic signal supports, including those with traffic signals, flashing warning devices, and lane control signs and signal equipment, unless otherwise indicated.

Maintain existing controller assemblies, as a unit. Store material on the project site. Provide a listing of the equipment for the municipal owner and make arrangements to deliver equipment to the municipal storage area. Do not damage items during removal and storage.

Abandon underground conduit, conductors, and detectors not interfering with new construction. Remove foundations and junction boxes that are designated to be abandoned and are located in an "off traveled roadway" area, to 0.3 m (1 foot) below final grade and dispose of removed materials. Fill, compact, and landscape the resulting hole, including topsoil if necessary by the particular planting.

Repair damage to galvanized finishes.

If any vegetation is blocking the visibility of signs or signals, in the opinion of the Representative, generate and submit a list of items to the Representative. Obtain approval to remove or relocate any of the items.

If not notified by the Representative, notify the Representative as soon as it is recognized that a utility facility is causing, or will cause, an obstruction to visibility.

Before the initial turn-on, verify for the Representative that all signals are working properly. Make the initial turn-on to flashing mode and full operation in the presence of the Representative between the hours of 9 AM and 2 PM, Tuesday through Thursday except holidays. Under special circumstances involving safety of motoring public, the Representative may grant exceptions to this rule. Give the Representative a minimum three-calendar day notice before the initial turn-on. For locations presently unsignalized, flash signals for a period of three to seven days.

After the traffic signal installation becomes operational, conduct a continuous, 24-hour operating test for not less than 30 consecutive calendar days. Correct failures during the test period by repairing or replacing malfunctioning parts or equipment or faulty workmanship regardless of the cause in less than 24 hours as directed. After correcting failures caused by defective equipment, material, or faulty workmanship, re-conduct the 30-day test.

During the 30-day test period, adjust or revise initial signal timing parameters, as directed, to optimize signal operation due to actual traffic flows and field conditions. During this time period, power and communication costs associated with maintaining the operation of the new or modified permanent traffic signal installation will be the responsibility of municipality or other party that will ultimately assume ownership or maintenance of the installation.

In addition to the provisions of Sections 105.10 and 107.10, those Department, Federal, and municipal personnel and agencies, as well as public and private interests, that are involved with the signal installation, have jurisdictional control over the installation or adjacent facilities, or will ultimately assume ownership or maintenance of the installation, shall, at the discretion of the Department, be allowed to observe signal turn-on, installation of initial timing parameters and any subsequent adjustment, and inspection before completion of 30-day test.

Guarantee the in-service operation of mechanical and electrical equipment, related components, and the controller assembly for a period of 180 days from the date of completion of the specified 30-day field test. During this period:

- Maintain equipment in the controller cabinet. Use additional locks, as necessary, to prevent entry by others.
- Repair faulty workmanship, repair or replace defective materials or equipment and correct malfunctions in the controller cabinet within 48 hours after commencing repairs.
- Commence repairs no later than the working day following notification of failures or malfunctions.
- Guarantee repairs or replacements for the balance of the 180-day guarantee period, or 30 days, whichever is the longer period.

- Repair or replacement work not performed within the guarantee period, or any extension period, will be considered latent defects as specified in Section 107.16(b).

Provide the Representative with the name and telephone number of the person to be notified in the event of failures or malfunctions during the guarantee period.

Restore areas damaged by construction.

Issuance of an acceptance certificate or final settlement of the Contract does not in any respect relieve the Contractor of responsibility for the in-service guarantee period described in these Specifications.

**950.4 MEASUREMENT AND PAYMENT**—The removal and storage of existing traffic signal material, the restoration of areas damaged by construction, and testing are incidental to the work specified in Sections 951 through 957.

# SECTION 951—TRAFFIC SIGNAL SUPPORTS

**951.1 DESCRIPTION**—This work is the furnishing and installation of complete and operational traffic signal supports for the mounting of traffic control devices and luminaires.

**951.2 MATERIAL**—Sections 950.2, 1104.01, and 1104.02 and as follows:

- Reinforcement Steel—Section 709.1
- Conduit—Section 1104.05(a)
- Class A Cement Concrete—Section 704
- Ground Rod—Section 1101.11(j)
- Nonshrink Mortar—Section 1001.2(e)
- Premolded Expansion Joint Filler—Section 705.1

Furnish all supports of one type from the same manufacturer unless otherwise directed.

**951.3 CONSTRUCTION**—Section 950.3, as shown on the Standard Drawings, and as follows:

**(a) Excavation.** Before forming and placing concrete, each foundation excavation will be inspected for the actual soil conditions encountered. Do not proceed with the work until the excavation is accepted. If necessary, revise the foundation design based on the soil conditions encountered. Before submitting the revised design for approval, obtain the signature and seal of a Professional Engineer registered in the State. Foundation locations may be changed to avoid underground obstructions, with written permission of the Representative.

**(b) Foundations.** Install reinforcement steel, anchor bolts, conduit sweeps, and ground rods with ground wire clamps. Orient the anchor bolt template to obtain the proper angle of the mast arm. Place concrete as specified in the applicable parts of Section 1001.3.

Backfill around the foundation in 150 mm (6-inch) layers with selected on-site material, then compact mechanically to the density of the undisturbed earth. Dispose of excess or unsuitable material. Place 12.7 mm (1/2-inch) premolded, expansion joint filler between the foundation and existing concrete sidewalks and pavements.

After placing concrete, do not install supports for a minimum of 72 hours.

**(c) Traffic Signal Supports.** Install supports, of the type indicated, on the foundation. Use leveling nuts on the anchor bolts to adjust the support shaft rake to provide a vertical set when the load is added.

Connect the ground wire to the grounding lug.

Install span and tether wires on strain poles. Allow enough span wire and tether wire length to fasten wire and for sag adjustment. After installing signal cable, signal heads, and signs, adjust sag of the span wire.

Check for vertical alignment of the shaft and for alignment of the mast arm after signals, brackets, signs, luminaires, and signal cable are in place. Adjust to the correct alignment.

Tighten anchor nuts, as specified in Section 1105.03.

Place nonshrink mortar. Provide the drain hole in the mortar. Finish mortar vertically at the outside edge of the base plate.

**951.4 MEASUREMENT AND PAYMENT**—Each and as specified in Section 950.4

# SECTION 952—CONTROLLER ASSEMBLY

**952.1 DESCRIPTION**—This work is the furnishing and installation of a traffic signal controller assembly of the type indicated.

**952.2 MATERIAL**—Sections 950.2, 1104.01, 1104.03, 1104.04, and 1104.05 and as follows:

- Class A Cement Concrete—Section 704
- Caulking Compound—Section 705.8(b)

**952.3 CONSTRUCTION**—Section 950.3, as shown on the Standard Drawings, and as follows:

**(a) Controller Assembly.** Install the controller assembly with internal time-base coordination, as indicated. For base-mounted controller assemblies, construct the foundation as specified in Sections 951.3(a) and (b). Connect field wiring for signals, interconnect, and preemption. Connect service to the input/output terminals of the controller assembly. Connect to the equipment safety ground.

Connect the conflict monitor or malfunction management unit to function as specified in Section 1104.03(b). When the controller assembly becomes operational, and during initial turn-on, demonstrate that the conflict monitor or malfunction management unit will cause transfer of the signals to flashing operation upon sensing all possible conflicting signal indications. Conduct the demonstration, as directed, in the presence of the Representative. The 30-day system test shall not begin until the conflict monitor or malfunction management unit is functioning properly.

Before or during the initial turn-on, connect output from shutdown relay to the output and power input of the signal load switches. Connect relay to controller assembly to provide flashing operation with the traffic signal controller unit installed or removed. Provide activation of the shutdown relay from any of the following sources:

- Remove controlled voltage, when indicated
- Police panel switch
- Output from conflict monitor or Malfunction Management Unit

Connect systems and communication control equipment as indicated. Before the 30-day system test, field test for the indicated operation as specified in Section 953.3(b).

**(b) Time Clock.** Install the time clock, when indicated. Connect to input/output terminals of the control equipment. Connect to the equipment safety ground. Field test for indicated operation.

**(c) Connector Harness.** Provide a separate harness and connector that meets NEMA Standards and is wired for the maximum phase capability of the controller unit.

**952.4 MEASUREMENT AND PAYMENT**—Each and as specified in Section 950.4 for the type indicated:

**(a) Controller Assembly.** Each
The price includes required Buss Interface Unit (BIU) and detector card rack assembly, excluding TS1.

**(b) Time Clock.** Each

# SECTION 953—TRAFFIC SIGNAL SYSTEMS

**953.1 DESCRIPTION**—This work is the furnishing and installation of the system equipment for the control of traffic signals.

**953.2 MATERIAL**—Sections 950.2, 1104.01, and 1104.04 and as follows:

- Class A Cement Concrete—Section 704
- Caulking Compound—Section 705.8(b)

**953.3 CONSTRUCTION**—Section 950.3 and as follows:

**(a) Master Controller Assembly.** Section 952.3

**(b) System Testing.** Conduct a separate 30-day operations test on the system and communications. Test the entire system for the indicated operation, including proper operation and communication between local controller assemblies, master controller assemblies, and other necessary remote control or monitoring equipment. System test includes hardware and software used for control, communication, or monitoring. During the 30-day system test, change inputs, outputs, and programming controls, and adjust or revise initial signal timing parameters, as directed.

**(c) System Training.** Provide initial system training during the first week of the 30-day system test.

**953.4 MEASUREMENT AND PAYMENT**—Section 950.4 and as follows:

**(a) Master Controller Assembly.** Each
For the type indicated.

**(b) System Training.** Lump Sum
Of the type indicated.

# SECTION 954—ELECTRICAL DISTRIBUTION

**954.1 DESCRIPTION**—This work is the furnishing and installation of the electrical distribution for the control and illumination of traffic signals.

**954.2 MATERIAL**—Sections 950.2, 1104.01, and 1104.05

**954.3 CONSTRUCTION**—Section 950.3, as shown on the Standard Drawings, and as follows:

**(a) Conduit Trench and Backfill.** Excavate and backfill as specified in the applicable parts of Section 910.3(c). Cut existing pavement only when indicated.

Restore existing pavement. For flexible pavement, use bituminous material of a type equal to the existing pavement, as determined by the Representative. For rigid pavement, use High Early Strength Cement Concrete as specified in Section 704.1.

**(b) Conduit.** Install as specified in the applicable parts of Section 910.3(g) and as follows:

If allowed by the Inspector-in-Charge, indicated conduit runs may be changed to avoid underground obstructions.

Install conduit as indicated. Maintain at least a 300 mm (12-inch) separation between conduit and other underground utilities. Install high-impact, plastic spacers a maximum of 2.4 m (8 feet) on center, if more than two rigid, nonmetallic conduits are to be installed in a common trench.

**(c) Bonding and Grounding.** Bond and ground all electrical equipment as indicated, as shown on the Standard Drawings, as specified in the applicable parts of Section 910.3(q), and as follows:

Provide a continuous mechanical and electrical grounding system from the controller assembly through the electrical distribution system.

Bridge grounding bushings on rigid metallic conduit.

Thread bonding bushings on the free ends and lock in place with stainless steel set screws, lug mountings, and binding screws.

**(d) Signal Cable and Wire.**

**1. General.** Install indicated cable to form a continuous circuit between the proper equipment terminals. Install cables inside supports and brackets.

Insert cable in conduit using lubricant. If new cable is to be installed in conduit with existing conductors, remove the existing cable, clean the conduit, as specified in Section 910.3(g), and then insert both old and new cable into the conduit as a unit. Replace existing cable damaged during removal as directed.

Use insulated, locking, spade terminals for conductor terminations. Neatly arrange conductors and tie with cable ties within fixtures. Attach cable tags at splices, indicating phase and function, within all junction boxes, pole bases, and cabinets.

Terminate all spare signal conductors collectively with a pressure-type mechanical lug and cover with electrical tape. Ground spare conductors.

Attach conductor terminations in controller cabinets to barrier-type terminal blocks with no more than one conductor per screw, otherwise use pressure-type mechanical lugs to accommodate the number of conductors being terminated. Identify and mark blocks.

Terminate on grounding bus and identify spare and reserved conductors.

Provide enough slack cable in pole bases, controller cabinets, and junction boxes to allow for proper wiring connections. For pole mounted signals and pedestrian pushbuttons, install signal cable inside pole to the terminal block of the signal or pushbutton.

For span wire installations, lash cable to the span wire.

Provide drip loops at wire entrances to poles and signal heads. Secure drip loops with outdoor-type, self-locking cable ties.

**2. Conductor Color Codes.**

**2.a Pedestrian Pushbutton.**

| | | |
|---|---|---|
| Cable | 1 Black | —Spare* |
| | 2 White | —Logic Ground |
| | 3 Red | —Pedestrian Call Detector |

**2.b Pedestrian Signal.**

| | | |
|---|---|---|
| 5/C Cable | 1 Black | —Walking Person (Walk) |
| | 2 White | —Neutral |
| | 3 Red | —Upraised Hand (Don't Walk) |
| | 4 Green | —Reserved |
| | 5 Orange | —Spare* |
| 7/C Cable | 1 Black | —Walking Person (Walk 1) |
| | 2 White | —Neutral 1 and 2 |
| | 3 Red | —Upraised Hand (Don't Walk 1) |
| | 4 Green | —Reserved |
| | 5 Orange | —Walking Person (Walk 2) |
| | 6 Blue | —Upraised Hand (Don't Walk 2) |
| | 7 White/Tracer | —Spare* |

**2.c Vehicular Signal.**

| | | |
|---|---|---|
| 5/C Cable | 1 Black | —Green Ball/Arrow |
| | 2 White | —Neutral |
| | 3 Red | —Red Ball |
| | 4 Green | —Reserved |
| | 5 Orange | —Yellow Ball/Arrow |
| 7/C Cable | 1 Black | —Green Ball |
| | 2 White | —Neutral |
| | 3 Red | —Red Ball |
| | 4 Green | —Reserved |
| | 5 Orange | —Yellow Ball |
| | 6 Blue | —Green Arrow |
| | 7 White/Tracer | —Yellow Arrow/Spare* |

* Or as indicated.

**(e) Electrical Service.** Install the conduit and service wire where indicated and consistent with the service type. Perform necessary circuit connections to complete service to the controller assembly as shown on the Standard Drawings.

Install power service outlets in cabinet as specified in Section 1104.03(g) and the NEC.

Install service pole as specified in Section 910.3(k) and as shown on the Standard Drawings.

Verify with the utility company the location of the service conduit on the service pole or to the service manhole. Notify the utility company of service requirements. Ensure that service is inspected as required by the utility.

**(f) Splicing.** Splice wires and cables only at the following locations:

- ground wires within junction boxes;
- signal wires and cables in pole bases; and

- places, where indicated, if existing traffic signals are being modified.

When splicing signal cables within pole bases, use wire nuts sealed with waterproof resin.

**(g) Junction Box.** Section 910.3(p)

**(h) Ground Rods.** Install ground rods and ground wire clamps as shown on the Standard Drawings.

**(i) Testing.** Test traffic signal wiring circuits after installation of the electrical distribution system, before connecting to operating equipment, and in the presence of the Representative. Demonstrate to the Representative that:

- circuits are continuous and free from short circuits;
- circuits are free from unspecified grounds; and
- the resistance to earth-ground is not more than 25 ohms. Supply and install additional ground rods until this requirement is met or as directed. Install additional rods at least one ground rod length from any other rod. Use an ohm meter designed for testing earth-ground resistance.

**(j) Field Wiring Diagrams.** Submit three copies.

**954.4 MEASUREMENT AND PAYMENT**—Section 950.4 and as follows:

**(a) Conduit.** Meter (Linear Foot)
For the type indicated.

**(b) Trench and Backfill.** Meter (Linear Foot)
For the type indicated.

**(c) Signal Cable.** Meter (Linear Foot)
The unit price includes cable, identification tags, and cable lashing.

**(d) Junction Box.** Each
For the type indicated.

**(e) Electrical Service.** Each
For the type indicated.
The price includes service pole, service head, meter socket, service disconnect, power line surge protector, exposed conduit, conduit fittings, service wire, ground rod, and ground wire.

# SECTION 955—SIGNAL HEADS

**955.1 DESCRIPTION**—This work is the furnishing and installation of assemblies for the control and illumination of vehicular traffic signals or pedestrian signals.

**955.2 MATERIAL**—Sections 950.2, 1104.01, and 1104.06.

**955.3 CONSTRUCTION**—Section 950.3, as shown on the Standard Drawings, and as follows:

**(a) General.** Securely mount signal heads, using signal mounting brackets, where indicated, and according to the regulations. Install signal heads over roadways with the top of the housings at the same elevation and as shown on the Standard Drawings. Where vehicular and pedestrian signals are to be installed on the same support, separate the assemblies. Aim vehicular signal heads, as directed, toward a point approximately 45 m (150 feet) in advance of the stop line and in the center of the traveled traffic approach. Aim pedestrian signals to the far side of the crosswalk they are to control. Securely cover signals with an opaque material that covers and hides signal indicators from the view of traffic until the signal is put into operation. Use material that is sufficiently opaque to hide any lighted signal face indication. Burlap may be used as a hood material if the signal indications are not lighted and will not be until the hood is removed. Maintain the hood and replace or repair the hood if it becomes loose, torn, or removed.

**(b) Light Emitting Diode (LED) Modules.** Install, or retrofit into existing signal heads, according to manufacturer's instructions.

**(c) Incandescent Lamps.** Install lamps securely in the socket and according to manufacturer's instructions. Rotate the socket until the lamp filament opening is up. Install lenses and gasket, with lens marking (top) properly oriented, and then tighten locking tabs.

**(d) Optically Programmed Signals.** According to the manufacturer's instructions, program each signal head to restrict signal visibility to the area indicated.

**(e) Programmable Louvered Head.** According to the manufacturer's instructions, program each signal head to restrict signal visibility to the area indicated.

**955.4 MEASUREMENT AND PAYMENT**—Section 950.4 and as follows:

**(a) Vehicular Signal Heads.** Each
For the type indicated.
The price includes, when indicated, louvers and backplates.

**(b) Optically Programmed Signal Heads.** Each
For the type indicated.
The price includes, when indicated, louvers and backplates.

**(c) Pedestrian Signal Heads.** Each
For the type indicated.
The price includes, when indicated, louvers and backplates.

**(d) Lane-Use Traffic Control Signal Heads.** Each
For the type indicated.
The price includes, when indicated, louvers and backplates.

**(e) Programmable Louvered Head.** Each
For the type indicated.

# SECTION 956—DETECTORS

**956.1 DESCRIPTION**—This work is the furnishing and installation of devices to sense the presence or passage of vehicles or pedestrians.

**956.2 MATERIAL**—Sections 950.2, 1104.01, and 1104.07

**956.3 CONSTRUCTION**—Section 950.3, as shown on the Standard Drawings, and as follows:

**(a) Loop Detector.** Saw cut slots in the pavement for the sensor, as indicated. Rotary drill a hole for the conduit at curb. Blow the slot and hole free of moisture and debris. Install the conduit. Install the number of sensor turns to obtain the inductance required by the manufacturer to achieve proper operation, without splices, kinks, or curls, and without straining or stretching around the corners of the slot. Install a minimum of two turns of wire for each loop detector. Use a blunt nonmetallic tool to seat the sensor in the bottom of the slot. Check for slack, raised portions, and tightness. Correct if necessary. Insert the two leads from the loop, twisted together a minimum of 10 turns per meter (3 turns per foot), in the conduit leading to the junction box. Test leakage resistance, series resistance, and inductance before sealing the sawcut slot. Leakage resistance greater than 10 megohms is necessary when tested at 375 V(dc) minimum. Series resistance is not to exceed 2.6 ohms per 300 m (1,000 feet). Inductance is to be between 50 microhenries and 700 microhenries. Seal the conduit with duct seal. Seal the hole and slots with sealant, according to the manufacturer's instructions. Do not apply the sealant if the air temperature is below 7 °C (45F), or during precipitation. Fill the slot to within 3 mm (1/8 inch) of the pavement surface and ensure that there are no voids. Do not allow traffic on the slot until the sealant is cured. Remove excess sealant from adjacent road surfaces, but do not use solvents.

If the contract includes resurfacing in the loop area, install the sensor in the existing pavement structure or in the binder course before placement of the wearing course. Do not install the top course of pavement before the sealant is cured.

Splice the sensor wires to the lead-in cable as shown on the Standard Drawings. Encapsulate the splice with sealant to prevent water from penetrating the splice. Connect the sensor to each lead-in pair, as indicated. Band all excess loop sensor/lead-in cable in the junction box to prevent movement resulting in false calls. Extend the lead-in cable to the terminal strip in the controller cabinet, without splices. Measure inductance of loop and lead-in. Inductance is to be between 50 microhenries and 700 microhenries. Place a record of the inductance readings in the controller cabinet. Connect to the loop detector amplifier. Adjust the amplifier, according to the manufacturer's instructions, to obtain the necessary sensitivity.

**(b) Magnetometer Detector.** Before installation, conduct the manufacturer’s test to determine if the earth’s magnetic flux at the point of installation is sufficient for the detector to operate. Rotary drill a hole in the pavement for the sensor. Saw cut slots for the lead, as indicated. Rotary drill a hole for the conduit at curb. Blow the holes and slot free of moisture and debris. Install the conduit. Insert the sensor vertically in the hole. Then insert the lead wire in the slot and in the conduit leading to the junction box. Use a blunt nonmetallic tool to seat the wires in the bottom of the slot. Test leakage resistance and series resistance. Leakage resistance greater than 10 megohms is necessary. Series resistance is not to exceed 2.6 ohms per 300 m (1,000 feet). Backfill the sensor hole, then seal the holes and slot with sealant, according to the manufacturer's instructions. Do not apply the sealant if the air temperature is below 7 °C (45F), or during precipitation.

Complete the installation for the magnetometer detector, as specified in Section 956.3(a).

**(c) Magnetic Detector.** Bore a tunnel, without disturbing the pavement, from the junction box to a point approximately 0.6 m (2 feet) beyond the centerline of the detection zone. Bore a diameter only large enough to insert the conduit. Repair any damage to the roadway caused by boring. Insert the capped, rigid, nonmetallic conduit in the tunnel, using a proper lubricant if necessary. Insert the sensor within the conduit. Test leakage resistance and series resistance. Leakage resistance greater than 10 megohms is necessary. Series resistance is not to exceed more than 2.6 ohms per 300 m (1,000 feet).

Complete the magnetic detector installation, as specified in Section 956.3(a). Adjust the location of the sensor to obtain proper operation.

**(d) Pedestrian Pushbutton.** Install the pedestrian pushbutton and indicated sign, using stainless steel vandal-resistant, machine screws, rivets, or stainless steel banding taking care not to impair the message on the sign. Ensure that the pushbutton and sign is right side up. Drill and tap mounting holes of the size and pattern specified by the manufacturer. Drill and deburr the cable entrance hole. Connect the pushbutton according to the manufacturer's instructions, as indicated, and as shown on the Standard Drawings. Provide sealant above pushbutton where it abuts connecting support.

Field-test the operation by activating the pushbutton and performing a visual check of the controller indicator lights and a timing check of the pedestrian phase or phase extension.

**(e) Microwave Sensor.** Install and mount according to the manufacturer's instructions to provide area of detection and operation as indicated without detecting conflicting movements. Secure sensors using appropriate mounting brackets as required by the manufacturer.

**(f) Video Detector.** Install and mount according to the manufacturer's instructions to provide area of detection and operation as indicated without detecting conflicting movements. Secure detectors using appropriate mounting brackets as required by the manufacturer. Adjust and realign video detector as necessary to obtain optimal detection zone. Mount at a minimum height of 9 m (30 feet) above the roadway.

**956.4 MEASUREMENT AND PAYMENT**—Section 950.4 and as follows:

**(a) Detector Lead-In Cable.** Meter (Linear Foot)

**(b) Detector Card Rack Assembly.** Each
Unless provided as part of new controller assembly.

**(c) Loop Sensors.** Meter (Linear Foot)
The Contractor will measure along sawcut to where it enters conduit.
The sensor in conduit is incidental to the payment for conduit.

**(d) Loop Amplifiers.** Each
For the type indicated.

**(e) Magnetometer Sensor.** Each

**(f) Magnetometer Amplifiers.** Each
For the type indicated.

**(g) Magnetic Sensors.** Each

**(h) Magnetic Amplifiers.** Each
For the type indicated.

**(i) Pedestrian Pushbuttons.** Each
The price includes signs and mounting hardware.

**(j) Microwave Sensor.** Each
The price includes cable, controller interface, and mounting hardware for complete installation.

**(k) Video Detector.** Each
The price includes cable, controller interface, video monitor for setting up detection zone, mounting hardware, and all software for complete installation.

# SECTION 957—TRAFFIC SIGNAL COMMUNICATIONS

**957.1 DESCRIPTION**—This work is the furnishing and installation of equipment to provide communication between controller assemblies in a system.

**957.2 MATERIAL**—Sections 950.2, 1104.01, and 1104.08

**957.3 CONSTRUCTION**—Section 950.3, the applicable requirements of Section 954.3, as shown on the Standard Drawings, and as follows:

**(a) Cable.** Install cables and hardware as required.
Do not splice cables, except at terminal strips. Test the cables, as specified in Section 954.3(i), as applicable.

**957.4 MEASUREMENT AND PAYMENT**—Section 950.4 and as follows:

**(a) Control Cables.** Meter (Linear Foot)

**(b) Communications Cables.** Meter (Linear Foot)

**(c) Instrument Cables.** Meter (Linear Foot)

# SECTION 960—HOT THERMOPLASTIC PAVEMENT MARKINGS

**960.1 DESCRIPTION**—This work is the furnishing and installation of hot thermoplastic pavement markings, of the indicated type and color with a surface application of glass beads.

**960.2 MATERIAL—**

**(a) General.** Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(b) Thermoplastic.** AASHTO M 249. Provide a material listed in Bulletin 15.

**(c) Glass Beads.** Section 1103.14, Type A

1. **Intermix.** Provide sufficient uncoated glass beads to comprise 40% of the marking material by mass (weight).

2. **Surface-applied.** Moisture resistant coated with a maximum of 5% passing the 180 µm (No. 80) sieve and a minimum of 70% rounds per sieve and a minimum or 80% rounds overall.

**960.3 CONSTRUCTION—**

**(a) General.** For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the hot thermoplastic pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Surface preparation is incidental to the application of hot thermoplastic pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 12 m (40-foot) intervals. The Inspector-in-Charge will approve the locations. Apply on dry pavement when the air and roadway temperatures are between 10 ºC and 32 ºC (50F and 90F) and when the wind speed is less than 32 km/h (20 miles per hour).

**(b) Application.** Uniformly apply the markings at a minimum thickness of 2.3 mm ± 0.08 mm (90 mils ± 3 mils). A tolerance of ± 6 mm (± 1/4 inch) from the specified width will be allowed provided the variation is gradual and does not detract from the general appearance. For skip line patterns maintain a tolerance of ± 150 mm (± 6 inches) for each 12 m (40-foot) cycle and ± 75 mm (± 3 inches) for each 3 m (10-foot) skip line.

**(c) Glass Beads.** Apply glass beads immediately after application of the markings at a minimum rate of 4.5 kg/9 $m^2$ (10 pounds per 100 square feet) of markings. Uniformly distribute glass beads on the surface. Provide markings with an average minimum initial retroreflectivity of 300 mcd/$m^2$/lux for white and 250 mcd/$m^2$/lux for yellow. Under the direction and supervision of the Representative, measure retroreflectivity with a 30-meter geometry retroreflectometer, conforming to ASTM E-1710 within 21 days after installation in accordance with PTM No. 431.

**(d) Defective Markings.** Remove any markings placed incorrectly and replace them. Repair those markings, which after application and drying, are determined to be defective by the Inspector-in-Charge. Complete this work at no additional cost to the Department. Major problem areas and method of repair include the following:

- Insufficient thickness or line width, uneven cross-section─Prepare defective material by grinding or blast cleaning to remove a substantial amount of beads and the marking surface is roughened. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in Sections 960.3(b) and (c).

- Inadequate retroreflectivity, glass bead coverage or retention─Remove defective markings and clean pavement surface, including 300 mm (1 foot) beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in Sections 960.3(b) and (c).

**(e) Guarantee.** Where directed, remove and replace material that has not remained within close conformity to location or has not remained effective in performing useful service in accordance with Section 107.16(b) for a period of 180 days from the date of acceptance. The minimum acceptable service is as follows:

- **Longitudinal Markings.** 90% of material remains in each 305 m (1,000-foot) section of marking where the intersection unit is defined as material on an approach leg within 50 m (160 feet) of the intersection.

- **Transverse Markings, Legends, and Symbols.** 90% of material remains for each individual legend, symbol, crosswalk, or stop line.

**960.4 MEASUREMENT AND PAYMENT—**

**(a) Line.** Meter (Linear Foot)

**(b) Legend.** Each

# SECTION 961—COLD PLASTIC PAVEMENT MARKINGS OR LEGENDS

**961.1 DESCRIPTION**—This work is the furnishing and installation of plastic pavement markings or legends, of the type indicated.

**961.2 MATERIAL**—ASTM D 4505. When required, provide compatible "adhesive activator" or "primer sealer," as listed in Bulletin 15 or as recommended by the manufacturer.

**961.3 CONSTRUCTION—**

**(a) General.** For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the cold plastic pavement markings or legends will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Use a cleaning method that includes, as a last operation, the use of compressed air over the application area to provide a dust-free surface. Surface preparation is incidental to the application of cold plastic pavement markings or legends, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings. The Inspector-in-Charge will approve the locations. Apply on dry pavement when the roadway temperature is greater than or equal to 16 °C (60F), unless, unless otherwise directed.

Apply according to the manufacturer's instructions.

Provide applicator units, manual or automatic, that are capable of applying two parallel lines simultaneously with a 150 mm (6-inch) space between the lines.

**(b) Retroreflectivity.** Provide markings with an average minimum initial retroreflectivity of 250 mcd/m²/lux for white and 200 mcd/m²/lux for yellow. Under the direction and supervision of the Representative, measure with a 30-meter geometry retroreflectometer conforming to ASTM E-1710 within 21 days after installation in accordance with PTM No. 431.

**(c) Inlaid.** Applied as part of a bituminous resurfacing project. Place the material, with a thickness of 1.5 mm ± 0.1 mm (60 mils ± 2 mils) to 2.25 mm ± 0.1 mm (90 mils ± 3 mils), on the pavement before final compaction and within the temperature range specified by the manufacturer. Roll the material into the new surface to achieve a flush finished surface.

**(d) Surface Applied.** Apply the material with a thickness of 1.5 mm ± 0.1 mm (60 mils ± 2 mils), onto the existing, cleaned surface of concrete or bituminous roadways.

**(e) Guarantee.** Where directed, remove or replace material that in accordance with Section 107.16(b) has not remained within close conformity to location or has not remained effective in performing useful service for a period of 180 days from the date of acceptance. The minimum acceptable service is as follows:

- **Longitudinal Markings.** 90% of material remains in each 305 m (1,000-foot) section of marking where the intersection unit is defined as material on an approach leg within 50 m (160 feet) of the intersection.

- **Transverse Markings, Legends, and Symbols.** 90% of material remaining for each individual legend, symbol, crosswalk, or stop line.

**961.4 MEASUREMENT AND PAYMENT—**

**(a) Line.** Meter (Linear Foot)

**(b) Plastic Legend.** Each

# SECTION 962—WATERBORNE PAVEMENT MARKINGS

**962.1 DESCRIPTION**—This work is the furnishing and application of waterborne pavement markings, of the type and color indicated.

**962.2 MATERIAL—**

**(a) General.** Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(b) Paint.** Provide waterborne traffic paints listed in Bulletin 15.

**(c) Glass Beads.** Section 1103.14, furnish Type A glass beads unless otherwise specified.

**962.3 CONSTRUCTION—**

**(a) General.** At least 5 days before beginning work, provide the Inspector-in-Charge with a schedule of operations. In addition, provide the Inspector-in-Charge with the manufacturer's instruction for the installation of the materials, application temperatures, proper mixing techniques, and any other data to ensure the material is being properly installed.

**(b) Equipment.**

**1. Line Application.** Use a machine that is:

- Capable of simultaneously applying two parallel lines of the width indicated in solid or broken patterns or various combinations thereof;
- Capable of automatically dispensing glass beads onto the painted surface, at the required application rate, by the pressurized gun method; and
- Equipped with a measuring device, which automatically and continuously measures the length of each line placed, to the nearest meter (foot).

**2. Legend Application.** Include crosswalks, symbols, legends, stop lines, and other miscellaneous items. Do not apply with hand brushes or rollers. Glass beads may be hand-applied.

**(c) Application Rates.**

**1. Paint.** Dispense at a wet-film thickness of 380 µm ± 30 µm (15 mils ± 1 mil) for all markings, except edge line markings are 300 µm ± 30 µm (12 mils ± 1 mil).

**2. Glass Beads.** Apply at a rate of 0.84 kg/L (7 pounds per gallon) of paint.

**3. Calibration.** Use a machine calibrated as follows:

- **Line Measuring Device .** Calibrate automatic line length gauges to maintain a tolerance of ± 4.75 m per 1 km (± 25 feet per mile).
- **Cycle Length/Line Timer .** Calibrate cycle length in a tolerance of ± 150 mm per 12 m (6 inches per 40 feet); calibrate line length to maintain a tolerance of ± 75 mm per 3 m (3 inches per 10 feet).

- **Bead Guns .** Calibrate to dispense glass beads at the specified rate. Check by dispensing glass beads into a gallon container for a predetermined fixed period of time. Verify the mass (weight) of glass beads.

- **Paint Guns .** Calibrate to simultaneously apply the paint at the uniform rates specified with an allowable tolerance of ± 30 mm (1 mil) and with an allowable width tolerance of ± 6 mm (1/4 inch).

**(d) Surface Preparation.** Clean the roadway surface where the waterborne pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the area to be painted with compressed air. Surface preparation is incidental to the application of waterborne pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 12 m (40-foot) intervals. The Inspector-in-Charge will approve the locations.

**(e) Temperature Restriction.** Apply on a dry pavement with minimum ambient and pavement temperatures of 10 ºC (50 F) and a maximum relative humidity of 80%. Confirm the proper atmospheric and pavement surface conditions with the Inspector-in-Charge.

**(f) Protection of Painted Surfaces.** Provide protection to allow adequate time for the markings to dry and be track-free from vehicular traffic. Follow the manufacturer's recommendations or use a minimum of 30 minutes. Use barrier cones to protect markings that do not dry in less than 2 minutes on a roadway where traffic is maintained. Repaint marked or damaged areas, as directed.

**(g) Centerline Application.** Locate and place as indicated and as follows:

Avoid placing markings on longitudinal pavement joints and seams. Where existing centerlines are visible and properly located, apply directly over the existing pattern.

Where centerlines do not exist or existing centerlines are improperly located, apply at the correct location, as determined by the Inspector-in-Charge. Remove the improperly located existing markings, as specified in Section 963.3.

Divide the roadway on two-lane roadways. However, if a portion of the roadway on either or both sides is to be used for parking, then divide the traveled way.

**(h) Edgeline Application.** Do not place markings on joints or seams between the traveled way and shoulder.

**(i) Retroreflectivity.** Provide markings with an average minimum initial retroreflectivity of 250 mcd/m$^2$/lux for white and 165 mcd/m$^2$/lux for yellow. Under the direction and supervision of the Representative, measure with a 30-meter geometry retroreflectometer conforming to ASTM E-1710 within 21 days after installation in accordance with PTM No. 431.

**(j) Defective Work.** Remove and replace any markings placed incorrectly. Repair those markings, which after application and drying, the Inspector-in-Charge determines to be defective. Complete this work at no additional cost to the Department. Major types of defective work and method of repair include the following:

- **Insufficient thickness or line width, uneven cross-section .** Grind or blast clean defective material to remove a substantial amount of beads and to roughen the marking surface. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in this specification.

- **Inadequate retroreflectivity, glass bead coverage or retention .** Restripe over defective marking.

- **Poor Adhesion, Delaminating.** Remove defective markings as specified in Section 963.3 and clean pavement surface, including 300 mm (1 foot) beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in this specification.

**(k) Guarantee.** Guarantee pavement marking material against failure due to premature wear or poor adhesion resulting from defective materials or method of application in accordance with Section 107.16(b) for a period of 90 days from the date of acceptance.

**962.4 MEASUREMENT AND PAYMENT—**

**(a) Line.** Meter (Linear Foot)

**(b) Legend.** Each

# SECTION 963—PAVEMENT MARKING REMOVAL

**963.1 DESCRIPTION**—This work is the removal of pavement markings and legends.

**963.3 CONSTRUCTION**—Remove existing pavement markings, as indicated, immediately before any change in traffic patterns or before the application of final markings. Remove markings that conflict with revised traffic patterns and may confuse motorists. Do not paint over existing lines with black paint.

Remove markings for restriping to the extent that 90% of the material is removed without materially damaging or grooving the pavement surface more than 0.8 mm (1/32 inch). For all other marking removal, eliminate the markings to the extent that the marking is not visible to motorists when viewed from a distance of 15 m (50 feet). Remove waterborne pavement markings by sandblasting, grit blasting, steel shot blasting, or waterblasting. Grinding is acceptable only for the removal of thermoplastic, cold plastic, or epoxy marking materials. Obtain approval from the Representative for the proposed removal method before beginning work.

Vacuum or collect residue, including sand, dust, and marking material, concurrently with the removal operation unless alternate procedure is submitted and accepted. Clean the area of dust with compressed air. Perform this work only in the area where the markings are to be applied. Do not allow sand, dust, or other residual material, which may interfere with drainage or constitute a traffic hazard, to accumulate. Dispose of all residue in an acceptable manner.

Repair any pavement or surface damage caused during the removal process.

Prevent damage to transverse and longitudinal joint sealers, and repair any damage as specified in Section 513.

**963.4 MEASUREMENT AND PAYMENT—**

**(a) Lines.**

1. Meter (Linear Foot)
2. Square Meter (Square Foot)

**(b) Legends.**

1. Each
2. Square Meter (Square Foot)

# SECTION 964—EPOXY PAVEMENT MARKINGS

**964.1 DESCRIPTION**—This work is the furnishing and installation of reflectorized, two-component epoxy resin pavement markings of the color indicated, with glass beads, at the locations indicated.

**964.2 MATERIAL—**

**(a) General.** Provide materials approved by the Department, from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(b) Epoxy Resin.** Provide only those epoxy materials listed in Bulletin 15. Do not use polluting solvents or fillers.

**1. Color.** Furnish white and yellow pavement markings that satisfy the following chromaticity coordinates:

| | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| | x | y | x | y | x | y | x | y |
| **White** | 0.330 | 0.370 | 0.355 | 0.345 | 0.310 | 0.300 | 0.285 | 0.325 |
| **Yellow** | 0.515 | 0.465 | 0.505 | 0.430 | 0.440 | 0.415 | 0.420 | 0.443 |

Furnish black epoxy that satisfies color chip 37038 of Federal Standard 595B and is equal to the quality of the white epoxy being used.

**2. No Track Time.** Dry to a no-track condition in 10 minutes or less when tested according to ASTM D 711 at a temperature of 24 ºC ± 1 ºC (75F ± 2F) at a thickness of 500 µm ± 30 µm (20 mils ±1 mil) with glass beads applied at a rate of 2.4 kg/l (20 pounds per gallon) of epoxy.

**(c) Glass Beads.** Section 1103.14.

**(d) Black Aggregate.** Furnish with the following gradations:

| Sieve Size | Retained (%) |
|---|---|
| 850 µm (No. 20) | 17-37 |
| 600 µm (No. 30) | 45-65 |
| 425 µm (No. 40) | 14-25 |

**964.3 CONSTRUCTION—**

**(a) Equipment.** Provide application equipment with a system capable of:

- Spraying epoxy material mixed in the proper formulation conforming to manufacturer's requirements.
- Applying symbol markings and longitudinal lines with the specified glass bead application.
- Heating Epoxy Part A to satisfy manufacturer's recommendations.
- Heating Epoxy Part B to satisfy manufacturer's recommendations.
- Mixing Part A with Part B according to manufacturer's recommendations.
- Applying glass beads using the double drop method.

Provide an operator for the equipment who is fully knowledgeable of all equipment operations and application techniques. Provide a pressure gauge on each proportioning pump to verify pressures. Position these gauges to be easily visible to the operator of the equipment and the Inspector-in-Charge.

Obtain from the manufacturer of the epoxy material being used, specifications for the proper mix ratios of the epoxy component, proper temperatures, proper mixing techniques, and any other data to ensure that the epoxy material is being properly installed. Furnish this information to the Inspector-in-Charge at least 5 days before beginning work.

**(b) Procedures.**

**1.** For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the epoxy pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Surface preparation is incidental to the application of epoxy pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 12 m (40-foot) intervals. The Inspector-in-Charge will approve the locations.

**2.** Before starting work, furnish four sample plates of each color of materials used. Prepare two plates with and two plates without glass beads or aggregate.

**3.** Uniformly apply the epoxy markings at a wet thickness of 500 µm ± 30 µm (20 mils ± 1 mil). A tolerance of ±6 mm (1/4 inch) from the indicated width will be allowed provided the variation is gradual and does not detract from the general appearance. For skip line patterns maintain a tolerance of ± 150 mm for 12 m (±6 inches for each 40-foot) cycle and ±75 mm for 3 m (±3 inches for each 10 foot) skip line.

**4.** Apply glass beads immediately after application of the epoxy markings. Use the double drop method with a minimum rate of 1.2 kg/L (10 pounds per gallon) for Type A beads and 1.2 kg/L (10 pounds per gallon) for Type B beads for a total minimum of 2.4 kg/L (20 pounds per gallon) of epoxy. Uniformly distribute glass beads on the surface. Provide markings with an average minimum initial retroreflectivity of 250 mcd/$m^2$/lux for white and 200 mcd/$m^2$/lux for yellow. Under the direction and supervision of the Representative measure retroreflectivity with a 30-meter geometry retroreflectometer conforming to ASTM E-1710 within 21 days after installation in accordance with PTM No. 431.

**5.** After the application of epoxy material and glass beads, protect the markings from traffic for a minimum period of 30 minutes or until the epoxy has dried sufficiently to prevent dirt pickup or tracking.

**6.** Apply black epoxy markings on cement concrete roadways. Place the black markings, flooded with black aggregate, immediately after all white skip line patterns. Use the same line dimensions for both colors.

**7.** Install epoxy on dry pavement only if the road surface and ambient temperatures are 4º C (40 F) or higher unless otherwise approved by the Inspector-in-Charge and acceptable to the manufacturer.

**(c) Defective Markings.** Remove and replace any markings placed incorrectly. Repair those markings, which after application and drying, the Inspector-in-Charge determines to be defective. Complete this work at no additional cost to the Department. Major types of defective work and method of repair include the following:

- **Insufficient thickness or line width, uneven cross-section .** Grind or blast clean defective material to remove a substantial amount of beads and to roughen the marking surface. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in this specification.

- **Inadequate retroreflectivity, glass bead coverage or retention .** Restripe over defective Marking.

- **Poor Adhesion, Delaminating.** Remove defective markings as specified in Section 963.3 and clean pavement surface, including 300 mm (1 foot) beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in this specification.

**(d) Guarantee.** Guarantee 90% of the pavement marking material against failure due premature wear or poor adhesion resulting from defective materials or method of application in accordance with Section 107.16(b) for a period of 180 days from the date of acceptance.

The Representative will identify material to be repaired or replaced.

Begin all repair or replacement work within 30 days of notification by the Representative and perform as specified in these specifications.

**964.4 MEASUREMENT AND PAYMENT—**

**(a) Line.** Meter (Linear Foot)

**(b) Legend.** Each

# SECTION 965—PREFORMED THERMOPLASTIC PAVEMENT MARKINGS

**965.1 DESCRIPTION**—This work is the furnishing and installation of preformed thermoplastic pavement markings, of the type and color indicated.

**965.2 MATERIAL—**

**(a) General.** Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(b) Thermplastic.** AASHTO M 249, Type 1, except that the material is in a preformed state. Provide a material listed in Bulletin 15. Furnish a material with a minimum initial skid resistance of 50 British Pendulum Number (BPN) for all crosswalks, stop lines, legends, or where indicated.

**(c) Glass Beads.** Section 1103.14, Type A.

1. **Intermix.** Provide sufficient uncoated glass beads to comprise 30% of the marking material by mass (weight) and have a minimum of 80% rounds overall.

2. **Surface-Applied.** Moisture resistant coated with a maximum of 5% passing the 180 µm (No. 80) sieve and a minimum of 70% rounds per sieve and a minimum or 80% rounds overall.

**965.3 CONSTRUCTION—**

**(a) General.** At least 5 days before beginning work, provide the Inspector-in-Charge with a schedule of operations. In addition, provide the Inspector-in-Charge with the manufacturer's instructions for the installation of the materials, application temperatures, proper mixing techniques, and any other data to ensure the material is being properly installed.

**(b) Pretreatment.** For proper adhesion, perform surface preparation of the road surface and provide the pretreatment according to Bulletin 15 or recommended by the manufacturer. Clean the roadway surface where the preformed thermoplastic pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any contaminants that would hinder adhesion. Clear any loose dirt and other debris from the application area. Surface preparation is incidental to the application of preformed thermoplastic pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Identify the location of the final pavement markings by applying spots on the pavement at 12 m (40-foot) intervals. The Inspector-in-Charge will approve the locations. Apply on dry pavement when the air and roadway temperatures are between 10 °C and 32 °C (50F and 90F) and when the wind speed is less than 32 km/h (20 miles per hours).

**(c) Application.** Apply markings, which have a minimum thickness of 3 mm ± 0.1 mm (125 mils ± 4 mils). A tolerance of ± 6 mm (± 1/4 inch) from the indicated width will be allowed provided the variation is gradual and does not detract from the general appearance. Use a heat gun to fuse the material to the pavement. Heat the material as recommended by the manufacturer.

**(d) Glass Beads.** Surface apply glass beads as recommended by the manufacturer immediately after application of the markings. Uniformly distribute glass beads on the surface. Provide markings with an average minimum initial retroreflectivity of 300 mcd/m$^2$/lux for white and 250 mcd/m$^2$/lux for yellow. Under the direction and supervision of the Representative measure retroreflectivity with a 30-meter geometry retroreflectometer conforming to ASTM E-1710 within 21 days after installation in accordance with PTM No. 431.

**(e) Defective Markings.** Remove any markings placed incorrectly and replace them. Repair those markings, which after application and drying, are determined to be defective by the Inspector-in-Charge. Complete this work at no additional cost to the Department. Major problem areas and method of repair include the following:

- Insufficient thickness or line width, uneven cross-section─Prepare defective material by grinding or blast cleaning to remove a substantial amount of beads and the marking surface is roughened. Remove loose particles and debris with compressed air. Restripe the cleaned surface as specified in this specification.

- Inadequate retroreflectivity, glass bead coverage or retention─Remove defective markings and clean pavement surface, including 300 mm (1 foot) beyond each end of the affected area. Remove loose particles and debris with compressed air. Restripe the marking on the cleaned surface as specified in this specification.

**(f) Guarantee.** Where directed, remove and replace material that has not remained within close conformity to location or has not remained effective in performing useful service in accordance with Section 107.16(b) for a period of 180 days from the date of acceptance. The minimum acceptable service is as follows:

- **Longitudinal Markings.** 90% of material remains in each 305 m (1,000-foot) section of marking where the intersection unit is defined as material on an approach leg within 50 m (160 feet) of the intersection.

- **Transverse Markings, Legends, and Symbols.** 90% of material remains for each individual legend, symbol, crosswalk, or stop line.

## 965.4 MEASUREMENT AND PAYMENT—

**(a) Line.** Meter (Linear Foot)

**(b) Legend.** Each

# SECTION 966—SNOWPLOWABLE RAISED PAVEMENT MARKERS

**966.1 DESCRIPTION**—This work is the furnishing, installation, and replacement of snowplowable, retroreflective, raised pavement markers of the type indicated.

**966.2 MATERIAL—**

**(a) General.** Provide materials listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(b) Snowplowable Raised Pavement Markers.** ASTM D 4383

**(c) Adhesive.** ASTM D 4383, A1 and X1. A type and formulation, recommended by the pavement marker manufacturer and approved by the Department, for bonding the reflectors or holders to the pavement or the reflectors to the holders.

**966.3 CONSTRUCTION**—As shown on the Standard Drawings, recommended by the manufacturer, and as follows:

**(a) Layout.** Before installing, lay out the pavement marker locations.

Do not place devices on pavement surfaces that show visible evidence of pavement cracking, checking, spalling, or failure of underlying base material. Do not place devices within 100 mm (4 inches) of a pavement joint. During the pre-installation layout, if it is determined that a device would be placed at a point where any of the above conditions exists, relocate it longitudinally to the directed location.

**(b) Sawing.** Cut the depression in the pavement.

**(c) Installation.** Install within 7 days of making the saw cuts. Before applying the adhesive, vacuum or blow the depression to remove loose material, then clean and dry the depression with compressed air. Apply the adhesive and place the unit into the depression. Be certain that markers are properly seated with the leading edges below the roadway surface or reflectors are placed as shown on the Standard Drawings. Secure in place until adhesive is set.

At the time of installation, be sure that devices are free of dirt, dust, oil, grease, rust, moisture, or any foreign matter that impairs adhesion to the pavement.

Do not apply devices if the pavement surface temperature and the air temperature at the time of application are less than 10 ºC (50F) or as recommended by the manufacturer. Do not install markers if the pavement surface is moist or wet.

**(d) Replacement.** Use the following procedures for the replacement of the holders or reflectors:

- Remove and dispose of any damaged device.
- Cut a new depression when required.
- Ensure the attachment area is smooth and clean.
- Apply adhesive and install the new holder or reflector as indicated above.
- Fill void in pavement left by missing or removed devices with an approved epoxy.

**(e) Guarantee.** Within 30 calendar days of notification, replace defective holders and/or reflectors if any of the following unsatisfactory conditions exist:

- The holder does not remain in place or does not resist deformation for 180 days after acceptance; has not remained in the exact location and alignment as originally placed; is deformed, cracked or otherwise not able to provide useful service; or shows visible signs of bond failure between the holder and the adhesive.
- Reflectors are missing or do not provide full service for a period of 180 days after acceptance.
- Reflectors fail between the date of notification and the replacement date.

**966.4 MEASUREMENT AND PAYMENT—**

**(a) Raised.** Each

**(b) Reflector Replacement.** Each

# SECTION 1000
# STRUCTURES

## SECTION 1001—CEMENT CONCRETE STRUCTURES

**1001.1 DESCRIPTION**—This work is construction of bridges, arches, culverts, and other cement concrete work.

**1001.2 MATERIAL—**

**(a) Cement Concrete.** Section 704. The cement factor may be increased to obtain high early-strength concrete, with written consent from the Representative. Do not use Type III high early-strength, non-air-entraining cement.

Design cement concrete mixes for bridge decks to meet a 28 day to 7 day compressive strength ratio greater than or qual to 1.33. A waiver for Section 704.1 Table A for cement factor and/or water cement ratio will be allowed if mix designs using the limits of the Table cannot achieve the 1.33 ratio. The 1.33 ratio is for mix design purposes only and not to be utilized as an acceptance factor during production.

**(b) Concrete Curing Material and Admixtures.**

- Curing and Protecting Covers—Section 711.1
- Curing Compounds—Section 711.2(a) (clear only) and 711.2(c)
- Concrete Admixtures—Section 711.3 Do not use admixtures containing chloride salts in bridge-deck concrete.

**(c) Structure Foundation Drains.** Section 610.2 and Section 615.2

**(d) Nonstaining, Nonshrinking Grout.** Use for minor patching of concrete surfaces. Mix one part cement, two parts fine aggregate, and enough water to provide a consistency stiff enough to place by either manual or mechanical tamping. Do not use more than 0.40 L of water per kilogram (4 1/2 gallons of water per bag) of cement. Mix for 60 seconds, cover to prevent loss of moisture, and allow to stand for 45 minutes. Remix for 60 seconds without further addition of water, then place within 30 minutes after completion of mixing. Use material as follows:

- Cement, Type IP, IS, or II—Section 701
- Fine Aggregate, Type A or C—Section 703.1
- Water—Section 720.1

The Contractor may use premixed grout. Obtain from a manufacturer listed in Bulletin 15. Mix according to the manufacturer's instructions. Certify as specified in Section 106.03(b)3.

**(e) Nonshrink Grout for Studs, Dowels, and Anchor Bolts.** Section 1080.2(c), except use Type C fine aggregate.

The Contractor may use premixed nonshrink grout. Obtain a grout, which passes a 2.36 mm (No. 8) sieve, from a manufacturer listed in Bulletin 15. Mix according to the manufacturer's instructions. Certify as specified in Section 106.03(b)3.

**(f) Bituminous Tack Coat (for Bridge Decks).** Section 460.2

**(g) Lighting Pole Anchorage.** Provide as shown on the Standard Drawings and as follows:

- Anchor Bolts, Nuts, and Washers—Section 1105.02(c)2 (metallic coated)
- Steel Angle—Section 1105.02(a)2
- Conduit—Section 1101.09(b)
- Junction Box—Section 1101.10

**(h) Forms.**

**1. Temporary.** Use plywood at least 15 mm (5/8 inch) thick or other accepted material made for form work. For final exposed concrete surfaces, use smooth material, free of knots, holes, bulges, and depressions.

**2. Metal Bridge Deck Forms.** Use permanent forms, fabricated from steel conforming to ASTM A 924/A 924M and ASTM A 653/A 653M (Structural Quality (SQ) excluding Grade 340 (Grade 50) Class 3), with a coating designation of Z500 (G165), and a minimum thickness of 0.83 mm (22 gage). Coat fasteners, if used, either by galvanizing according to ASTM A 153 or ASTM B 633, Thickness Class Fe/Zn 12; or cadmium plating, according to ASTM B 766, Class 12.

An alternate form system may be used, if indicated or if accepted in writing by the Chief Bridge Engineer. Submit material details and erection methods of the alternate form system for review and acceptance.

Certify as specified in Section 106.03(b)3.

**(i) Other Material.**

- Premolded Expansion Joint Filler—Section 705.1
- Closed Cell Neoprene Sponge—Section 1107.02(p)1
- Joint Sealing Material—Section 705.4(b), (c), or (d)
- Waterstops—Section 705.5
- Caulking Compound—Section 705.8
- Reinforcement—Section 1002.2
- Steel Welded Wire Fabric—Section 709.3
- Deformed and Plain Bar Dowels—Section 709.1
- Structural Steel—Section 1105
- Waterproofing—Section 680.2
- Coarse Aggregate, No. 57—Section 703.2
- Conduits and Conduit Protective Coating—Sections 1101.09(b) and (d)
- Selected Borrow Excavation—Structure Backfill, as shown on the Standard Drawings.
- Anchor Bolts—Section 1105.02(c)2
- Bituminous Material, Class RC-250—Section 702

- Geotextiles, Class 1—Section 735

**(j) Tremie Cement Concrete.** Use Class A cement concrete as specified in Section 704, modified as follows:

- Cement Factor (Min)—390 kg/m$^3$ (7.0 bags per cubic yard)
- Slump—175 mm ± 25 mm (7 inches ± 1 inch)
- Compressive Strength at 7 Days—14 MPa (2,000 pounds per square inch)

Provide admixtures that retard concrete set 1500 mm (5 feet) above and below the tremie pipe outlet, are compatible with the air entrainment agents, and do not allow excessive segregation of the aggregate.

**(k) Concrete Bonding Compound.** Section 706.1

**1001.3 CONSTRUCTION**—Construct as shown on the Standard Drawings and as follows:

**(a) Forms and Centering.**

**1. General.** Support forms so that deflection does not exceed 12 mm (1/2 inch) under plastic concrete. Before using forms, clean them and obtain approval for use. Use forms that are strong and firm; securely braced; tied together, if required, by means of form ties, tight enough to prevent the leakage of mortar; and strong enough to withstand the action of mechanical vibrators, if used.

Remove dirt, chips, sawdust, and other foreign materials before placing concrete. Except for stay-in-place forms, before placing reinforcing steel, thoroughly coat forms with a release agent. Coat forms for exposed surfaces with a nonstaining release agent.

Adequately brace forms. If forms are insufficiently braced or unsatisfactorily built, the work will be halted, either before or during concrete placement, until such defects have been satisfactorily corrected. Chamfer the edges as indicated. Do not leave wood separators in the completed work.

Do not use form support systems that will cause unacceptable overstress or deformation to permanent bridge members.

Use ties that are adjustable in length, to allow tightening of forms. Use ties that leave no metal in the concrete within 40 mm (1 1/2 inches) of the exposed surface. Do not fit ties with lugs, cones, washers, or other devices to act as spreaders within the form, or devices that leave depressions in back of the exposed surface of the concrete. Flat bands may be used, if the bands conform to the following:

- Not less than 20 mm (3/4 inch) wide.
- Not less than 1.9 mm (14 gage) thick.
- Placed on edge.
- Protected by adequate spreaders to prevent twisting during construction.

Do not use wire ties or thin, narrow, flat bands, except in the construction of endwalls, inlets, and manholes. Where necessary, coat the form ties with a release agent to facilitate removal. Do not damage the concrete on the exposed surface when removing forms and ties. Do not cut ties back from the concrete face.

Before starting construction, obtain acceptance of working drawings required for centering and falsework, as specified in Section 105.02(c). Before placing concrete, obtain acceptance of in-place forms. Camber the centering to compensate for dead-load deflection and settlement of centering. Provide for gradual and uniform lowering.

Where required, drench the inside of forms with water immediately before placing concrete.

**2. Metal Bridge Deck Forms (Permanent).** When portions of a bridge deck are constructed adjacent to each other and divided by an open or a preformed joint, do not use metal forms in the cantilever area on either side of the joint, except with prior written permission of the Chief Bridge Engineer.

Submit shop drawings of the forms as specified in Section 105.02(d) for review and acceptance. Include the following on the shop drawings:

- Grade of steel.
- Physical and section properties for permanent metal bridge deck form sheets.
- Methods of attachment.
- Locations where the forms are supported by steel beam flanges, subject to tensile stresses.

Prepare the drawings, conforming to the details and design shown on the Standard Drawings.

Before welding in a tension zone, make a test installation on a sample of a simulated flange, using the same welding procedure, materials, and fit-up that are to be used in the tension zone. Allow no burn-through of the parts being welded or fusion to the flange. Do not weld to flanges in tension zones. When this welding procedure has been satisfactorily demonstrated, do not deviate from that used in the test during welding in the tension zone.

Perform field cutting of forms, supports, and closures using saws, shears, or other acceptable methods. Do not cut by burning or melting. Make the attachments concrete tight. A fastening system, using a low-velocity, powder-actuated piston tool to attach forms to support angles, may be used. Thoroughly clean and wire brush form metal where galvanized coating has been damaged. Paint with two coats of Zinc Dust-Zinc Oxide Primer, no color added, according to Bulletin 26, or ASTM A 780. Areas of welds and of weld burns need not be touched up. Uncoated edges, resulting from shearing or punching, are acceptable.

**(b) Reinforcement.**

**1. Reinforcement Bars.** Section 1002.3. For bridge decks, also comply with the following:

Place bars as indicated. Use reinforcement chairs, spaced not greater than 900 mm (3 feet) apart, to maintain the position of bottom and top bars. Tie down the top bar mat with annealed iron wire. Tie the top bar mat to the lower bar mat, forms or form straps, or studs or chairs tied to the lower mat, at sufficient locations to hold the reinforcement in the proper position. Provide beam haunch reinforcement as indicated and as shown on the Standard Drawings.

Use galvanized chairs with ASTM A 641, Class 3 coating, or use stainless steel, plastic-coated or epoxy-coated steel chairs. Use chairs with exposed cut-ends coated or turned up.

Place reinforcement so the indicated cover clearance does not deviate from position by more than ±6 mm (±1/4 inch).

Do not place concrete until the reinforcing placement is accepted.

**2. Steel Welded Wire Fabric.** Place as indicated. Lap ends and sides 300 mm (12 inches). Fasten with annealed iron wire or metal clips.

**(c) Weep Holes.** Construct holes as indicated. Place geotextiles, Class 1, as specified in Section 212.3. Then, place approximately 0.4 $m^3$ (1/2 cubic yard) of No. 57 coarse aggregate within the geotextiles at the inlet end, unless otherwise directed.

**(d) Structure Foundation Drains.** Construct as indicated. Place within geotextiles, Class 1, as specified in Section 212.3.

**(e) Pipes and Conduits.** Place pipes and conduits in the structure concrete as indicated, including pipes and conduits supplied by others. Maintain existing pipes and conduits, where indicated. If indicated, wrap pipes with bituminous paper.

**(f) Placing Anchor Bolts and Expansion Plates.** Place expansion plates, anchor bolts, pier nosing angles, and other material as indicated. Place anchor bolts supplied by others as indicated or directed. Paint projecting

portions of anchor bolts as specified in Section 1060.3 as soon as practical after the anchor bolts have been set, but not until the surrounding concrete or grout has hardened sufficiently to preclude damage from the painting operation. Coat threads with grease after painting.

If the bridge substructure and superstructure are built under separate contracts, proceed as specified in Section 1050.3(c)4.g.

**(g) Placing Lighting Pole Anchorage.** Construct the lighting pole anchorages as an integral part of the structure. Where indicated, install anchor bolts, nuts, and washers, as specified in Section 1105.02(c)2, 35 mm (1 1/4-inch) conduit, junction box, drain pipe, steel angles, and the required fittings. Cap the conduit with a cap or plug to prevent entry of foreign material and moisture.

For future lighting, protect the anchor bolts using a painted hardwood block.

**(h) Consistency of Concrete at the Time of Placement.** Do not add water to concrete in the field, unless authorized in writing by the District Executive. If written authorization is obtained, the quantity of water may be increased by a maximum of 5 L/m$^3$ (1 gallon per cubic yard). Immediately remove free water, soft concrete, or mortar that appears on the surface of the concrete, and correct the cause of this condition.

**(i) Mixing Conditions.** Section 704.1(f)

**(j) Proportioning and Mixing Concrete.** Section 704

**(k) Placing and Finishing Concrete.**

**1. General Requirements.** At least 15 days before the element of work is started, submit, for review and acceptance, a QC Plan showing the methods, sequence, and schedule for placing concrete. Maintain material on hand and in place, if necessary, for curing and protecting the concrete. Before placing foundation concrete, ensure that the bearing area is firm, reasonably dry, and free of water. The Representative will inspect the foundation area for bearing capacity before placement If directed, drill or drive a bar into the material below the foundation or footing bottom to a depth sufficient to determine the suitability of the material. Place concrete without segregation. Remove and discard any concrete that is segregated, too wet for use, or not of uniform consistency. Do not drop the concrete mixture a distance greater than 1.2 m (4 feet). Do not allow concrete to come in contact with aluminum, unless the aluminum is coated with an accepted coating.

Do not place consecutive batches adjacent to each other at concrete temperatures differing by more than 11°C (20F). Do not place concrete upon frozen foundation material, in forms containing frost, around frosted reinforcement, or in pile shells surrounded by ice or frozen earth.

For succeeding batches, place concrete in the forms within 30 minutes. Place concrete in horizontal layers no more than 380 mm (15 inches) in depth. Fill each part of the form by depositing the concrete as close to its final position as possible. Do not work or flow concrete along the forms from the point of deposit. Work the concrete without displacing the reinforcement. Place concrete so that the upper surface of the concrete is at the indicated elevation after it has been struck off and after initial shrinkage has taken place.

Finish exposed concrete surfaces accurately and evenly, free from open and rough areas, and free from depressions and projections. In bridge seats and walls, place concrete to the required elevation. Strike off with a straightedge and float to the correct elevation. Do not add water or curing agent to the concrete surface to assist in finishing.

Finish bearing areas of substructures, as specified in Section 1001.3(k)9.

In areas where reinforcement extends through a construction joint, do not place concrete adjacent to previously placed concrete until at least 24 hours has elapsed.

**2. Use of Vibrating Equipment.** Keep sufficient vibration equipment in reserve to guard against a work shutdown, caused by the failure of the equipment in operation.

Use an acceptable mechanical vibrator. Do not attach it to the forms or reinforcement. Use a vibrator capable of transmitting vibration to the concrete with a frequency of not less than 100 impulses per second. Determine the vibrator size by the reinforcement spacing.

When sufficient concrete has been deposited, spade and manipulate it to fill the form. Apply the vibrator to the concrete, at intervals not exceeding 900 mm (3 feet), immediately after the concrete has been deposited. Move the vibrator throughout the mass, completely working the concrete around the reinforcement and other embedded

fixtures, and into the corners and angles of the forms. Correct any reinforcement displacement caused by the vibrator before continuing vibration. Move the vibrator slowly to prevent segregation. Do not use vibrators to spread concrete.

Remove and discard concrete segregated by the vibrating operation. Ensure that the vibrator does not penetrate or disturb partially hardened layers. Reinforcement in freshly placed concrete may be vibrated for short durations to ensure proper reinforcement embedment.

**3. Placing Concrete in Water.** (See animation of tremie method).

**3.a General.** When the depth of water in the foundation area is 25 mm (1 inch) or greater, place concrete only in still water and add 25% more cement than the quantity specified for the concrete class being used, as specified in Section 704.1(h). Do not deposit concrete in water having a temperature below 5 °C (40F).

Hold a concrete placement meeting and present all details of the placement to the Representative. Do not begin concrete placement until the placement procedures, concrete mix design, inspection procedures, and concrete sampling procedures have been accepted.

If the tremie method is selected for placing concrete, submit a concrete placement procedure plan for approval at least 21 calendar days before performing the work, and include the following:

- Concrete mix design.
- Available concrete production capability.
- Availability and capacity of equipment to be used to transfer concrete to the tremie.
- The total volume of concrete to be placed.
- The various placement schemes available.
- Tremie locations.
- Maximum flow distance of concrete.
- Any restrictions to flow, such as reinforcing steel, piles, and internal form bracing.
- The method of sealing the tremies and the emergency restart procedure if the seal is broken.
- An inspection plan detailing sounding locations and the frequency of soundings. Take soundings over the entire placement area on, at least, an hourly basis.
- A concrete sampling and testing plan.

**3.b Water Under 600 mm (2 feet) Deep.** If placing concrete in water 600 mm (2 feet) deep or less, build the concrete above the water level in one end of the form, then place the concrete on top of the concrete above water, and gradually work ahead so that the smallest possible area of fresh concrete is exposed to the water.

**3.c Water Over 600 mm (2 feet) Deep.** If concrete is placed in water deeper than 600 mm (2 feet), place in approximately horizontal layers, in a consolidated mass in its final position, using the tremie method or other acceptable method, and do not disturb after placing. Do not place concrete with bottom-dump buckets.

Use tight forms, constructed to retain concrete under water, and maintain still water within the forms. Regulate the consistency of the concrete to prevent segregation of the material.

Before placing tremie concrete, ensure the foundation area is level, and all forms and surfaces are free of mud and silt.

Use a tremie with a smooth interior face; and watertight discharge tube at least 250 mm (10 inches) in diameter, long enough to reach the bottom of the placement, and marked in 300 mm (1-foot) increments. Provide

a valve or similar device, including various types of plugs, at the lower end of the discharge tube that closes tightly while the tremie is being charged and lowered into position, and that can be fully opened in the lowered position. Attach tremie tube to a funnel or hopper of at least 0.4 $m^3$ (1/2-cubic yard) capacity to facilitate transfer of concrete to the tremie. Do not use tremie tubes fabricated from aluminum. Furnish at least two tremie tubes to ensure continuous concrete placement. Do not place tremie concrete by pumping directly to the bottom of placement. Place tremie concrete only in the presence of the Representative.

Maneuver the tremie tube by using an accurately controlled crane or hoist that allows free vertical movement of the discharge end of the tube. Keep the concrete level in the tremie tube stable. Maintain the equilibrium level. Keep the discharge end of the tremie tube fully submerged in the freshly deposited concrete. Keep the tremie tube relatively motionless. Do not move the tremie laterally during concrete placement.

Place tremie concrete in one continuous operation. Place concrete at a rate that prevents aggregate segregation and allows flow over the entire placement area. Keep the top surface of concrete as level as possible. Maintain balanced hydrostatic pressures to prevent form failure and movement of water through the plastic concrete.

When the tremie concrete has reached a minimum compressive strength of 14 MPa (2,000 pounds per square inch), proceed with dewatering of forms. Upon completion of dewatering, and in the presence of the Representative, thoroughly inspect the hardened tremie concrete. Remove laitance and other undesirable material by chipping, scraping, or other means that are not detrimental to the sound concrete. Visually inspect tremie slabs 900 mm (3 feet) or less in thickness, and if any areas of the concrete are suspect, drill cores as directed. For slabs greater than 900 mm (3 feet) in thickness, verify concrete integrity by drilling four 50 mm (2-inch) diameter cores, or one 50 mm (2-inch) core for every 9 $m^2$ (100 square feet) of slab area, whichever is greater. Drill additional cores as directed. Use a double tube core barrel with a diamond bit to obtain the cores. Do not exceed 1500 mm (5 feet) for individual core runs. Drill cores from the top of the tremie slab to within 300 mm (12 inches) of the bottom. Operate drilling equipment at speeds and pressures that ensure satisfactory core recovery. Pull the core at the end of each run. Identify and store to preserve the integrity of the cores. Record the existence of any void areas or other concrete deficiencies. If defective concrete areas or voids are found, fill with pressure grout or Class A cement concrete as directed. Completely fill all core holes as specified in Section 1001.3(k)11. Upon completion of the project, dispose of cores in a satisfactory manner.

**4. Pumping Concrete.**

**4.a Concrete Pump and Reduction Device.** Provide a concrete pump with a flexible end section at least 3 m (10 feet) long equipped with a reduction device or combination of devices to provide a steady and continous discharge. Devices that may be used include, but are not limited to, a combination of 90 degree angles, a tapered reduction hose, a slide gate, a 1.8 m (6-foot) diameter loop in rubber hose, or a finger reducer. Pump and waste enough material through the pump to insure that the grout used to prime the pump has been discharged from the system.

**4.b Determining QC and Acceptance Testing Location.** The location of the QC sampling and acceptance sampling will be determined daily on the first load of concrete and for every 160 $m^3$ (200 CY) therafter, by the following procedure:

- Provide a concrete mixture in conformance with specification requirements in Section 704 for slump, air content, and temperature before placement into the pump.
- Obtain a sample of concrete before placement in the pump and perform slump and air content tests.
- Position the pump into the most severe vertical drop boom configuration, or, when pumping from the same elevation as the placement, at the longest horizontal section configuration that will occur during placement.
- Obtain a sample of conrete at the discharge end of the pump and perform slump and air content tests.
- The entrained air in the hardened concrete must be between 3.5% and 8.0% as specified in Section 704.1(c)3.

If the test results for slump and air content taken at the discharge end of the pump are within ± 25 mm (1.0 inch) of the slump and ± 1.0% of the air content taken before placement into the pump, QC and

acceptance testing may be performed before placement into the pump. If the test results are not within these tolerances, acceptance testing will be performed at the discharge end of the pump.

The Representative may require acceptance testing and QC testing to be performed at the point of placement at any time the quality of the material comes into question.

If more than one pump is utilized during a placement, each pump must comply with the above procedure.

**5. Superstructures.** When constructing superstructures, place the concrete in one continuous operation, unless otherwise indicated, specified, or directed.

Before constructing spandrel walls, barriers, or other concrete construction placed on concrete slab, T-beam, rigid frame superstructures, or open or closed spandrel arches, relieve the supporting centering of falsework to allow the superstructures to take part of the permanent deflection.

Do not place barriers for concrete rigid frame structures until after completing the backfilling and the embankment adjacent to the structures.

**6. Bridge Decks.** At least 2 weeks before concrete deck placement, schedule a deck preplacement meeting to review the specification, method and sequence of placing deck concrete, quality control testing, and method of protective measures, to control the concrete evaporation rate. Place concrete at a concrete temperature of between 10 °C and 27 °C (50 °F and 80 °F). Provide the necessary equipment and determine the evaporation rate before starting deck placement and every hour during the placement. Do not exceed an evaporation rate of 0.732 kg/m²/hr (0.15 pounds per square foot per hour). The allowable Evaporation Rate for exposed finished concrete is determined by ACI 305R-91, Figure 2.1.5 Have readily available at the bridge deck placement site, all remediation equipment and procedures as submitted and approved at the deck preplacement meeting before starting the placement. If the value is exceeded, stop concrete placement until protective measures are taken to reduce the values to an acceptable level. Fog cure misting is an acceptable method to mitigate an excessive evaporation rate. Use high pressure equipment that generates at least 8.3 MPa (1,204 pounds per squar inch) at 8.3 L per minute (2.19 gallons per minute), or with low pressure equipment having nozzles capable of supplying a maximum flow rate of 6.3 L per minute (1.66 gallons per minute). Use nozzles that atomize droplets and can keep a large surface damp without causing water deposits. Apply the fog over the entire placement that is not covered by wet burlap. Do not leave concrete exposed for extended duration. Place concrete 1.5 m to 2.5 m (5 feet to 8 feet) ahead of finishsing machine to prevent any premature concrete drying.

For rigid frame decks, place the concrete from the center of the span toward each leg or abutment simultaneously. Continuously check falsework or supporting beams so the concrete, as placed, meets the lines and grades indicated. Keep wedges and blocking tight during placement of the concrete.

Use a placing sequence for continuous spans, as indicated.

Unless allowed in writing by the District Executive, do not allow truck mixers, truck agitators, or other heavy motorized equipment on the deck spans in which concrete is being placed.

If it is necessary to stop operations, due to weather or operational conditions, provide bulkheads at the work site, and place them as directed. Remove bulkheads before resuming concrete placement operations.

Obtain acceptance of changes or additions to indicated construction joints, before incorporating into the work.

Use motorized, mechanical finishing equipment. Submit a sketch to the Inspector-in-Charge, describing the equipment and showing complete details of supports for the equipment.

Adjust the deck openings at expansion joints and at expansion dams at the time concrete is placed to provide the openings indicated at 20 °C (68F) under full dead load.

Vibrating screeds may be used, with the written permission of the District Executive. Vibrating screeds are to be power-vibrated and moved by means of a positive, power-operated apparatus, but are not to be a substitute for high-frequency vibrators. Hand-finishing methods will be allowed outside mechanically screeded areas and to a placed bulkhead in cases of power equipment failures.

Use strike-off finishing machines or screeds large enough to finish the full width of deck between curbs or between longitudinal construction joints, or between both.

When strike-off finishing machines are used, support the wheels above the pavement surface on temporary rails, supported on non-deflecting forms or other horizontal structural devices. Support vibrating screeds on temporary pipe guides or on-grade angles. Use adjustable finishing machine supports or vertical supports for screed guides. Fix supports during finishing, at intervals to limit deflection to not more than 3 mm in 3000 mm (1/8 inch in 10 feet). Use supports that are removable to at least 50 mm (2 inches) below the surface with a

minimum disturbance of concrete. Fill voids left upon removal of screed guides and supports with nonstaining, nonshrinking mortar, after the deck concrete has reached its initial set.

Do not allow screed or runway supports to bear on the forms, unless direct undersupport is provided to prevent form damage or deflection. Do not discharge concrete near side laps or at midspan of the corrugated sheets, to a depth greater than 250 mm (10 inches) above the top of the forms. Do not discharge concrete in a manner that causes excessive concentrated construction loads.

Place concrete, at a minimum rate of 6 m (20 linear feet) of deck per hour, in a longitudinal direction, except for reinforced concrete slabs and rigid frames.

Vibrate the concrete to prevent honeycombing and voids, especially at construction joints, expansion joints, valleys, and ends of form sheets. Obtain acceptance of placing sequences, procedures, and mixes before placing concrete.

Repair or replace damaged material.

Conduct final finishing operations immediately behind the finishing machines or screeds from work bridges of rigid construction, not in contact with the surface of the concrete, set on rails, and easily moved. Finish with a 3 m (10-foot), long-handled straightedge to achieve a smooth surface. Make one pass of the float if after the finishing machine operations the concrete surface remains open. Do not overfinish. Fog misting equipment is allowed on the finishing machine to maintain the evaporation rate below the allowable value.

Perform intermediate curing as specified in Section 1001.3(p)3.c. immediately after the final finishing operations and after texturing operations are completed.

Perform straightedge testing and surface correction as specified in Section 501.3(k)3 while the concrete is workable. After completing the straightedge testing and surface corrections, before the concrete becomes nonplastic, texture the surface as specified in Section 501.3(k)4. Cure the deck as specified in Section 1001.3(p)3.b. Minimal marking of the fresh concrete is allowed. Maintain wet burlap application within 3 1/2 m to 6 m (10 feet to 18 feet) behind the finishing equipment at all times. After the requirements of Section 1001.3(p)3.b have been satisfied, apply a Liquid Membrane-Forming Curing Compound (white), as specified in Section 1001.3(p)3.a. Following secondary cure, straightedge test the surface again, as specified in 1019.3(c) 2 for any bridge deck poured between September 1 and March 1.

**Method 1.** Before the concrete becomes nonplastic, texture the surface, as specified for concrete pavements in Section 501.3(k)4. Then, cure the deck as specified in Section 1001.3(p) as soon as possible, without marking the fresh concrete. After the concrete has hardened, test the surface again, as specified in Section 501.3(o).

**Method 2.** Cure the deck as specified in Section 1001.3(p) as soon as possible, without marking the fresh concrete. After the concrete has hardened, test the surface again, as specified in Section 1001.3(p). Then, provide the deck slab finish specified in Section 501.3(k)4 by saw cutting.

If directed to facilitate inspection, remove at least one section of permanent forms, at a location directed, for each span of every bridge in the project. After the deck concrete has been in place for a minimum period of 2 days, test the concrete by sounding with a hammer, where directed. If hollow sounding areas are found, and if directed, remove the forms for the Representative's inspection after the concrete has attained adequate strength. The forms need not be replaced. Repair the adjacent metal forms and supports in order to present a neat appearance. Remove or repair unsatisfactory concrete. Provide facilities for the safe and convenient conduct of the inspection.

**7. Reinforced Concrete Arches.** Place the concrete symmetrically on each side of the span and progress uniformly from the spring line to the crown.

**8. Reinforced Concrete Box Culverts.** Place concrete in the base slab with horizontal construction joints formed in the sidewalls as indicated. Form horizontal construction joints to provide keys, as shown on the Standard Drawings.

When the concrete has reached the top of the sidewall, stop the concrete operation for 2 hours to allow for settlement of the wall concrete before placing the top slab.

**9. Bearing Areas of Substructures.** As indicated, construct concrete bearing areas of substructures upon which neoprene pads, masonry plates, shoes, pedestals, column bases, or other metallic bearing devices are to be placed. Slope areas between and surrounding bearings to drain so no water accumulates or stands at any point.

After curing, grind the defined bearing area to the indicated elevations, as necessary, according to the following tolerances:

- Deviation from specified elevations:
  - For steel beam superstructures, ±3 mm (±0.01 feet), except do not exceed a 3 mm (0.01 feet) difference between specified elevations of bearing areas of adjacent beams measured at the centerline of beams and centerline of bearings.
  - For prestressed concrete beam superstructures, ±6 mm (±0.02 feet)

- Having no projecting irregularities exceeding 1.5 mm (1/16 inch)

- Variation in flatness:
  - For neoprene pads, ±1.5 mm (±1/16 inch)
  - For metal bearings and high load multi-rotational bearings:
    - Bearing seats up to 750 mm (30 inches) long, ±1.5 mm (±1/16 inch)
    - Bearing seats over 750 mm (30 inches) but less than 1100 mm (45 inches) long, ±2.5 mm (±3/32 inch)
    - Bearing seats over 1100 mm (45 inches) long, ±3 mm (±1/8 inch)

- Variation in slope between specified elevations for each beam seat:
  - For neoprene pads, 1:300 (300:1)
  - For metal bearing and high load multi-rotational bearings, 1:200 (200:1)

When using neoprene pads, provide a bearing surface with a rough texture.

For metal and high-load multi-rotational bearings, fill minor depressions caused by finishing, bush hammering, or grinding with a low-viscosity epoxy applied with a squeegee.

**10. Final Finishes.**

**10.a Conventional Finish.** Do not brush or bag finish, or paint with grout or neat cement. After the forms are removed, correct irregularities in the exposed concrete surfaces. Exposed surfaces are surfaces above normal ground level or water level, when applicable, and surfaces that will not be concealed by other construction. Irregularities include fins, protrusions, individual holes larger than 25 mm (1 inch) in any dimension, and clusters of smaller holes.

**10.b Tooled Finish.** Tool finish surfaces as indicated by cutting into the body of the concrete with a pointed tool or bush hammer until the concrete surface shows a grouping of broken aggregate particles in a matrix of mortar.

**10.c Other Finishes.** Finish surfaces by other methods as indicated.

**11. Patching.** Saturate holes with water and, immediately, completely fill the holes with nonstaining, nonshrinking mortar. For holes passing entirely through walls, use a plunger-type caulking gun or other device to force the mortar through the wall starting at the back face. Hold a piece of burlap or canvas over the hole on the front face. Then, when the hole is completely filled, strike off the excess mortar until the mortar is flush with the surface. Completely fill holes not passing entirely through the wall by ramming the mortar in place with a suitable tool. Strike off the excess material until the material is flush with the wall surface.

For minor patching, treat concrete surfaces to be patched with a paint coat mixture of neat cement and water. Tamp mortar into place manually, preferably to at least 15 mm (1/2 inch) depth. When possible, overfill spaces being repaired. Allow the excess to stand for 5 minutes, then strike off and finish without excess troweling. Where the space cannot be overfilled, finish immediately. Cure for at least 3 days using an acceptable method that ensures against loss of moisture by evaporation. When required for all or part of the curing period, hold the mortar in place or support by using an acceptable method that ensures retention of the mortar without its drying out.

**12. Concrete Bridge Barriers.**

**12.a General.** For bridges with spans of 6 m (20 feet) or more, construct barrier as indicated and as shown on the Standard Drawings, using either a slip form, or conventional fixed forms.

Conform to the following finished tolerances for both slip-form and conventional fixed-form methods of bridge barrier construction:

| | |
|---|---|
| • Bar Reinforcement Cover | ±6 mm (±1/4 inch) |
| • Width (Top) | ±6 mm (±1/4 inch) |
| • Width (Bottom) | ±6 mm (±1/4 inch) |
| • Surface Straightness (Deviation from centerline of individual section of unit) | 6 mm in 3 m (1/4 inch in 10 feet) |
| • Vertical Profile Alignment (Deviation from a line parallel to the grade line) | 6 mm in 3 m (1/4 inch in 10 feet) |
| • Alignment with Edge of Bridge Deck | 6 mm in 3 m (1/4 inch in 10 feet) |

Test surface straightness and vertical alignment along the front face, top, and rear face of the barrier using a 3 m (10-foot) straightedge. Hold the straightedge in successive positions for the entire length of the barrier and advance in stages of not more than 1.5 m (5 feet).

**12.b Slip-Forming Bridge Barriers.** If the slip-form method is used, submit a QC Plan to the Representative, at least 15 calendar days before beginning slip-forming. Obtain acceptance of the QC Plan before placing barrier concrete. As a minimum, include in the QC Plan the type of equipment, materials, slump target and range, coarse aggregate source and procedures required for the test section and to construct the barrier.

Provide Class AA cement concrete, as specified in Section 704; except, use No. 8, No. 67, or No. 57 coarse aggregate, and furnish concrete conforming to the QC Plan.

If the finished tolerances, specified in Section 1001.3(k)12.a, cannot be maintained during production, stop slip-forming operations, remove the unacceptable work, and modify the operation. If the modifications do not produce acceptable results, as specified in Section 1001.3(k)12.a, use the fixed-form method of construction, as specified in Section 1001.3(a). The Department will not grant additional compensation or additional time as a result of required removals, modifications, or changes resulting from the method of forming concrete bridge barriers.

**12.b.1 Test Section.** Construct one 15 m (50-foot) test section per project to demonstrate that an acceptable product can be produced. Construct this test section at a location near the project site using the same equipment, material, personnel, and procedures as described in the QC Plan. Construct an additional test section if any changes in equipment, material, procedures, or personnel are made. Place the test section on a concrete slab with reinforcing steel to simulate actual conditions. With the District Executive's written approval, the test section may be constructed in-place, on the bridge structure. The test section will consist of the first 15 m (50 feet) of the bridge barrier placed. Include in the submission to the District Executive, documentation of past experience constructing slip-form bridge barriers, with contract references.

Test concrete as specified in Section 704. In addition, obtain three test cores from the test section, according to PTM No. 1. Submit cores to MTD to be tested for information. Repair tears as directed. Honeycombing, sags, tears, or other evidence of poor quality concrete that cannot be satisfactorily repaired without the use of water or extra concrete or grout, will be cause for rejection of the test section. Test reinforcement cover, in the presence of the Representative, using a Pachometer, or other non-destructive test method.

The Representative will evaluate the procedure, material, equipment, and appearance of the test section. If the test section is rejected by the Representative, place an additional test section, with the approval of the Representative, or use the fixed-form method of construction. Remove and dispose of rejected test sections. Leave the accepted test section in place until all the slip-formed bridge barriers are complete. The slip-formed bridge barriers will be compared to the accepted test section to ensure that similar, acceptable quality is being achieved. If

the test section was not constructed in place on the bridge structure, remove and dispose of the test section following completion and final acceptance of all slip-formed bridge barriers.

**12.b.2 Construction of Slip Formed Bridge Barriers.** After set up, make a dry run of the equipment to ensure it will clear obstacles to be embedded or flush with surfaces, such as pull boxes, expansion joint plates, and light standard foundations. Ensure that clearances for concrete cover are maintained on reinforcement bars. If modifications are necessary, correct any deficiencies and perform another dry run, in the presence of the Representative, before starting the slip-form operation. At no additional cost to the Department, place additional epoxy-coated reinforcing steel to provide bracing for the barrier against displacement due to the pressure developed by the slip-form extruding process. Apply a uniform coat of concrete bonding compound as specified in Section 706 and according to the manufacturer's recommendations, to the interface between the bridge deck surface and the slip-formed bridge barrier, before the slip-forming operation. Coordinate operations for mixing, delivering and placing of concrete with minimal stopping and restarting of the slip-form machine and according to the QC Plan. Do not allow vehicular traffic on the bridge while slip-forming operations are in progress, except for slip-form machine and supply trucks. Meet temperature and humidity requirements as specified in Section 1001.3(k)3.

Ensure that the barrier maintains its shape, without support, after extrusion. If honeycombing, sagging, or tearing of the bridge barrier occurs during the slip forming operation, repair according to the approved QC Plan. Ensure that the completed surface is free of honeycombing, sags and tears, and finish with a light vertical brushing.

Cure slip-formed bridge barriers as specified in Section 1001.3(p).

Mark the bridge deck in advance of the concreting operation to ensure that saw cuts are made at the indicated locations and do not conflict with the reinforcing steel pattern. Space joints as indicated. Accurately locate saw cut joints to ensure the reinforcement steel will have the specified cover. Saw cut as soon as possible after concrete has set sufficiently to preclude raveling during the sawing, and before any shrinkage cracking occurs in the concrete. Saw cut joints, 3 mm (1/8 inch) wide and 19 mm (3/4 inch) deep, in the top, outside, and inside faces. Complete saw cuts 75 mm (3 inches) above the top of the deck slab or pavement surface.

**(l) Not used.**

**(m) Connections of Existing and New Concrete.**

**1. Terms.** The terms “new concrete construction,” “fresh concrete,” and “hardened concrete” refer to work performed under the current contract.

The terms “existing concrete structures” and “existing concrete” refer to work performed under a previous contract.

**2. General.** To connect fresh concrete with hardened or existing concrete, thoroughly clean the connecting surface of laitance and loose and foreign material.

Coat contact surfaces with concrete bonding compound at construction joints, deck expansion joints, expansion dam block out areas, and where indicated, as specified in Section 1040.3(e).

**3. Tied Connections.** Where indicated, to connect new concrete construction to existing concrete structures, use drill holes of the required depth and diameter in the existing structure to allow placing dowel bars, expansion bolts, or extensions of reinforcement. Furnish and place in the holes, dowel bars, expansion bolts, and reinforcement of the size and type indicated. Grout studs, dowels, and anchor bolts with nonshrink grout or anchor as indicated.

**(n) Joints.** Rivet or fold-seam the splices of metal waterstops before soldering. Make splices for rubber, plastic and similar waterstops according to the manufacturer's recommendations.

If the construction plane is to be horizontal and concrete placement is stopped for more than 30 minutes, provide acceptable keyways and sufficient dowel bars.

When directed, place vertical construction joints, then place acceptable dowel bars as required.

**(o) Not used.**

**(p) Curing and Protection of Concrete.** Begin curing as soon as the concrete has been placed and is sufficiently hardened. Cure concrete, either by membrane curing or by water curing.

Do not count as a curing day, a day on which the curing temperature drops below 10 °C (50F) at any time during that day, except for flood curing of footings. If at any time during the curing period, the curing temperature falls below 2 °C (35F), the Department will consider the work unsatisfactory and will reject it.

**1. Definitions of Temperatures.**

**1.a Air Temperature.** Section 101.03

**1.b Curing Temperature.** Curing temperature is the temperature of the air immediately adjacent to concrete. Where concrete is not covered by forms or other protective coverings, or where protective coverings are considered inadequate, the curing temperature will be the air temperature. During cool and cold weather, the curing temperature is the temperature inside the forms, protective coverings, or housings specified in Section 1001.3(p)5. The curing temperature for the first 24-hour period after placing concrete will be considered as not more than the temperature of the concrete at the time of its placement in the forms.

**2. Records of Temperature.** Provide high-low thermometers to maintain an accurate daily record of air and curing temperatures during cool and cold weather. In the presence of an Inspector, take curing temperatures on the surface of the concrete, at representative locations on a structure. Submit these temperature records daily to the Inspector-in-Charge.

**3. Normal Curing and Protection.**

**3.a Liquid Membrane-Forming Curing Compound.** For surfaces cured by the membrane method, finish before application of the curing compound. During the finishing period, and until forms are removed, protect the concrete by the water method of curing.

Apply the compound in two coats, by spraying, to provide a continuous, uniform membrane. For each coat, apply at least 1 L (1 gallon) of compound per 7 $m^2$ (300 square feet) of concrete.

On formed surfaces, apply the first coat immediately after stripping forms, and after acceptance of the concrete finish. If the surface is dry, soak the concrete with water, and apply the curing compound just as the surface film of water disappears. Apply the second application after the first application has set. During spray-curing operations, keep unsprayed surfaces wet with water.

Apply compound to unformed surfaces immediately after finishing operations have been completed and after the surface film of water has disappeared.

Do not apply membrane-curing compound to construction joint surfaces. Protect exposed steel during application of curing compounds. Water cure these areas, as specified in Section 1001.3(p)3.b.

If membrane is damaged or membrane peels from concrete surfaces, repair immediately.

**3.b Water Curing.** Use a fog-spray, perforated pipe or hose watering system to keep forms and curing covers saturated during the curing period. For curing and protecting covers on endwalls, inlets, manholes, copings, bridge seats, and similar miscellaneous concrete, keep saturated using an acceptable method. Flood curing of concrete footings will be allowed if the water temperature is 5 °C (40F) or above.

Use covers of either burlap-backed, white polyethylene sheeting, or a double thickness of burlap. For bridge decks, use only a double thickness of burlap. Use one type of cover for the duration of curing, unless a change in type is accepted. Place covers without marring the finished surface. Secure covers to prevent their being lifted and displaced.

Saturate the covers prior to use and keep in a saturated condition for the curing period. Cure for a minimum of 7 days; when high early-strength concrete is used, cure for a minimum of 3 days. Cure for at least the minimum time stated above and until minimum compressive strengths are attained, as specified in Section 704.1(d)4.b, as determined from molded cylinder specimens tested according to PTM No. 604.

As soon as the concrete has hardened sufficiently, place curing covers on the exposed concrete. If the double thickness of burlap method is used, place burlap so each strip overlaps one-half its width.

As soon as forms or sections of forms are loosened or removed, cover the exposed concrete surfaces with pre-saturated curing covers, then keep saturated for the remainder of the curing period.

**3.c Bridge Deck Intermediate Curing.** Apply an intermediate monomolecular film curing agent to all concrete bridge decks. If directed, apply additional applications to prevent surface drying before placement of curing covers.

Apply the monomolecular film in a light-fog application, using a pressure spray tank with an adjustable nozzle. Use a water-to-curing agent ratio and rate of application, both according to the manufacturer's recommendations. Agitate the solution before each application.

Apply the monomolecular film in a continuous film, immediately after the final finishing operation is completed on any area. Do not perform finishing after application of the curing agent.

After application of the monomolecular film, complete curing using water.

**4. Cool Weather Curing and Protection.** If the forecasted air temperature during concrete curing is expected to drop to 10 °C (50F) but not below 2 °C (35F), or if concrete is placed at an air temperature below 10 °C (50F) but above 2 °C (35F), follow the requirements for normal curing and protection. In addition, cover burlap with polyethylene sheeting; and place insulating mats, as specified in Section 711.1(e), or place hay or straw, to a depth of at least 300 mm (12 inches), over concrete not covered by forms. Keep the insulation mats, hay, or straw in place as required to maintain proper curing temperatures.

**5. Cold Weather Curing and Protection.** If the forecasted air temperature is expected to drop to 2 °C (35F) or lower, during concrete curing, or if concrete is to be placed at air temperatures below 2 °C (35F), comply with the requirements specified for normal curing and protection, and use heating and/or insulation, as necessary, to maintain the curing temperature for the duration of the curing period.

If forms are removed before the end of the curing period, provide additional heating or insulation, as necessary, to maintain the curing temperature for the remainder of the curing period.

After the concrete has cured for the required length of time, gradually lower its temperature to that of the surrounding air. Do not allow the temperature of the concrete to drop more than 12 °C (20F) in any 24-hour period for the first 3 days after the curing period. Continue to record the air temperature and curing temperature during this 3-day period.

**5.a Heating.** Furnish and place sufficient canvas and frames, or another type of housing to enclose and protect the fresh concrete and forms. Before placing the concrete, furnish necessary fuel and sufficient acceptable heating apparatus; preferably steam-heating equipment.

Keep the air surrounding the fresh concrete at a temperature above 10 °C (50F) but not more than 27 °C (80F). Keep the concrete covers moist during the curing period.

**5.b Insulating Mats or Foam Insulation.** Insulating mats or foam insulation, as specified in Section 711.1(e) and Section 711.1(f), respectively, may be used to maintain curing temperature.

Apply the mat insulation tightly against the forms. Seal the ends of the mat to exclude air and moisture. Overlap the insulation on previously placed concrete by 300 mm (1 foot).

When using steel forms, place the insulation tightly against the forms. In addition, insulate the framework of the steel forms, either by the use of the insulating mat material or foam insulation, or by draping polyethylene sheets or tarpaulins over the exposed members, to effectively reduce the heat loss.

Immediately repair tears in the mat liner. Where tie rods extend through the insulated form, place close-fitting washers on the rod against the mat and secure, to provide adequate protection.

Cover the tops of piers, abutments, and similar concrete surfaces with the insulation mat, tightly secured to prevent loss of heat.

For the areas around protruding reinforcement that cannot be protected with the insulation mat, cover with a double thickness of burlap. Cover with enough straw or hay to prevent loss of heat from the concrete during the curing period. In addition, cover insulated areas with tarpaulins.

Do not insulate bridge decks unless the underside is enclosed and preheated before the concrete is placed and the heat is maintained at the specified temperature during the entire curing period.

When foam insulation is used, use a minimum thickness of 40 mm (1 1/2 inches). The Contractor may use cracked molded foam boards only after repairs are made with an adhesive.

Keep the insulation protection in place for the full curing period, but do not allow the concrete temperature to rise above 70 °C (160F).

Do not expose fresh concrete to subfreezing temperatures. Provide standby heat, if directed. Do not expose fresh concrete to subfreezing temperatures. Provide standby heat, if directed. Failure to properly place the

insulation material or failure to maintain the necessary concrete temperature will be cause for the Representative to deny continued use of the material on the project, for curing in cold weather, and require the use of heating, as specified in Section 1001.3(p)5.a.

**(q) Removal of Falsework and Forms and Application of External Loads to Concrete.** Except for flood curing of concrete footings, do not count a day during which the curing temperature falls below 10 °C (50F) in the total elapsed days required for removal of falsework or forms or for the application of external loads on concrete.

**1. Removal of Falsework and Forms.** Keep falsework and forms under arches, box culverts, pier caps, slabs, beams, girders, and brackets in place for 5 days after placing the final portion of the section involved, after which they may be removed provided the concrete has attained a minimum compressive strength as specified in Table A. Determine the minimum compressive strength according to PTM No. 604. Cure test cylinders according to PTM No. 611.

During normal and cool-weather curing, keep forms for walls, columns, outside faces of pier caps, arches, sides of beams, and other vertical faces not sustaining loads, in place for a minimum of 12 hours after completing placement of concrete. Then, remove forms, provided the concrete has hardened enough to preclude damage resulting from form removal. Barrier forms may be removed in less than 12 hours, provided the concrete has hardened enough to preclude damage from form removal. During cold-weather curing, keep forms in place for a minimum of 5 days.

At construction joints, keep bulkheads in place for a minimum of 12 hours after placing concrete. Then, remove bulkheads provided the concrete has hardened enough to preclude damage resulting from removal of the bulkheads. During cold weather curing, keep bulkheads in place for 48 hours, and keep the concrete moist at all times.

Table A
Minimum Compressive Strength

| | Minimum MPa (psi) |
|---|---|
| Class AAA | 23 MPa (3,300 psi) |
| Class AA | 19 MPa (2,730 psi) |
| Class A | 17 MPa (2,500 psi) |

**2. Application of External Loads to Concrete.**

**2.a Dead Loads.** Do not begin work on wall, column, or pier shaft construction until 12 hours after placing footings. For footings on piles, do not begin work until 48 hours after placing footings.

Where falsework for the cap on pier bents is supported on the footings or from the ground, do not begin work on the cap construction until 24 hours after placing the columns.

Where forms are supported on collars attached to the columns, do not begin work on cap construction until 5 days after placing the columns, and the concrete has attained its minimum compressive strength, as specified in Table A.

Construct column- and pier-shaft lifts according to one of the following methods:

**Method 1.** Where the forms for previous lifts, not including the footing, are left in place and adequately braced, do not place the next higher lift until 24 hours after placing the lift immediately below.

**Method 2.** Where forms are supported by the concrete in the previous lift, not including the footing, and where other forms and bracing have been removed from the lower lifts, do not place the next higher lift until 5 days after placing the previous lift, and the concrete has attained its minimum compressive strength, as specified in Table A.

Do not place superstructure beams on abutment walls, or solid shaft piers until 3 days after placing the wall or shaft, and the concrete has attained its minimum compressive strength, as specified in Table A.

Do not place superstructure beams on caps, pier bents, or on cantilevers of hammerhead piers until 5 days after placing the caps or cantilevers, and the concrete has attained its minimum compressive strength, as specified in Table A.

**2.b Backfilling.** Backfill as specified in Section 206. Do not backfill or place material adjoining abutment walls, backwalls, retaining walls, box culverts, and arches until 7 days after placing last concrete, and then only if concrete has attained the 7-day Minimum Mix Design Compressive Strength as specified in Section 704, Table A.

Maintain symmetrical loading on each side of the span, and progress uniformly in placing embankment and structure backfill adjacent to, and over, arch rings, box culverts, or rigid frame structures, unless otherwise indicated.

**2.c Live Loads.** Do not allow diamond grinding and diamond saw grooving equipment or power-operated concrete buggies to cross a deck until 10 days after the deck concrete in a span has been placed and the deck concrete has attained its minimum compressive strength of 25MPa (3,600 pounds per square inch).

Do not place the conveyor-belt systems on a deck until 72 hours after the concrete is placed and their mass (weight) is uniformly distributed and operation of the system does not damage the deck.

Do not allow truck mixers, truck agitators, other heavy equipment, construction traffic, or the traveling public on a structure until authorized by the Representative. This authorization will be given as follows:

- A truck mixer not exceeding 8.0 km/hour (5 miles per hour) and a slip form paver for barrier will be allowed on the deck for construction of other concrete appurtenances when the concrete in the deck has attained a minimum compressive strength of 25 MPa (3,600 pounds per square inch) and after minimum 7 day wet cure. Do not allow more than one truck on the deck at a time in a span or continuous unit for each truck placement occurrence.

- Bridge deck may be opened to traffic after a period of 14 days after placing the last deck concrete and the deck concrete has attained a minimum compressive strength of 28 MPa (4,000 pounds per square inch).
  and;

- After a period of 7 days after placing the last barrier concrete and the barrier concrete has attained a minimum compressive strength of 21 MPa (3,600 pounds per square inch).

Do not construct barrier on new decks until 7 days after placing the deck concrete and the deck concrete has attained a minimum compressive strength of 25MPa (3,600 pounds per square inch).

Do not allow trucks or heavy equipment to travel within 3.5 m (12 feet) of barrier until 7 days after placing the barrier concrete and the barrier concrete has attained a minimum compressive strength of 21MPa (3,000 pounds per square inch).

Control speed of trucks, equipment, and the traveling public until barriers have attained a minimum compressive strength of 24 MPa (3,500 pounds per square inch).

**(r) Waterproofing.** Apply waterproofing as indicated or where directed, as specified in Section 680.3 and as follows:

**1. Cracks in Culverts.** Where directed, cover minor cracks in culverts by waterproofing them with an accepted sealer. Apply the sealer as recommended by the sealant manufacturer. Seal cracks on backfill sides only.

**2. Form Tie Holes.** If directed, satisfactorily waterproof form tie holes on the backfill side of the box or arch culverts.

**(s) Tack Coat for Bridge Decks.** If a bituminous concrete surface is to be placed on the bridge deck, apply a bituminous tack coat on the deck, before placing the bituminous material as specified in Section 460.3.

**(t) Backfilling and Placing Structure Backfill and Embankment.** Not used.

**(u) Defective Work.** Remove and replace concrete that is bulged, uneven, or that shows honeycombing or marks that cannot be satisfactorily repaired. If directed, remove and replace concrete that has not attained the minimum compressive strength.

## 1001.4 MEASUREMENT AND PAYMENT—

**(a) Cement Concrete.** Cubic Meter (Cubic Yard) or Lump Sum
As indicated, for the class specified, for the item indicated.
The Department will not make a deduction in measurement for anchor bolts, expansion plates, drainage openings, weep holes, pipes, or conduits if the volume displaced by an installation of opening does not exceed 0.4 $m^3$ (1/2 cubic yard).
The Department will not deduct the volume of reinforcement bars from the measured volume of concrete.
Where it is impractical to measure concrete in cavities or sink holes, the Department will measure by the volume shown on the certified slips of the delivered batch weights, as recorded by Department representatives assigned to the work.
The cost of concrete cores, taken to examine tremie-placed concrete, is incidental to the other concrete work.

**(b) Reinforcement.**

**1. Reinforcement Bars.** Section 1002.4
Dowel bars required for unplanned joints are incidental to other reinforcement.

**2. Steel-Welded Wire Fabric.** Kilogram (Pound)
Annealed iron wire, chairs, and ties are incidental to the mass (weight) of the steel wire fabric.

**(c) Structure Foundation Drain.** Meter (Linear Foot)
For the size indicated.
Measurement includes all pipe connections.

**(d) No. 57 Coarse Aggregate.** Cubic Meter (Cubic Yard)

**(e) Excavation.** Section 204.4
For the class indicated.

**(f) Backfill for Excavation Below Indicated Elevation.** Cubic Meter (Cubic Yard)
Paid as specified in Section 110.03.

**(g) Selected Borrow Excavation, Structure Backfill.** For the type indicated, and as follows:

**1. Volume Basis.** Cubic Meter (Cubic Yard)
Measured in place as compacted material, using the average end-area method.

**2. Mass (Weight) Basis.** Tonne (Ton)

**(h) Lighting Pole Anchorage.** Each
The price includes anchor bolts, nuts, washers, 35 mm (1 1/4-inch) conduit, junction box, drain pipe, steel angle, and required fittings.

# SECTION 1002—REINFORCEMENT BARS

**1002.1 DESCRIPTION**—This work is the furnishing and placement of reinforcement bars for cement concrete construction.

**1002.2 MATERIAL—**

**(a) Reinforcement Steel.** Reinforcement bars, Section 709.1. As indicated, provide epoxy coating for reinforcement bars as specified in Section 709.1(c). Galvanized reinforcement bars as specified in Section 709.1(e) may be substituted for epoxy-coated reinforcement bars.

**(b) Other Material.**

- Annealed Iron Wire—ASTM A 684/A 684M
- Cement—Section 701
- Water—Section 720.1
- Welding Material—Section 1105.02(t)

**(c) Mechanical Splice System.** From a manufacturer listed in Bulletin 15 and conforming to the following physical requirements:

| | |
|---|---|
| • Ultimate tensile strength of mechanical coupler system (California Test No. 670) | 90% of ultimate tensile strength of reinforcement bars, minimum |
| • Allowable slip (California Test No. 670) | 0.25 mm (0.0100 inch), maximum |
| • Yield strength of mechanical coupler | 125% of specified yield strength of reinforcement bars, minimum |
| • Fatigue resistance, allowable slip (California Test No. 670, +172 MPa to -172 MPa (+25 kips per square inch to -25 kips per square inch) for 10,000 cycles) | 1.25 mm (0.05 inch), maximum |

Provide epoxy coating for mechanical splice systems according to applicable portions of AASHTO M 284/M 284M.

Certify as specified in Section 106.03(b)3.

**1002.3 CONSTRUCTION—**

**(a) General.** Provide reinforcement bars free from injurious defects such as cracks and laminations. Provide reinforcement bars free from frost, dirt, oil, grease, paint, mortar, loose rust, mill scale, and other materials that would reduce bond. The Department will not reject reinforcement bars for bonded rust, surface seams, surface irregularities, or mill scale provided the minimum dimensions, cross-sectional area, and tensile properties of a hand wire brushed specimen meet the physical requirements for the size and grade of steel indicated.

Remove loose, scaly, or thick rust. A light powdery coating of rust, formed during project storage, does not require cleaning. The Representative will reject reinforcement bars with rusting that has caused detectable reduction in cross-

sectional area. Obtain the Representative's acceptance of in-place reinforcement bars before concrete is placed. Maintain the reinforcement bars in the correct position.

Verify the compatibility of the bar schedule with the structure plans and details. Make adjustments to the bar schedule, including reinforcement bar details and quantities, and obtain the Representative's acceptance before fabrication. The Department will not grant additional Contract time as a result of adjustments to the bar schedule or to reinforcement bars. With each shipment of reinforcement bars delivered to the project, have the material supplier furnish a bill of lading that provides an itemized listing, as shown on the bar schedule for individual structural units, of all bars in the shipment by quantity, size, length, mark, type, mass (weight), and bending dimensions, as indicated. Include general project identification information as well as any appropriate remarks and plan references (drawing number, description, etc.) on the bill of lading. Submit bills of lading to Department inspection personnel to verify and document field quantities and for the Department's project records.

**(b) Storage.** Section 106.05(d) and as follows:

Store reinforcement bars off the ground on platforms, skids, or other supports, and protect the reinforcement bars from mechanical injury and surface deterioration caused by exposure to conditions producing rust. Keep reinforcement bars free from frost, dirt, oil, grease, paint, mortar, loose rust, mill scale, and other materials that would reduce bond.

Handle and store epoxy-coated reinforcement bars by methods that will not damage the epoxy coating. Furnish all systems for handling epoxy-coated reinforcement bars with adequately padded contact areas if possible. Pad all bundling bands and lift all bundles with a strong back, multiple supports, or platform bridge to prevent bar-to-bar abrasion from sags in the bar bundle. Do not drop or drag bars or bundles. Transport and store epoxy-coated reinforcement bars on wooden or padded supports. For additional storage and handling requirements for epoxy-coated reinforcement bars see Section 1002.3(g)1.

For additional storage and handling requirement for galvanized reinforcement bars, see Section 1002.3(h)2.

**(c) Field Adjustment.** Furnish bars with shapes and dimensions, as indicated. Do not field bend except to make minor adjustments when approved by the Representative. If field bending or straightening is required, see Table A. Do not field bend rail or axle steel.

**TABLE A (Metric)**
**Bend and Straightening Requirements** [(1) (2)]

| Bar Size | Carbon Equivalent | Bend Temp. °C | Straighten Temp. °C | Bar Size | Dia. of Former Millimeters Min. |
|---|---|---|---|---|---|
| 10<br>15 | Unknown | 760-810 | 760-810 | 10<br>15 | 70<br>100 |
| 20 | 0.55 or less and A 706/ A 706M | 20-40 or 760-810 | 20-40 or 760-810 | 20 | 120 |
| 25 | Any | 760-810 | 760-810 | 25 | 150 |
| >25 | Bending and straightening not recommended | | | | |

(1) Use temperature sticks.

(2) Avoid:

- 230 °C to 320 °C
- 1000 °C and greater

**TABLE A (English)**
**Bend and Straightening Requirements** [(1) (2)]

| Bar Size | Carbon Equivalent | Bend Temp. F | Straighten Temp. F | Bar Size | Dia. of Former Inches Min. |
|---|---|---|---|---|---|
| 4 through 7 | Unknown | 1400-1500 | 1400-1500 | 4<br>5 | 3<br>4 |
| | 0.55 or less and A 706 | 70-100 or 1400-1500 | 70-100 or 1400-1500 | 6<br>7 | 5<br>6 |
| 8 | Any | 1400-1500 | 1400-1500 | 8 | 8 |
| >8 | Bending and straightening not recommended | | | | |

(1) Use temperature sticks.
(2) Avoid:

- 450F to 600F
- 1800F and greater

Note:
A. Apply heat to sufficient area to encompass bend area.
B. Apply heat for sufficient time to bring bar center to required temperature.
C. Maintain temperature while bending and/or straightening.
D. Allow free rotation.
E. Bend with smooth continuous application of force.
F. Straighten by moving hickey bar (if used) progressively around bend.

**(d) Placing and Fastening.**

**1. General.** Accurately place reinforcement bars as indicated and hold it firmly in position during the placing and settling of concrete using metal chairs or acceptable supports. Do not allow bar spacing to vary from the design spacing by more than 12 mm (1/2 inch). Do not allow the distance from the surface of the formwork to the bars to vary more than 6 mm (1/4 inch) from the design distance. Do not place reinforcement bars closer than 1.5 times the maximum nominal size of the aggregate used in the concrete mix design. Firmly tie bars with annealed iron wire or secure the bars with acceptable metal clips. Tie bars at all perimeter intersections and at all intersections on the top mat of bridge decks and in bridge barriers. For other intersections, when bar spacing is greater than or equal to 300 mm (12 inches), tie all intersections; when bar spacing is less than 300 mm (12 inches), either tie all intersections or tie alternate intersections in each direction to provide a staggered tie layout. Tie bundled bars together at not more than 1800 mm (6-foot) centers. When reinforcement bars are tied together and lifted into place as a unit, ensure stability of the unit and maintain proper bar alignment during lifting and placement operations. For epoxy-coated reinforcement bars and galvanized reinforcement bars, provide plastic-coated tie wire, epoxy-coated tie wire, metal clips, or plastic clips. If fabric reinforcement is shipped in rolls, straighten it into flat sheets before placing it. Do not weld cross bars (tack weld) for assembly of reinforcement bars unless authorized in writing by the Representative.

**2. Support Systems.** Support reinforcement bars in its proper position by use of mortar blocks, wire bar supports, supplementary bars, or other devices. Supply such devices of proper height and at sufficiently frequent intervals to maintain the distance between the reinforcement bars and the formed surface or the top surface of deck slabs within 5 mm (1/4 inch) of that indicated.

Support platforms, supporting personnel and equipment during concrete placement, directly on the forms and not on the reinforcement bars.

**2.a Mortar Block Supports.** Furnish mortar blocks of the same class as the concrete in which they are to be embedded. Ensure that block faces in contact with forms for exposed surfaces do not exceed 50 mm x 50 mm (2 inches by 2 inches) in size, and that their color and texture will match the concrete surface. If used on vertical or sloping surfaces, provide such blocks with an embedded wire for securing the block to the reinforcement bars. If used in slabs, use either a tie wire or, if the gravitational force of the reinforcement bars is sufficient to firmly hold the blocks in

place, a groove in the top of the block. For epoxy-coated reinforcement bars or galvanized reinforcement bars, use plastic-coated or epoxy-coated tie wires.

**2.b Wire Supports.** Furnish wire bar supports, such as ferrous metal chairs and bolsters conforming to industry practice as described in the Manual of Standard Practice of the Concrete Reinforcing Steel Institute. Ensure that chairs or bolsters that bear against the forms for exposed surfaces are either Class 1 - Maximum Protection (Plastic Protected) or Class 2, Type B - Moderate Protection (Stainless Steel Tipped) for which the stainless steel conforms to ASTM A 493, Type 430. For epoxy-coated reinforcement bars or galvanized reinforcement bars, provide plastic-coated, epoxy-coated, or galvanized wire bar supports and bar clips.

**2.c Plastic Supports.** Use chairs and bolsters that do not deflect more than 6 mm (1/4 inch) under the minimum point load requirement of 1.56 kN (350 pounds-force) as described in PTM No. 430. Use supports molded in a configuration that does not restrict concrete flow.

**3. Adjustments.** Adjust reinforcement used in post-tensioned concrete, or relocate it during the installation of prestressing ducts or tendons, as required to provide planned clearances to the prestressing tendons, anchorages, and stressing equipment, as approved by the Representative.

**(e) Splicing and Lapping.** Furnish all reinforcement in the full lengths, as indicated, unless otherwise allowed by the Representative.

Do not splice bars, except as indicated or directed. If splicing is allowed, lap the reinforcement bars as shown on the Standard Drawings and as indicated, and wire together securely. Do not substitute alternate bars unless allowed by the Representative. Stagger splices as far as possible.

In lapped splices, place and wire the bars maintaining the minimum distance to the surface of the concrete as indicated. Do not use lapped splices for Nos. 45 and 55 (Nos. 14 and 18) bars, except as provided in Articles 5.11.5.2.1 and 5.11.5.5.1 of the AASHTO LRFD Specification.

As indicated, use welded splices or mechanical splice systems. For welded splices, use butt splices only. Stagger welded splices or mechanical splice system connections if possible.

Only use welded splices if indicated or if the Chief Bridge Engineer gives written authorization to do so. Ensure that welding conforms to the Structural Welding Code, Reinforcing Steel, AWS D1.4 of the American Welding Society and applicable special provisions.

Do not use welded splices on epoxy-coated reinforcement bars or galvanized reinforcement bars. Do not weld so close to epoxy-coated reinforcement bars to cause any heating of the coating.

Assemble mechanical splice systems according to the manufacturer's recommendations. Mark reinforcing bars with scribe marks or indelible ink before splice attachment to ensure equal embedment.

If mechanical splice systems are used, construct sample and actual splices in the presence of the Representative. The Representative will select, for each size of reinforcement bar used, three splices, either sample or actual, to be tested for verification of physical properties. Submit verification samples to the MTD within 7 days.

Use an epoxy-coated mechanical splice system to splice epoxy-coated reinforcement bars. Paint the entire splice area with compatible epoxy paint after the system is assembled.

Use a galvanized mechanical splice system to splice galvanized reinforcement bars. Galvanize mechanical splice system in accordance with ASTM B 695 Class 50, Type II with a minimum thickness of 50 µm (2 mils) or 355 grams per square meter (1.2 ounce per square foot). Chromate in accordance with ASTM A767, Section 4.3

Do not encase mechanical splices in concrete until visual examination and required testing have been completed and approved.

**(f) Epoxy-Coating Exposed Stirrups.** If stirrups in precast bridge elements are not epoxy-coated during fabrication, epoxy-coat the exposed portion of the bars. Wire brush the bars before applying the epoxy coating. If epoxy-coated stirrups are expected to be exposed for more than 6 months, cover with opaque polyethylene, or other suitable material, to prevent ultra-violet damage to the epoxy coating.

**(g) Epoxy-Coated Reinforcement Bars.** In addition to the above, the following requirements apply if using epoxy-coated reinforcement bars:

**1. Storage, Handling, and Placement.** Where possible, do not store epoxy-coated reinforcement bars at the jobsite for more than 2 months. If field storage on site is expected to exceed 2 months, cover the epoxy-coated reinforcement bars or bundles with opaque polyethylene or other protective material. Provide ventilation to prevent condensation from forming under the covering.

Store, handle, and place epoxy-coated reinforcement bars at the jobsite according to ASTM D 3963/D 3963M. Inspect the bars before placement. If the epoxy coating is damaged and the damages do not exceed 2% of the surface area in any 0.3m (1-foot) section of the epoxy-coated reinforcement bars, repair all visible damage according to ASTM D 3963/D 3963M before bar placement. Replace epoxy-coated reinforcement bars if damage to the surface area exceeds 2% in any 0.3m (1-foot) section.

After placement, inspect the epoxy-coated reinforcement bars again and repair areas damaged during placement.

**2. Welding.** Do not weld.

**3. Appurtenances.** Use plastic-coated or epoxy-coated tie wire. Use epoxy-coated, plastic-coated, or galvanized chairs and metal supports. Submit any proposed alternate support devices for acceptance. Use appurtenances with a minimum coating thickness of 75 µm to 100 µm (3 mils to 4 mils).

**(h) Galvanized Reinforcement Bars**. In addition to the above, the following requirements apply if using galvanized reinforcement bars:

**1. Fabricate.** Fabricate reinforcement bars before galvanization. Use minimum bend diameters conforming to requirements given in Table 2 of ASTM A 767/A 767M. Make adjustments to the bar schedule, including reinforcement bar details and quantities and obtain the Representative's acceptance before fabrication.

**2. Storage, Handling, and Placement.** Where possible, do not store galvanized reinforcement bars at the jobsite for more than 30 days. Store in accordance with Section 1002.3(b) to allow air circulation to prevent the formation of wet storage stain. If field storage is expected to exceed 30 days, cover bars with opaque polyethylene or other protective material.

Provide galvanized reinforcement bars having uniform appearance. Do not use reinforcement bars with visible corrosion deposits, uncoated spots, or acid, flux or black spots.

When handling, avoid bundle-to-bundle or bar-to-bar abrasion and use equipment with protected contact areas.

Do not field bend galvanized reinforcement bars except to make minor adjustments when approved by the Representative. Do not apply heat to bend or straighten galvanized reinforcement bars.

Do not place or store galvanized reinforcement bars in contact with uncoated reinforcement bars or other uncoated steel or stainless steel.

After placement, inspect the galvanized reinforcement bars and repair areas damaged during placement in accordance with ASTM A 780/A 780M.

**3. Welding.** Do not weld.

**4. Appurtenances.** Use plastic-coated or epoxy-coated tie wire. Use epoxy-coated, plastic-coated, or galvanized chairs and metal supports. Submit any proposed alternate support devices for acceptance. Use appurtenances with a minimum coating thickness of 75 µm to 100 µm (3 mils to 4 mils).

**1002.4 MEASUREMENT AND PAYMENT—**

**(a) Reinforcement Bars.** Kilogram (Pound) or Lump Sum
As indicated for the type specified.
Galvanized coating mass (weight) is incidental to the mass (weight) of the reinforcement bar.
Annealed iron wire, chairs, and ties are incidental to the mass (weight) of the reinforcement bar.

**(b) Mechanical Splice System.** Each or Lump Sum
As indicated for the type specified.

Epoxy paint for painting the splice area after assembly is incidental, if epoxy-coated reinforcement bars and mechanical splice systems are used.

# SECTION 1003—DOWEL HOLES

**1003.1 DESCRIPTION**—This work is the drilling of holes for dowels and the grouting of the dowels in place.

**1003.2 MATERIAL**—

- Nonshrink Grout—Section 1001.2(e)

**1003.3 CONSTRUCTION**—Drill holes for dowels at the locations and to the diameter and depth as indicated. Grout the dowels in place, using nonshrink grout to form a complete bond between the dowels and the concrete. Repair structure damage caused by dowel operations.

**1003.4 MEASUREMENT AND PAYMENT**—Each

# SECTION 1005—PILES

**1005.1 DESCRIPTION**—This work is the furnishing and the driving of test piles, test load piles, and bearing piles. The following definitions apply:

**(a) Test Pile.** A pile driven to verify the pile hammer's capability, to determine driving characteristics, and to establish the predetermined pile tip elevation, before driving test load piles or bearing piles.

**(b) Test Load Pile.** A pile in a pile load test, also referred to as a load test pile.

**(c) Pile Load Test.** A test to determine pile capacity by the application of a static load.

**(d) Bearing Pile.** A pile driven for the purpose of providing structure support.

**(e) Point Bearing Pile.** A pile that develops bearing capacity primarily by point-bearing on bedrock.

**(f) End Bearing Pile.** A pile that develops bearing capacity primarily by embedment of the lower portion in a dense or hard-bearing stratum.

**(g) Friction Pile.** A pile that develops bearing capacity primarily from friction with the surrounding soil throughout the pile length.

**(h) Penetration.** The length of pile driven into a soil or rock stratum.

**(i) Driving Resistance.** The resistance of soil or rock strata to pile driving, in blows per length of penetration.

**(j) Penetration Rate.** The rate at which driving advances a pile into a soil or rock stratum, in millimeters (inches) per blow. Penetration rate is the reciprocal of the driving resistance.

**(k) Estimated Pile Tip Elevation.** The estimated elevation of the pile tip as indicated.

**(m) Predetermined Pile Tip Elevation.** The tip elevation, determined by the Representative, from the pile load test or test piles. The predetermined pile tip elevation locates the intended bearing strata for point bearing or end bearing piles, or establishes the length of friction piles. Predetermined pile tip elevations are used to verify or adjust the estimated pile tip elevations indicated.

**(n) Impending Damage.** A driving stress above which rupture or excessive deformation of the pile occurs. The point of impending damage is given as a percentage of the yield point of the material in the pile.

For timber piles, impending damage is defined as a driving stress of 85% of the crushing strength of the timber material as estimated from a wave-equation analysis.

**(o) Not Used.**

**(p) Maximum Permissible Driving Resistance for Timber Piles.** The driving resistance (in blows per 25 mm (blows per 1 inch)) at which 0.5 times the nominal pile capacity predicted by the wave equation analysis is equal to the factored critical load as indicated.

**(q) Wave Equation.** An equation developed from wave propagation theory, used to evaluate the integrity and the bearing capacity of piles, using strain and acceleration measurements taken from dynamic testing.

**(r) Pile Driving Analyzer.** A portable computer used to determine pile bearing capacity and integrity through dynamic testing.

**1005.2 MATERIAL—**

**(a) Timber Piles.** ASTM D 25

Certify as specified in Section 106.03(b)3.

Provide timber piles of either Southern Pine, Douglas Fir, or Western Larch; cut from live, sound, and solid trees; free from reverse bends and large unsound knots.

Timber piles are to be clean-peeled and pressure-treated.

Pressure treat according to AASHTO M 133 pressure process. Use preservatives of either creosote oil or creosote coal-tar solution. Retain a minimum preservative amount of 160 kg/m$^3$ (10 pounds per cubic foot) of wood if treated by the empty-cell process.

Furnish an affidavit, giving treatment details, obtained from the treating company.

Use timber piles with minimum 25 mm (1-inch) thick sapwood at the butt end and at least 25 mm (1 inch) of clean wood between any two inner bark strips.

Do not use timber piles with a defect or combination of defects that will impair the strength of timber piles more than the largest knot.

Measure the timber pile circumference or diameter under the bark, and limit the maximum and minimum measurements as follows:

**TABLE A (Metric)**
**Maximum and Minimum Timber Pile Measurements**

| Length (m) | 0.9 m from Butt (mm) | | | | Tip (mm) Minimum | |
|---|---|---|---|---|---|---|
| | Maximum | | Minimum | | | |
| | Circum. | Dia. | Circum. | Dia. | Circum. | Dia. |
| Under 12.0 | 1600 | 500 | 960 | 300 | 625 | 200 |
| 12.0 to 15.0 | 1600 | 500 | 960 | 300 | 550 | 175 |
| Over 15.0 to 21.0 | 1600 | 500 | 1040 | 325 | 550 | 175 |
| Over 21.0 to 27.0 | 1600 | 500 | 1040 | 325 | 475 | 150 |

**TABLE A (English)**
**Maximum and Minimum Timber Pile Measurements**

| Length (feet) | 3 feet from Butt (inches) | | | | Tip (inches) Minimum | |
|---|---|---|---|---|---|---|
| | Maximum | | Minimum | | | |
| | Circum. | Dia. | Circum. | Dia. | Circum. | Dia. |
| Under 40 | 63 | 20 | 38 | 12 | 25 | 8 |
| 40 to 50 | 63 | 20 | 38 | 12 | 22 | 7 |
| Over 50 to 70 | 63 | 20 | 41 | 13 | 22 | 7 |
| Over 70 to 90 | 63 | 20 | 41 | 13 | 19 | 6 |

Provide timber piles with acceptable metal points, firmly attached to the piles, in full contact with the pile tips.

**(b) Cast-in-Place Concrete Piles.** These piles consist of steel shells equipped with steel end closures or other acceptable designs, reinforced as indicated, then filled with Class A cement concrete, after driving.

**1. Steel Shells.** Provide the type and size shells as indicated and as follows:

- Of watertight construction.
- Cylindrical, uniformly tapered, step-tapered, or a combination of the shapes.
- Having a nominal diameter not less than 300 mm (12 inches) for cylindrical shells and not less than 300 mm (12 inches) for the butt end of uniformly tapered shells.
- Having a tip diameter of less than 200 mm (8 inches) for uniformly tapered shells.
- Having a diameter at any section of step-tapered piles not less than the diameter of a shell of uniform taper from point to butt and having the same butt diameter.
- Having plain, fluted, or other acceptable wall design.

Submit a certified report showing the chemical and physical properties of the base metal used in the shells, end closures, and splice material. Obtain the Representative's acceptance for end closure details and splicing details, if not indicated, before beginning driving.

The wall thickness indicated is the minimum required to satisfy structural design requirements. Increase the thickness, as necessary, to withstand driving without failure. If a minimum shell thickness is not indicated, use a thickness that will withstand driving without failure.

Submit a certification from the manufacturer of steel shell piles stating that the shells, end closures, and splice material comply with the specification requirements. Forward these certifications with the shipment, together with a copy of the certified report showing the chemical and physical properties of the base metal to the Representative for the project file.

Certify as specified in Section 106.03(b)3.

**1.a Thick-Wall Steel Shells.** Provide shells having a wall thickness of 3.8 mm (9 gage) or thicker; consisting of steel pipe, ASTM A 252, Grade 1, 2, or 3; or cold-rolled steel tubing, basic open-hearth steel (AISI G10100 (1010) (AISE C1010 or SAE 1010)) with a minimum yield strength of 345 MPa (50,000 pounds per square inch).

Provide end closures of forged steel, cast steel, steel plate, or other material as follows: forged steel, AISI 1020; cast steel, AASHTO M 103/M 103M, Grade U-415-205 (Grade U-60-30). For flat steel plate end closures, provide plates not less than 20 mm (3/4 inch) thick, according to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36). Provide end enclosures not extending more than 5 mm (1/4 inch) beyond the surface of the shell, welded to the shell.

Provide shells preferably in one piece without splices. If splicing is necessary, use extensions between the tip and butt end of at least 3.0 m (10 feet) long. At the butt ends, use extensions at least 1.5 m (5 feet) in length for approximately 75% of the shells within a footing. At the tip ends, use extensions, if necessary, at least 1.5 m (5 feet) in length.

Splice shells by welding using full penetration butt welds and acceptable backing bars, using acceptable sleeves with full perimeter fillet welds, or using another accepted design. Provide splices developing the yield strength of the shell based on the indicated shell thickness. If the shell thickness exceeds the required indicated thickness, base the splice strength on the indicated shell thickness, unless a stronger splice is needed to resist driving forces.

**1.b Thin-Wall Steel Shells.** Provide shells having a wall thickness less than 3.8 mm (9 gage). The indicated diameter is the diameter of a mandrel that can be inserted in the shell. Provide shell and end closures of basic open-hearth steel (AISI C1010 or SAE 1010) or other accepted material. Provide shell thickness that will withstand driving without failure and will support the surrounding material after the shell has been driven, but with a minimum thickness of 1.3 mm (18 gage). Provide end closures extending not more than 5 mm (1/4 inch) beyond the shell surface.

Make splices and end-closure connections with full perimeter welds or with other acceptable methods that keep the shells watertight after being driven.

**(c) Steel H-Piles.** Provide piles, pile sections, and splice material according to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36). Provide cast tip reinforcement according to AASHTO M 103/M 103M (ASTM A 27/A 27M), Grade 450-240 (Grade 65-35), and fabricated tip reinforcement according to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36). Preferably, provide each pile in one piece without splices. If splicing is allowed, use extensions between the tip and butt end, not less than 3.0 m (10 feet) long. At butt ends, use extensions at least 1.5 m (5 feet) in length for approximately 75% of the piles in a footing, as required. At the tip ends, use extensions at least 1.5 m (5 feet) long. Provide splices that fully develop the yield strength of the pile.

Submit a certified report showing the base metal chemical and physical properties used in the piles or pile sections, tip reinforcement, and splice material. Before pile driving, obtain the Representative's acceptance of tip reinforcement, splice location, and splicing details.

Submit a certification from the manufacturer of the steel H-piles and pile tip reinforcement as specified in Section 106.03(b)3. Forward these certifications within three working days after shipment, together with a copy of the certified report showing the chemical and physical properties of the base metal to the Representative for the project file.

**(d) Other Material.**

- Class A Cement Concrete—Section 704, with HRWR admixture and a slump of 125 mm to 200 mm (5 inches to 8 inches).
- Reinforcement—Section 709.1
- Welding—Section 1105.02(t)

## 1005.3 CONSTRUCTION—

**(a) Equipment.** Use pile-driving equipment of an acceptable type, mass (weight), and capacity. Use air compressors of sufficient capacity to provide 25% more air than shown in the manufacturer's specifications for air-driven hammers.

Acceptance of the pile hammer and driving equipment will not relieve the Contractor's responsibility for properly driving piles, in satisfactory condition, to the driving resistance and tip elevations indicated or directed.

Do not use capblocks or cushions containing asbestos.

**1. Hammers.** Use either drop-steam, air, or diesel actuated pile-driving hammers.

Use hammers capable of developing at least 9 500 J (7,000 foot-pounds) per blow for timber piles and not less than 16 000 J (12,000 foot-pounds) per blow for other types of piles, unless otherwise allowed.

Equip closed-end diesel hammers with a dial gage for measuring pressure in the bounce chamber. Provide a hose for the gage long enough to enable reading at ground level. Calibrate the dial gage to allow for losses in the gage hose. Verify the accuracy of the calibrated dial gage to allow for losses in the gage hose. Verify the accuracy of the calibrated dial gage both during driving of the test piles and, when directed, during driving of the bearing piles. Ensure that cylinder lift occurs when the bounce chamber pressure is consistent with the maximum energy given in the hammer specifications. Do not use closed-end diesel hammers that do not attain cylinder lift at the maximum energy bounce chamber relationship given in the hammer specifications.

Equip hammers with a suitable drive head or anvil that accurately and securely holds the top of the pile in correct position, with reference to the hammer, and that distributes the blows from the ram over the entire top area of the pile or mandrel.

Within reasonable limits, use the optimum type and size of hammer for the indicated pile and subsurface conditions at the structure site. The Representative will verify the capability of the hammer to properly drive the piles from driving records of test piles at each substructure unit, at locations indicated or directed. If information from indicated soundings, dug test pits, and auger or test borings is used to analyze subsurface conditions, refer to Section 102.05 for conditions pertaining to use of this information.

Use a hammer of a type and size that enables piles to be driven to any driving resistance without pile damage due to driving stresses.

An estimate of the point of impending damage, due to driving stresses, in piles will be made from a wave equation analysis for the hammer, drive head size, type of capblock, cushion material, and length of pile in the leads to be used, or by observations during the test-pile driving operation. The point of impending damage in steel piles or shells is defined as a driving stress of 100% of the yield point of the pile material, as estimated from a wave-equation analysis, or a lesser value if the strength of the pile or shell is governed by the strength of the splice. The Representative will reject hammers that cause damage in steel piles at any driving resistance.

Acceptance of a hammer relative to driving stress damage will not relieve the Contractor's responsibility for piles damaged because of misalignment of the leads, failure of capblock or cushion material, failure of splices, malfunctioning of the hammer, or other improper construction methods. The Representative will reject piles damaged for these reasons, if it is determined that the damage impairs the strength of the completed pile installation.

At least 21 calendar days before driving test piles, submit the hammer's operating specifications for review and acceptance. Include the following:

- The mass (weight), diameter, and length of the ram.
- Drive head and anvil dimensions and masses (weights).
- Capblock and cushion data, such as material, thickness, area, modulus of elasticity, and coefficient of restitution.
- Mass (weight) of hammer, mass (weight) of cylinder.
- Piston areas for double-acting or differential-acting air or steam hammers.
- Explosion force and maximum stroke for open-end diesel hammers.
- Bounce chamber pressure versus equivalent energy graphs for closed-end diesel hammers.
- Mandrel type and mass (weight), if applicable.

Measure inlet pressures for double-acting and differential-acting air or steam hammers, using a needle gage at the head of the hammer when driving test piles and, if directed, when driving bearing piles. As an alternative to periodic measurements with a needle gage, develop a pressure versus speed calibration for the driving conditions at the site.

If a hammer is used for timber piles for which the Maximum Permissible Driving Resistance (MPDR) is less than 20 blows per 25 mm (1 inch), do not drive piles beyond MPDR if piles do not reach bedrock. Although point bearing is discouraged, if piles are required to reach bedrock or into very dense stratum for capacity, do not use a hammer with MPDR less than 20 blows per 25 mm (1 inch). Size the hammer so that MPDR is approximately 20 blows per 25 mm (1 inch).

**2. Leads.** Construct pile driver leads to allow free movement of the hammer. Hold the leads in true vertical or inclined positions, as required, by guys or stiff braces to ensure support of the pile during driving. Provide leads of sufficient length so a follower will not be necessary under normal conditions. With the Representative's approval, the Contractor may drive bearing piles around cofferdams, or in areas where headroom is limited, without leads.

**(b) Piles.**

**1. General.** Do not drive piles until the excavation is complete in the areas the piles are to occupy, unless otherwise allowed by the Representative. Do not drive piles within 7.6 m (25 feet) of uncured concrete.

Use test piles and bearing piles of the types or sizes indicated. The Department may omit any or all test or bearing piles. Furnish each timber pile, steel shell for cast-in-place concrete piles, or steel beam pile of the full length indicated and in one continuous unit, unless otherwise allowed by the Representative. If a pile is too short for the intended purposes, extend it to the length directed, as specified in Section 1005.3(e).

**2. Driving Test Piles.** Unless otherwise indicated, drive test piles in one continuous operation, except for splicing, so that they can be incorporated into the permanent work. Drive piles to absolute refusal, unless otherwise indicated or directed. If test piles extend above ground for the open bent, Abutment on Mechanically Stabilized Earth Wall, or Integral Abutment construction, drive each pile with butt within 50 mm (2 inches) of the location indicated.

**3. Driving Bearing Piles.** Do not drive bearing piles until the Structure Control Engineer has established the predetermined pile tip elevation and driving resistance from representative test piles or pile load tests.

Drive piles plumb or to the batter indicated. Drive piles to absolute refusal, or to the predetermined pile tip elevation and to the driving resistance established from test piles or pile load tests.

Unless otherwise indicated, the predetermined pile tip elevation is considered approximate in order to allow for variations in the locations or strength of the stratum from which the pile obtains its primary capacity. The limits of the approximation is established from pile load tests or test piles.

Drive bearing piles for a given structure, bridge, or foundation unit with the same hammer, under the same operating conditions, and with the same type and size of capblock and cushion material used to drive the test piles or load test piles.

Redrive piles raised by the driving of adjacent piles to the required driving resistance and tip elevation.

The Structure Control Engineer will reject driven piles with a deviation of more than 50 mm in 3000 mm (2 inches in 10 feet), from vertical or from the batter indicated. Do not drive the piles with their tops more than 150 mm (6 inches) out of the indicated position after driving. If piles extend above ground for open bent construction, Abutment on Mechanically Stabilized Earth Wall, or Integral Abutment construction, drive each pile with the butt within 50 mm (2 inches) of the location indicated.

In full-depth footings, enclose piles that are driven closer to the edges of footings than indicated. Extend far enough to obtain the indicated encasement. Add additional reinforcement, as directed.

**4. Absolute Refusal.** For steel piles, absolute refusal is reached when the driving resistance attains an average of 20 blows per 25 mm (1 inch), or more. The total number of blows required to calculate the average driving resistance specified for absolute refusal is determined from test pile driving results. Minimum blow requirements are as follows:

**Case 1. Piles Required to Be Driven to Absolute Refusal into Sound, Well Defined Bedrock (Point Bearing Piles).** After the pile tip reaches the predetermined bedrock elevation, and after penetration becomes 6 mm (1/4 inch) or less for five consecutive blows, absolute refusal is reached if the penetration for five additional blows is less than 6 mm (1/4 inch).

**Case 2. Piles Required to Be Driven to Absolute Refusal into Soft or Decomposed Bedrock, or Dense or Hard Soil Strata (End-Bearing Piles).** After the pile tip reaches the predetermined elevation of the intended bearing stratum, and after the penetration becomes 12 mm (1/2 inch) or less for ten consecutive blows, absolute refusal is reached if the penetration for ten additional blows is 12 mm (1/2 inch) or less. After the pile tip enters the intended bearing stratum, if an unreasonably large number of blows is required to increase the driving resistance from 10 blows per 25 mm (1 inch) to 20 blows per 25 mm (1 inch), the Structure Control Engineer may waive the requirement for driving to absolute refusal.

**Case 3. Piles Which Attain Absolute Refusal Above Predetermined Pile Tip Elevations.** If hard driving is encountered because of dense strata or because of obstructions located above the bearing stratum identified by a predetermined pile tip elevation, absolute refusal is not reached until the Structure Control Engineer determines that the total number of blows, as the average driving resistance specified for absolute refusal, indicates that further driving will not advance the pile through the dense strata or obstructions.

The Structure Control Engineer will determine the acceptability of bearing piles that attain absolute refusal above the predetermined pile tip elevation. If bearing piles are determined unacceptable, drive additional piles at locations directed. If the additional piles also fail to reach the predetermined pile tip elevation, and if directed, drive additional test piles to determine whether the predetermined pile tip elevation may have to be adjusted. Perform test borings and pile load tests, if directed. If the predetermined pile tip elevation cannot be adjusted, and if directed, change

the type and size of pile. Perform augering, predrilling, spudding, pre-excavation, or jetting, if directed.

If bearing piles attain absolute refusal above the predetermined pile tip elevation due to freezing resulting from discontinuous driving, the Structure Control Engineer will reject the piles.

**5. Cast-in-Place Piles.** As indicated or directed for cast-in-place concrete piles, securely weld end closures to the shells of test and bearing piles.

Thoroughly clean driven shells of water and debris and obtain the Structure Control Engineer's acceptance before placing concrete in them. Use special care in filling the shells to avoid honeycombs and air pockets in the concrete.

**6. Timber Piles.** Avoid injury to timber piles during storage and handling. Protect timber pile butts with metal bands, collars, or other devices to prevent splitting, excessive brooming, or other damage to the pile.

Do not break the surface of treated timber piles and do not use cant-hooks, dogs, or pike-poles.

Apply three brush coats of hot creosote oil to all bolt holes, cuts, daps, or chamfers of timber piles made subsequent to the treatment as well as abrasions of the surface before driving and to tops of timber piles after cutoffs for impregnation treatment.

Furnish timber piles with sufficient length, including the complete removal of material damaged by driving.

Drive timber piles to a maximum bearing value of 250 kN (28 tons) as determined by the wave equation.

**7. Jetting Piles.** Jet piles, if directed. Do not jet through embankment areas. Use enough jets and enough volume and pressure of water at the jet nozzles to erode the material adjacent to and below the pile joint. Withdraw jets before the predetermined pile tip elevation is reached.

**8. Driving Piles through Embankments.** Drive piles through embankments until they penetrate approximately 3 m (10 feet) into original ground, unless absolute refusal is obtained in bedrock or in a dense or hard soil stratum less than 3 m (10 feet) below original ground. As indicated or directed, spud, auger, or predrill through the embankment material to the original ground.

**9. Splicing Piles.** For timber test piles, use the lengths indicated. If indicated lengths are insufficient, extend by splicing, as required. Do not use timber pile sections less than 1.5 m (5 feet) long.

The Contractor may splice or extend steel piles during the driving operation with the Structure Control Engineer's approval. Inspect driven steel shells using a safe light attached to a cord long enough to reach the entire pile length.

**10. Damaged Piles.** Remove piles showing damage due to improper driving, if the damage would impair the strength of the completed pile and if the pile cannot be rebuilt or extended. Backfill the resulting hole if it interferes with other construction. Drive another pile as close as possible to the required location within the indicated distance from the edges of the footing. Fill damaged steel shells left in place with concrete.

**11. Pile Tip Reinforcement.** Attach pile tip reinforcement of the necessary types and sizes to bearing piles at locations indicated. Use pile tip reinforcement for test piles and test load piles representative of the bearing piles for which tip reinforcement is indicated. The Contractor may use prefabricated or cast steel tips as an alternate to the indicated tip reinforcement. Submit details, including method of attaching, for acceptance.

**(c) Cutting Off Piles.** After piles have been driven and accepted, cut them off at the indicated top elevations, perpendicular to their axis, unless otherwise directed.

Cut off timber piles that support timber caps or grillage, to conform to the plane of the bottom of the superimposed structure.

**(d) Filling Shells with Concrete.**

**1. Filling Thick-Wall Steel Shells.** Fill shells with Class A cement concrete. As indicated, place reinforcement as specified in Section 1001.3(b).

Place and cure the concrete as specified in the applicable parts of Section 1001.3. Drop the concrete into the shells slowly without forming air pockets. Discharge concrete through hoppers with a short pipe centered on the shell for

piles without rebar-cages. Do not allow concrete to free-fall within the length of the rebar-cage.

Vibrate concrete within the rebar cage.

**2. Filling Thin-Wall Steel Shells.** As specified for thick wall shells and as follows:

Use reinforced concrete for shells 6.0 m (20 feet) in length or shorter, for the full length. Reinforce concrete for shells longer than 6.0 m (20 feet), to 6.0 m (20 feet) below the cut off elevation or as indicated. Unless otherwise indicated, the minimum vertical reinforcement required is six No. 15 (No. 5) reinforcing bars or their equivalent, spaced uniformly and parallel to the perimeter of the shell, with a 50 mm (2-inch) concrete covering measured from the shell interior surface to the face of reinforcement. Enclose the vertical steel bars with 6.35 mm (1/4 inch) round hoops. Space the hoops on centers 300 mm (1 foot) or less for a length of 1.2 m (4 feet) at each end of the reinforcement, and on centers 600 mm (2 feet) or less for the intervening portion. The Contractor may use equivalent spiral reinforcement in place of hoops.

**(e) Rebuilding or Extending Piles.** The Contractor may rebuild or extend by splicing piles driven below the indicated top of pile elevations, or piles cut off after being driven, if the Representative approves. However, do not splice pile reinforcement, unless allowed in writing by the District Executive.

Splice, rebuild, or extend timber piles using suitable timber, as indicated or as accepted.

The Contractor may rebuild or extend by splicing thick-wall shells for cast-in-place concrete piles and steel-beam piles, if both of the following conditions exist:

- The method to be used has been accepted, in writing, by the District Executive.
- The lengths of sections are as specified in Sections 1005.2.

The Contractor may splice thin-wall shells for cast-in-place piles at any point if the alignment of the shell is maintained. However, do not splice reinforcement unless allowed in writing by the District Executive.

While piles extend above ground for open bent construction, do not rebuild or splice between the cutoff elevation and a point 3.0 m (10 feet) into satisfactory material, unless otherwise directed.

**(f) Pile Load Tests.** If pile load tests are required, the proposal will specify the detailed requirements.

**(g) Bearing Value of Piles.** If piles are not required to be driven to absolute refusal, the Representative will determine driving resistances, tip elevations, and safe bearing values from pile load tests, pile driving analyzer tests, or wave equation analysis of the test pile-driving results. If a pile load test is used to predict the pile capacity, the product of a resistance factor of 0.8 times the predicted capacity shall meet or exceed the factored critical load as indicated. If a Pile Driving Analyzer is used to predict the pile capacity, the product of a resistance factor of 0.7 times the predicted capacity shall meet or exceed the factored critical load as indicated. If the wave equation is used to predict the pile capacity, the product of a resistance factor of 0.5 times the predicted capacity shall meet or exceed the factored critical load as indicated.

**(h) Pile Log.** A detailed and accurate record will be kept during the driving of piles, showing the pile numbers, types, sizes, actual lengths before driving, sound lengths after driving, driving dates, lengths in footings, penetration rates, model of the hammer, capblock material, capblock inspection dates, rebuilt lengths, extended lengths, and final pay lengths.

**(i) Welding.** Weld splices, pile tip reinforcement, or metal end-closures as specified in Section 1105.03(m) for the type and position of the welding required.

**1005.4 MEASUREMENT AND PAYMENT**—The Department will not pay for unauthorized piles, defective piles, unsatisfactorily driven piles, portions of bearing piles cut off, bearing piles not driven, or for any costs for such piles or portions of piles.

Augering, predrilling, spudding, pre-excavation, jetting below the original ground, extracting satisfactorily driven piles, and test borings related to such work, when directed to advance piles to predetermined pile tip elevations, will be performed as Extra Work. This Extra Work will be done at a negotiated price or on a force account basis, if payment for

such work is not otherwise provided for in the Contract.

The cost of spudding, augering, or drilling to original ground through embankments placed within this Contract is incidental for test piles and bearing piles, unless payment for such work is provided in the Contract.

The Department will not pay for the extraction and replacement of damaged piles.

**(a) Test Piles.** Lump Sum

The Department will pay for test piles at the Contract lump sum price per unit or group of units, including necessary cutting off, splicing and rebuilding to the indicated test pile length. The price includes necessary excavation for pile splicing, rebuilding, and extending; all pile driving equipment furnished on the project; costs of transporting the equipment to the project; erecting, maintaining, and moving the equipment within the project; and dismantling and removing the equipment from the project, and pile tip reinforcement.

Additional test piles and extensions in excess of the indicated number and location and the length of extensions added or placed in the leads to make the piles longer than the indicated test pile lengths will be measured and paid for by the meter (linear foot) price of bearing piles. The length will be measured from the driven end or the beginning of the splice to the top of the pile or cutoff elevation, for the corresponding type of bearing pile.

For any test piles specified in the proposal but not required to be placed, adjustment of payment will be made as specified in Section 110.02. Cutoff portions of test piles will remain the property of the Contractor.

Costs associated with the use of proximity switch(es) for the monitoring of piles, as specified, will be incidental to the price bid for test piles.

**(b) Bearing Piles.** Meter (Linear Foot)

Measured from the pile driven end to the indicated cutoff elevation. If piles are ordered driven to an elevation other than that indicated, measurement will be made from the new pile driven end to the cutoff elevation indicated or directed.

This will not include any portion of the tip reinforcement that extends below the driven end of the pile, if tip reinforcement is paid for separately.

The unit price includes costs of furnishing and driving, cutting off, splicing, rebuilding or extending and excavating necessary for splicing and rebuilding or extending.

A bearing pile that is in satisfactory condition after being driven and that meets specifications except for bearing capacity and/or stability, or because absolute refusal was attained above a predetermined pile tip elevation, will be considered acceptable for payment. If acceptable piles have to be replaced with another type of construction, and are removed or cut off, the length below the cut off elevation, or the bottom of the other construction, is the length for which payment will be made.

Piles that reach absolute refusal above a predetermined pile tip elevation due to freezing resulting from discontinuous driving are unsatisfactorily driven piles, and the Department will not pay for these piles. If either augering, predrilling, spudding, pre-excavation, or jetting is directed because of these unsatisfactory piles, the additional work is to be done at no expense to the Department.

The Department will not deduct the volume of concrete displaced by piles from the foundation concrete quantities.

Costs associated with the use of proximity switch(es) for the monitoring of piles, as specified, will be incidental to the price bid for bearing piles.

**(c) End Closures for Shells and Points for Timber Piles.** Metal end closures for shells for cast-in-place bearing piles and metal points for timber bearing piles will be included in the Contract unit price per meter (linear foot) for the pile of which it is a part. The Department will not pay separate or additional compensation.

End closures and points for test piles and test load piles will be included in the Contract lump sum prices for those items.

**(d) Bearing Pile Tip Reinforcement.** Each

# SECTION 1006—DRILLED CAISSONS

**1006.1 DESCRIPTION**—This work is construction of reinforced cement concrete drilled caisson foundations consisting of shaft sections with or without casings left in place, and with or without rock sockets or belled footings, all formed within drilled excavations.

The following definitions apply:

**(a) End Bearing Drilled Caisson.** Cast-in-place foundation element consisting of shaft section with or without enlarged bearing area at its base, a minimum of 750 mm (30 inches) in diameter, and deriving the majority of its compression load capacity through load transfer to the shaft base.

**(b) Bell Footing.** Enlargement at base of shaft.

**(c) Bearing Strata.** Layer(s) of soil or rock providing principal support at base of shaft.

**(d) Rock Stratum.** A stratum of geomaterial having an unconfined compressive strength equal to or greater than 1.7 MPa (250 pounds per square inch) that cannot be drilled with conventional earth augers or underreaming tools, thus requiring the use of special rock augers, core barrels, air tools, blasting, or hand excavation.

**(e) Shaft Section in Soil.** Length of caisson shaft from top of shaft to top of rock stratum.

**(f) Shaft Section in Rock.** Length of caisson shaft from top of rock stratum to top of rock socket.

**(g) Rock Socket.** Length of caisson in rock stratum below the shaft, providing a fixed connection between the caisson and the rock stratum.

**(h) Permanent Casing.** Steel pipe, typically of cylindrical shape, installed by drilling, driving, or vibrating that when filled with concrete, becomes a permanent part of the drilled caisson.

**(i) Temporary Casing.** Protective steel pipe, typically of cylindrical shape, installed by drilling, driving, or vibrating, that provides lateral earth support during shaft excavation, cleaning, and inspection; controls groundwater infiltration; and is removed as part of the concrete placement operation.

**(j) Obstruction.** A natural or manmade object above designated rock socket elevation that cannot be drilled with conventional earth augers or underreaming tools, and that requires the use of special rock augers, core barrels, air tools, blasting, or hand excavation.

**1006.2 MATERIAL—**

**(a) Casing.** Smooth, clean, rust-free metal casing of sufficient strength to withstand handling and installation stresses and the pressure of concrete, water, and the surrounding earth; and to prevent water seepage.

**(b) Class A Cement Concrete.** Section 704, with high-range water-reducing (HRWR) admixture and a slump of 125 mm to 200 mm (5 inches to 8 inches).

**(c) Reinforcement Bars.** Section 1002.2. Use deformed bars.

**(d) Bentonite Slurry.** A mixture of fully hydrated bentonite and clean fresh water of adequate unit mass (weight). Submit manufacturer's specifications, type, and properties of the slurry to the Representative for approval.

**(e) Welding Material.** Section 1105.02(t)

## 1006.3 CONSTRUCTION—

**(a) Excavation.** Excavate to the dimensions and elevations indicated, or as directed. Unless otherwise indicated, bore excavations for vertical caissons plumb to within a tolerance equal to 2% of the shaft length; and for battered caissons, as indicated, to within a tolerance equal to 5% of the shaft length but not more than 300 mm (1 foot). If holes are more than 150 mm (6 inches) out of plumb, redesign the footing that is to be supported by the caissons. If caissons are out of tolerance, make needed corrections to the structure at no additional expense to the Department. Do not place the top of a caisson out of the indicated position by more than 1/24 of the shaft diameter or 75 mm (3 inches), whichever is less. If belled footings are required, excavate to form a bearing area of the size and shape indicated. The Contractor may blast if allowed by the Representative. Submit blasting plan to the Representative for review and acceptance at least three weeks before the start of blasting operations. Do not disturb formations below or outside the limits of the caisson under construction or any previously constructed caissons adjacent to the excavation.

Do not excavate within three diameters of caissons with new concrete until 24 hours after concrete placement.

If satisfactory foundation materials are encountered at other than the indicated elevations, adjust drilling depths as directed.

If a caving condition or excess groundwater is encountered, discontinue the drilling operation and employ a construction method that prevents caving and groundwater infiltration, such as the installation of casings. As an alternate, the Contractor may drill in a bentonite slurry with removal of cuttings or dewatering, or other construction methods that control the size of the excavation, provided the Contractor can demonstrate the ability to perform such work to the satisfaction of the Representative.

Remove, as directed, caked material from the sidewalls and loose cuttings from the bottom of the excavation so that such material will not cause unanticipated settlement, reduce caisson capacity, or affect concrete strength.

If bentonite slurry is used to support the caisson excavation, provide slurry mix design for review and acceptance before caisson construction. As a minimum, provide mix design criteria for density, viscosity, shear strength, and pH and procedures for mixing, QC, maintaining level in excavation, cleaning, reuse, and disposal.

Provide casing through soil and broken or unstable rock at all times during hand cleaning and inspection of the excavation. If joining two or more sections of casing to obtain the required length, weld sections together as specified in Section 1105.03(m) to develop the full tensile strength of each section.

**(b) Test Holes.** For caissons founded on rock, drill standard NW (NX) size core borings at each caisson location, to a minimum depth of 3 m (10 feet) below the bottom of the excavation (caisson or rock socket), unless otherwise directed. Drill, log, store, and ship the samples according to the Department's Standard Specification for Subsurface Boring, Sampling, and Testing, Publication 222M (222). The samples will be used to determine whether there is material of sufficient strength and thickness to support the required load and for proper founding of caissons.

**(c) Probe Holes.** Drill 50 mm (2-inch) diameter unsampled holes at the specified locations, to the specified depth below the bottom of the excavation (caisson or rock socket), or as directed. The Representative will use the rate of drilling of the holes to determine whether there is satisfactory material or rock of sufficient thickness and type to support the required load, and to locate the presence of open joints, voids, soft rock, or other deleterious material that may be inadequate for support of the required load.

**(d) Exploratory Drilling.** Before drilling caissons, drill a 50 mm (2-inch) diameter unsampled hole at each caisson location, as indicated or directed. Drill the exploratory holes from existing grade to the top of the rock stratum. The exploratory drilling will be used to establish the presence of obstructions within the soil shaft of the caisson.

**(e) Inspection.** Do not place concrete until the foundation excavation has been inspected and accepted. If access to the bottom of the excavation for visual inspection cannot be provided because of inability to dewater the excavation using acceptable pumping methods, provide drilling logs and core samples, or other acceptable data, for determining the condition of the excavation and the quality of the foundation material. As a minimum, inspect each shaft that cannot be dewatered with an underwater video camera.

Follow safety practices as specified in Section 107.08 and include, as a minimum, the following items specifically required for inspection of drilled caisson excavations:

- Cover open excavations immediately upon completion or, if work is discontinued for any period of time, with a cover capable of preventing persons from falling into or entering the excavation without proper authorization. Secure the cover by approved methods.

- Provide casing through soil cavities and broken or unstable rock for inspection of the excavation.

**(f) Reinforcement.** Section 1002.3 and as follows:

Do not place reinforcement bars until all loose material has been removed from the bottom of the excavation and immediately before the start of concreting operations. Support reinforcement a minimum of 75 mm (3 inches) above bearing level and from the sides using precast concrete spacer blocks or other approved spacer devices, and secure it in position so that the required concrete cover is maintained throughout concrete placement.

Vibration of the concrete is required, unless the clear distance between bars is more than three times the bar diameter or three times the maximum aggregate size. Unless otherwise indicated or specified, place No. 20 (No. 6) deformed bars vertically around the circumference at a 150 mm (6-inch) spacing, and No. 10 (No. 4) bars as tie bars on 250 mm (12-inch) centers. Furnish bars with hooks meeting seismic requirements.

**(g) Dewatering.** Unless otherwise specified, dewater all excavations before placing concrete. A drilled caisson excavation is considered dry if less than 75 mm (3 inches) of groundwater is present in the bottom of the excavation at the start of concrete placement and the groundwater infiltration rate is less than 6 mm (1/4 inch) rise per minute. Remove water that has accumulated in the excavation after final inspection and before concrete placement using approved methods.

**(h) Concrete Placement.** Submit the method of concrete placement, including details on equipment, rate of placement, concrete head, etc., to the Representative for review and acceptance three weeks before anticipated first placement. Do not start concrete placement without written acceptance. Mix, place, vibrate, and cure concrete as specified in Section 1001.3. Place concrete within 18 hours of the completion of excavation and within three hours of final inspection. Keep the excavation free from accumulated seepage water and loose material until concrete is placed. Place the concrete for each caisson in one continuous operation. Thoroughly work and vibrate the upper 1.5 m (5 feet) of concrete. If the Representative determines that water seepage will be detrimental to the quality of the caisson or hinder proper placement of concrete by the free fall method, fill the excavation to the surrounding groundwater level with clean, fresh water and place concrete to the cutoff elevation by the tremie method, as specified in Section 1001.3(k)3.c, in one continuous operation. Provide documentation to satisfactorily demonstrate experience in the use of tremie or pumping procedures for placement of concrete for drilled caissons, and submit details of the placement method for review and acceptance. Do not allow concrete to come in contact with aluminum during placement.

**1. Placement by Free Fall Method.** Place concrete by free fall only in dry, clean, unobstructed excavations that are at least 750 mm (30 inches) in diameter. Provide a hopper and a section of rigid pipe not less than 1.5 m (5 feet) long and 250 mm (10 inches) in diameter to direct concrete fall and avoid impact with reinforcement on the sides of the excavation. Unless otherwise directed, limit depth of free fall to 7.6 m (25 feet).

**2. Placement by Tremie Method.** Place concrete using a rigid, watertight, ferrous metal tremie pipe, as specified in Section 1001.3(k)3.c. Begin placement with the tremie pipe discharge within 150 mm (6 inches) off of the bottom of the excavation. Maintain a concrete head of at least 1.5 m (5 feet) above the discharge at all times.

**3. Placement by Pumping Method.** Pump only if concrete placement cannot be done by other means. Place concrete by pumping through a flexible; ferrous metal, rubber, or plastic pipe with a minimum diameter of 150 mm (6 inches). Do not allow the concrete to segregate during pumping. If directed, pump 28 L (1 cubic foot) of concrete into a container so that the Inspector may verify that the concrete is not segregating during the pumping operation.

Begin pumping with the pipe discharge positioned not more than 150 mm (6 inches) off of the bottom of the excavation. Maintain a concrete head of not less than 1.5 m (5 feet) above the discharge at all times. Keep the pump hopper continuously filled with concrete to prevent entrapment of air in the discharge.

**4. Placement within Casing.** Use the free fall or tremie method to place concrete in dewatered excavations supported by casing. Pump concrete within casing only if placement cannot be done by other means. Use the tremie method to place concrete under water in casing supported excavations.

If the top of shaft elevation is below ground level at the time of concrete placement, provide an oversized casing from ground elevation to a point below the top of shaft to prevent extraneous material from falling into fresh concrete during and after placement. Keep the oversized casing in place until concrete has cured at least 24 hours.

For permanently cased drilled caissons that carry lateral loads, grout the area between casing and excavation to provide adequate bearing.

**5. Placement Under Bentonite Slurry.** Use the tremie method to place concrete in excavations supported with bentonite slurry. Pump concrete under bentonite slurry only if placement cannot be done by other means. Displace slurry with concrete beginning at the bottom of the excavation and proceeding upward, forcing the slurry out of and away from the top of the excavation.

**(i) Casing Removal.** If temporary casing is used, withdraw each section, except the final section, in partial stages, as concrete is deposited, at a rate that keeps the bottom of the casing below the top of the fresh concrete. During removal, ensure that there is no reduction in shaft cross-section and that displacement of steel reinforcement is less than 50 mm (2 inches) upward and less than 50 mm (2 inches) downward per 6 m (20 feet) of shaft length. Maintain the specified 75 mm (3-inch) reinforcement bar clearance at bearing level and on the sides during casing removal. If observations indicate otherwise, reduce the rate of casing removal and establish a head of concrete within the casing sufficient to offset the forces tending to cause concrete arching or displacement of the reinforcing cage. As concrete is deposited, withdraw the final section of casing to a point 600 mm (2 feet) below existing ground elevation and allow it to remain for approximately 2 hours, depending on the temperature. Then, completely withdraw the section or cut it off flush with existing ground. If cavities or unstable materials are encountered and the danger exists of losing concrete or of the concrete becoming mixed with extraneous material, cut off the casing at the top of shaft elevation and leave in place.

**(j) Records.** Prepare and submit detailed inspection reports for each shaft, and include the following information:

- Accurate location and dimensions of the excavation.
- Accurate top and bottom elevations.
- Measurement data for plumbness.
- Methods of excavation used.
- Description of materials encountered during excavation.
- Description of groundwater conditions encountered.
- Description of obstructions encountered and whether or not obstruction removal was achieved.
- Description of temporary or permanent casing placed including purpose, length, and wall thickness, and anchorage or sealing methods used, if any.
- Measurements of slurry quality including, as a minimum, density, viscosity, shear strength, and pH.
- Elevation at which bearing material was encountered. Description of bearing material. Probe holes made, along with method of probing, rate of drilling in rock, samples taken, tests made, and conclusions reached with regard to adequacy of bearing material.
- Shaft, bell footing, and rock socket measurements.

- Description of clean-out methods and adequacy of initial clean-out and final clean-out just before concrete placement.
- Record of depth of water in excavation and rate of water infiltration before concrete placement.
- Record of reinforcing steel inspection for position and adequacy.
- Method of concrete placement and casing removal, if any. Record of concrete head during removal of casing. Record of concrete elevation when vibration started.
- Difficulties encountered including soil inclusion, voids, shaft squeeze-in, and casing collapse.
- Concreting curves showing actual versus theoretical volume of concrete required to fill caisson excavation.
- Condition of concrete delivered to site including record of slump, density, air content, and other tests. Record of cylinders made for compression testing.
- Any deviations from the specifications.

**(k) Qualifications.** Construct the caissons with a supervisor and workforce experienced in the construction of drilled caissons, and meeting the following qualifications:

- Submit a list containing at least five projects that, together, demonstrate a minimum of three years experience in the construction of drilled caissons, including the proposed method of concrete placement. Include a brief description of each project, and the name and telephone number of owner's representative knowledgeable in each project listed.
- Furnish the name of a Professional Engineer registered in the State, with at least 3 years of experience in the design and construction of drilled caissons, who is to direct the work.
- Furnish the names of drill operators and on-site supervisors under the direction of the Professional Engineer. Each drill operator and on-site supervisor must have at least 1 year of experience in the construction of drilled caissons.
- Do not use only the company names of consultants or manufacturers to meet the requirements of this section; use the names of the personnel.
- Submit documentation of staff qualifications to the Representative and allow at least 21 calendar days for approval.

## 1006.4 MEASUREMENT AND PAYMENT—

**(a) Drilled Caissons, Shaft Section.**

**1. Shaft Section in Soil.** Meter (Linear Foot)
Measured from the shaft top to the top of rock.

**2. Shaft Section in Rock.** Meter (Linear Foot)
Measured from the top of rock to the shaft bottom.

**(b) Drilled Caissons, Bell Footing.** Each

**(c) Drilled Caissons, Rock Socket.** Meter (Linear Foot)
Measured from the shaft bottom to the socket bottom. For uneven rock surfaces, measure length of rock excavation from the rock surface at shallowest depth to the socket bottom.

**(d) Permanent Casing for Drilled Caissons.** Meter (Linear Foot)
The Department will measure and pay for temporary casing left in place, as specified in Section 1006.3(i), as permanent casing.

**(e) Test Holes.** Meter (Linear Foot)
Augering through overburden, from existing ground surface to the elevation at which NW (NX) core boring is to begin (bottom of caisson or rock socket excavation as specified in Section 1006.3(b)), is incidental to this work.

**(f) Probe Holes.** Meter (Linear Foot)

**(g) Exploratory Drilling.** Meter (Linear Foot)

**(h) Obstructions.** Meter (Linear Foot)
The unit price includes mobilization of drilling equipment.

# SECTION 1008—PREFORMED NEOPRENE COMPRESSION JOINT SEAL FOR BRIDGES

**1008.1 DESCRIPTION**—This work is the furnishing and installation of preformed neoprene compression seals for bridge joints.

**1008.2 MATERIAL—**

**(a) Seal and Lubricant Adhesive.** Section 705.4(d) and from a manufacturer listed in Bulletin 15. Notify the District Executive as to the brand of seal to be furnished. Do not change the brand, except with written permission from the District Executive.

**(b) Premolded Expansion Joint Filler.** Section 705.1

**(c) Foam Joint Fillers.** Section 705.4(e) or (f), except that the dimensions specified in Section 705.4(f) do not apply.

**1008.3 CONSTRUCTION—**

**(a) General.** Construct the joint as indicated by forming or sawing.

**(b) Basic Joint.** Place two strips of foam joint filler in the joint, with one strip placed tightly on top of the other. Provide a depth of the upper strip equal to the depth of the seal plus 20 mm (3/4 inch). After the joint is sawed, remove this upper strip of foam with the broken concrete.

**(c) Seal Groove.** The opening into which the seal is to be installed is the seal groove. The width of the seal groove is equal to the basic joint width, plus the two seal seating ledge widths. Make joints true to alignment, ±5 mm (±1/4 inch), with their faces vertical and uniform in width throughout their length.

**1. Deck Slab.** If a sawed joint is used, saw, as soon as practical, the seal groove in the deck slab using a double-bladed, self-propelled concrete saw, to the width and depth indicated. Begin the saw-cut at the centerline of the bridge and proceed beyond the gutter line in one operation. Use a saw speed that minimizes spalling. After sawing, remove the concrete to produce smooth, even seal seating ledges.

**2. Curb on Sidewalk Section.** Form or saw cut the seal groove in the curb, sidewalk, and barrier section, as indicated or as shown on the Standard Drawings.

**(d) Seal Installation.** Before installing the seal, thoroughly clean the joint to remove foreign material, including broken concrete. Keep the joint in a dry or damp-dry condition. Swab the lubricant adhesive on the faces of the groove according to the material manufacturer's instructions. While the adhesive is wet, install the seal according to the manufacturer's instructions.

For curb and sidewalk installations, the Contractor may notch the seal to allow bending. Install the seal with the top surface continuous. At walls, place the top of the seal in contact with the deck joint at a uniform depth of 5 mm (1/4 inch) minimum to 15 mm (1/2 inch) maximum below the deck surface. Waterproof the intersection of the vertical and horizontal seals at the gutter line. Do not install cocked or twisted seals.

Unless indicated, do not make field joints in seals. The Contractor may use watertight, factory-spliced, bonded joints. If necessary to stretch the seal during installation, do not exceed 5% elongation.

If the seal is damaged during installation, remove and install a new seal. Seal or cap the ends of the seal.

**1008.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measured out-to-out along centerline of seal, including horizontal, vertical, inclined, or curved portions.

# SECTION 1012—PEDESTRIAN RAILING

**1012.1 DESCRIPTION**—This work is the construction of a pedestrian railing.

**1012.2 MATERIAL**—Before fabrication, submit shop drawings of the railing for review and acceptance.

**(a) Railing.**

- Aluminum-Alloy Casting—ASTM B 26/B 26M, Alloy SG70A-T6 or ASTM B 108, Alloy SG70A-T6.
- Aluminum-Alloy Bolts—ASTM B 211/B 211M, Alloy 2024-T4.
- Aluminum-Alloy Nuts—ASTM B 211/B 211M, Alloy 6061-T6.
- Aluminum or Nylon Washers—Section 1103.11(b)
- Bolt Heads—Regular hexagon, ANSI B18.2.3.5M (ANSI B18.2).
- Nuts. Finished hexagon, ANSI B18.2.4.6M (ANSI B18.2)—Threads, Class 6, 6g, or 6H (Threads, Class 2, 2A, or 2B).
- Other Aluminum Alloys—Section 1013.2(a)

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

**(c) Caulking Compound.** Section 705.8

**1012.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Before erection, thoroughly coat the surface of aluminum alloys in contact with other metals, stone masonry, or concrete with caulking compound. After erection and alignment, seal openings between metal surfaces and concrete with caulking compound.

After the concreting and other operations have been completed, thoroughly clean the railing. Remove accumulations of oil, grease, dirt, or foreign materials, using a solvent cleaner.

**(b) Assembly.** Assemble, as shown on the accepted shop drawings and the Standard Drawings.

Make cuts true, smooth, and free from burrs or ragged edges. Fillet-drill all re-entrant cuts, before cutting. Do not flame cut.

To facilitate bending, the Contractor may heat material to a temperature of 205 °C (400F) for a period not exceeding 15 minutes.

Drill rivet and bolt holes, or subpunch 5 mm (3/16 inch) smaller than the nominal diameter of the fastener; then ream to size.

**1012.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measured from center to center of end posts. The Department will not deduct gaps at lighting pole foundations.

# SECTION 1013—ALUMINUM BRIDGE RAILING

**1013.1 DESCRIPTION**—This work is the construction of an aluminum bridge railing.

**1013.2 MATERIAL**—Before fabrication, submit shop drawings for review and acceptance.

**(a) Railing.**

- Cast Aluminum Railing Posts—ASTM B 108, Alloy A444-T4 or ASTM B 26/B 26M, Alloy SG70A-T6.
- Aluminum-Alloy Extruded Bars, Rods, Shapes, and Tubes—ASTM B 221/B 221M, Alloy 6061-T6 or 6351-T5.
- Aluminum-Alloy Drawn Seamless Tubes—ASTM B 210/B 210M-Alloy 6061-T6.
- Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube—ASTM B 241, Alloy 6061-T6, 6061-T4 or Aluminum-Alloy Extruded Structural Pipe and Tube ASTM B 429, Alloy 6061-T6.
- Aluminum-Alloy Sheet and Plate—ASTM B 209/B 209M-Alloy 6061-T6, 1100-0 or Alclad 2024-T4.
- Aluminum-Alloy Bars, Rods, and Wire—ASTM B 211/B 211M, Alloy 6061-T6, 6262-T9, or 2024-T4. (Alloy 2024-T4 with an anodic coating of 5 µm (0.0002 inch) minimum thickness and dechromate or boiling water seal.)
- Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded—ASTM B 308/B 308M-Alloy 6061-T6
- Toggle Bolts—Section 1014.2(a)
- Miscellaneous—Aluminum wedges, shims, end caps, washers, and nuts of acceptable material.

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

**(c) Caulking Compound.** Section 705.8

**1013.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Section 1012.3(a)

**(b) Assembly.** Section 1012.3(b) except:
At bend areas, do not vary the diameter of rail tubes by more than 5% of the outside diameter, when rail tubes are bent to the radii indicated.

**1013.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)
Measured from center-to-center of end posts. The Department will not deduct gaps at lighting pole foundations.

# SECTION 1014—STEEL BRIDGE RAILING

**1014.1 DESCRIPTION**—This work is the construction of a steel bridge railing.

**1014.2 MATERIAL**—Galvanize materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings for review and acceptance.

**(a) Railing.**

- Steel Rails—Rails may be either pipe conforming to ASTM A 53, Type E or S, Grade B; or tubing conforming to ASTM A 500 or A 501.
- Railing Posts—ASTM A 47/A 47M, Grade 24018 (Grade 35018), or ASTM A 536, Grade 60-40-18.
- Toggle Bolts—An acceptable, galvanized type, capable of supporting a 40 kN (9,000-pound) load in tension, when tested through a 25 mm (1-inch) round hole. Toggle bolts may be cadmium-plated to conform to the requirements of ASTM B 766, Class 5, in place of galvanizing.
- Miscellaneous—Malleable iron wedges, shims, end caps, washers, and nuts of acceptable material

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

**(c) Caulking Compound.** Section 705.8

**1014.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Before erection, use caulking compound to thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound to seal openings between metal surfaces and concrete.

**(b) Assembly.** Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, paint with two coats Zinc Dust-Zinc Oxide Primer, Bulletin 26. Assemble the rail members to grade and the posts normal to grade.

Make cuts true, smooth, and free from burrs or ragged edges. Fillet-drill all re-entrant cuts, before cutting. As indicated, provide slotted holes for expansion.

The diameter of holes in the posts, for anchor bolts, may exceed the nominal bolt diameter up to 50%, with a maximum measurement of 12 mm (1/2 inch) greater than the nominal bolt diameter.

Place joints, as indicated.

At bend areas, do not vary the diameter of rail tubes by more than 5% of the outside diameter when rail tubes are bent to the radii indicated.

**1014.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measured from center-to-center of end posts. The Department will not deduct gaps at lighting pole foundations.

# SECTION 1015—PROTECTIVE BARRIER

**1015.1 DESCRIPTION**—This work is the construction of a protective barrier on bridges over electrified railroads.

**1015.2 MATERIAL**—Before fabrication, submit shop drawings for review and acceptance.

**(a) Barrier.**

- Aluminum-Alloy Extruded Section—ASTM B 221/B 221M, Alloy 6061-T6 or 6351-T5.
- Aluminum-Alloy Sheet and Plate—Alloy 6061-T6
- Aluminum-Alloy Bolts—Section 1103.11(a)
- Aluminum-Alloy Nuts—ASTM B 211/B 211M, Alloy 6061-T6.
- Aluminum or Nylon Washers—Section 1103.11(b)
- Bolt Heads—Regular hexagon. ANSI B18.2.3.5M (B18.2)
- Nuts—Finished hexagon, ANSI B18.2.4.6M (B18.2) Thread, Class 6, 6g, or 6H (2, 2A, or 2B)
- Other Aluminum Alloys—Section 1013.2(a)

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

**(c) Caulking Compound.** Section 705.8

**(d) Miscellaneous Connection Elements.**

**1.** Used for barrier attachment at PA HT Bridge Barrier, PA Type 10M Bridge Barrier and PA Bridge Barrier

- High strength bolts. ASTM A325 as specified in Section 1105.02(d), galvanized as specified in Section 1105.02(s).
- Elastomeric pads and washers. Section 1113.03(h), Type I
- Fabric bushing material, Section 1113.03(h), Type II
- Anchor bolts. Section 1105.02(c)3, galvanized as specified in Section 1105.02(s).

**2.** Used for barrier attachment at PA HT Bridge Barrier and PA Type 10M Bridge Barrier.

- Galvanized plate channel assembly, C200 x 20 (C8 x 13.75), 19mm (3/4 inch) fill plate and 12 mm x 75 mm x 380 mm (1/2 inch x 3 inch x 1 foot 3 inches) connection plate. ASTM A709M, Grade 250 (A709, Grade 36), as specified in Section 1105.02(a), galvanized as specified in Section 1105.02(s).

**3.** Used for barrier attachment at PA Bridge Barrier.

- 12 mm (1/2 inch) fill plate as specified in Section 1105.02(a), galvanized as specified in Section 1105.02(s).

**1015.3 CONSTRUCTION**—As shown on the Standard Drawings and as specified in Section 1013.3.

**1015.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)
Measured from end-to-end of barrier.

# SECTION 1016—PROTECTIVE FENCE

**1016.1 DESCRIPTION**—This work is the construction of barrier protective fences and sidewalk protective fences.

**1016.2 MATERIAL**—Before fabrication, submit shop drawings for review and acceptance.

**(a) Protective Fence (Steel).**

**1. Fabric.** Section 1110.01(a), size of mesh, 25 mm (1 inch).

**2. Fabric Tie Wire.** 3.76 mm (No. 9 gage) aluminum wire; or 3.76 mm (No. 9 gage) steel wire, galvanized, conforming to ASTM F 626, or aluminized, conforming to ASTM A 491.
Certify as specified in Section 106.03(b)3.

**3. Posts, Rails, and Fittings.** End, corner, and line posts; top and bottom rails; brace rails; fittings; and hardware, as specified in Section 1110.02(a), ANSI Schedule 40 pipe, with plain ends.
Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

**(c) Caulking Compound.** Section 705.8

**1016.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

**(a) General.** Fasten fabric to the line posts, top and bottom rails, and brace rails, using tie wires spaced not more than 600 mm (24 inches) apart; fasten to end and corner posts using 5 mm x 10 mm (3/16-inch by 3/8-inch) stretcher bar bands. Use stretcher bars with square edges attached by threading through the fabric, attached with clamps, or attached by other positive mechanical means.

Use brace bands and stretcher bar bands 3 mm x 25 mm (1/8 inch by 1 inch), with 10 mm (3/8-inch) diameter by 40 mm (1 1/2 inches) long, non-removable bolts.

Do not use bent or damaged posts or rails. Place moisture-proof post tops. Position line-post tops to pass the top rail through the post tops.

Place top rails in 6 m (20-foot) lengths, with couplings or expansion devices joining the lengths to form a continuous brace for each stretch of fence. Fasten top rails to end and corner posts by means of rail ends and brace bands.

Use brace rails at end and corner posts, midway between the top and bottom rail, extending from the end or corner post to the adjacent line posts.

Fasten bottom rails and brace rails to end, to corner, and to line posts, using rail ends, brace ends, and brace bands.

Place truss rods, 10 mm (3/8 inch) in diameter, with turnbuckles, between the brace ends of the brace rail and the bottom rail.

**(b) Steel Welding.** According to AWS.

**1016.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measured from center-to-center of end posts. The Department will not deduct gaps at lighting pole foundations.

# SECTION 1017—PRESSURE MORTAR POINTING AND SURFACING

**1017.1 DESCRIPTION**—This work is the pointing and the surfacing of areas of structures.

**1017.2 MATERIAL—**

**(a) Cement.** Section 701

**(b) Fine Aggregate.** Type A, Section 703.1

**(c) Water.** Section 720.1

**(d) Reinforcement Bars.** Section 709.1

**(e) Fabric Reinforcement.** AASHTO M 55 (ASTM A 185). Use fabric reinforcement, consisting of galvanized, welded straight-line fabric, conforming to one of the following:

- 2.68 mm (No. 12 gage) wire, spread 50 mm (2 inches) in each direction;
- 3.43 mm (No. 10 gage) wire, spaced 75 mm (3 inches) in each direction; or
- as indicated.

Certify as specified in Section 106.03(b)3.

**(f) Burlap.** Section 711.1(d)

**(g) Liquid Membrane-Forming Curing Compound, Clear.** Section 711.2(a)

**(h) Expansion Bolts.** From a manufacturer listed in Bulletin 15.
Certify as specified in Section 106.03(b)3.

**1017.3 CONSTRUCTION—**

**(a) Preparation of Structure.** Thoroughly clean the surfaces and voids of rust, scale, grease, loose and disintegrated particles, and material that might impair the bond between the surfaces to be covered and the mortar mixture. Remove unsound concrete and mortar, as directed. Clean by means of compressed air and waterblasting, by handscraping, and by sandblasting, if necessary.

**(b) Placing Reinforcement.** Lap adjacent sheets of fabric at least 100 mm (4 inches) for 50 mm (2-inch) mesh and at least 150 mm (6 inches) for 75 mm (3-inch) mesh. Fasten fabric together with wire ties at intervals of not more than 450 mm (18 inches).

**1. Steel Surfaces.** Place fabric on the top, sides, and bottom of steel members. Bend the fabric to conform to the outlines of the members and hold approximately 20 mm (3/4 inch) away from the surface of the members, or as directed. Place 6 mm (1/4-inch) diameter bars vertically on each side of the webs, then tie in place, using holes in the webs or clip plates. Space on 900 mm (3-foot) centers, or as indicated. Tie the fabric outside of and to the bars, on approximately 300 mm (12-inch) centers. Place the fabric or bars clear of the surface of the members.

**2. Masonry Surfaces.** In areas of buildup for the replacement of disintegrated material, unless otherwise indicated or directed, place a layer of fabric for each 75 mm (3-inch) layer of mortar or fraction thereof. More than one layer of fabric may be attached to an anchor bolt, provided the bolt is long enough.

Hold the fabric in place by means of lead-collared expansion bolts, either 6 mm x 75 mm (1/4 inch by 3 inches), or 10 mm x 100 mm (3/8 inch by 4 inches). Use longer bolts, where necessary. Space 6 mm (1/4-inch) diameter bolts approximately 500 mm (20 inches) center-to-center in each direction, starting 75 mm (3 inches) from the outside edges of the areas to be pressure-mortared. Space 10 mm (3/8-inch) diameter bolts approximately 750 mm (30 inches) center-to-center in each direction, starting 150 mm (6 inches) from the outside edges of the areas to be pressure mortared. Fasten the fabric to the expansion bolts away from the prepared surface, with 25 mm (1 inch) clear below the finished surface of the repair.

Where existing reinforcement is exposed due to removal of deteriorated concrete, fabric may be tied to this reinforcement at 450 mm (18-inch) intervals, to form a cage to position and support the fabric within 25 mm (1 inch) of the finished surface of repair.

Avoid excessive fabric layers, which may create planes of weakness or internal stresses.

**(c) Mixing Mortar.** Mix the mortar of one part cement and 3 1/2 parts fine aggregate. Thoroughly dry-mix the mortar in a batch mixer. Screen the dry-mix and remove material retained on a 4.75 mm (No. 4) sieve, before placing the mixture in the hopper of the mortar pressure gun. Do not mix more than 1 hour's supply of mortar at a time. Keep the mixture in the gun bin thoroughly stirred.

**(d) Pressures.** At the gun, supply air pressure of at least 240 kPa (35 pounds per square inch) when shooting the mixture. Increase the air pressure, as necessary, when the lift is greater than 7600 mm (25 feet), or when using more than 30 m (100 feet) of hose. Maintain uniform air pressure. At the nozzle, maintain a uniform water pressure of at least 100 kPa (15 pounds per square inch) greater than the air pressure at the gun. Supply pressure in the lower gun chamber to produce a nozzle velocity of 115 m/s to 140 m/s (375 feet per second to 450 feet per second), with a 32 mm (1 1/4-inch) tip opening. Vary these pressures and velocities only when directed. Determine the nozzle pressure and velocity from the nozzle velocity meter attached to the gun.

**(e) Moisture Content of Mortar.** Use approximately 8% to 10% moisture, by mass (weight), when shooting, of approximately 0.31 L of water per kilogram (3 1/2 gallons of water per bag) of cement. Do not use a greater quantity of water than necessary to produce a proper mixture. When using reinforcement fabric, supply a moisture content of approximately 8%, for mortar below the fabric, and approximately 9% to 10% above the fabric.

**(f) Application.** Perform pressure mortar work under the continuous supervision of an experienced pressure-gun foreperson, using only experienced personnel as gun and nozzle operators. When pointing masonry, saturate the surfaces with clean water before applying mortar. When surfacing structural steel, keep the outer edges of the mortar at the flanges and stiffeners square and true to line by using shooting strips, placed to maintain the specified dimensions without trapping the rebound.

Use guide strips at corners and other places, where necessary, to ensure true lines, corners, and the placement of specified thickness, dimensions, and designs. Bring mortared surfaces to a reasonably true plane, then finish the entire mortared area with a pressure-gun finish. Apply the main body of the mortar in at least two coats. Apply bottom surfaces in at least two coats to obtain proper adhesion and to avoid sagging. Bring the last main coat to within 3 mm (1/8 inch) of the proposed surface, then correct irregularities and remove high spots with trowels. Give the entire surface a thin coat of mortar, but do not trowel or float. If directed, give the final surfaces a finish using a long-bristled brush, saturated with clean water, then dragged over the surfaces. Do not work the surfaces with the brush.

For masonry pointing, or pointing and surfacing, fill voids with mortar, making the surface flush with the adjacent face of the structure. After completing the pointing, clean the face of the masonry.

Shoot mortar at right angles to the surface, holding the gun nozzle approximately 900 mm (3 feet) from the surface, when using a 20 mm (3/4-inch) or a 25 mm (1-inch) nozzle, or 1200 mm (4 feet) from the surface, when using a 32 mm (1 1/4-inch) nozzle. Use a shorter distance only where working space requires closer shooting. Remove deposits of loose fine aggregate. If any deposit of loose, fine aggregate is covered by succeeding layers of mortar, remove the surfacing and replace with suitable mortar. At the end of a day's work or at other required stopping periods, slope off the mortar to a thin edge. Do not use square joints. Before shooting the adjacent section, joining new work to old work, or placing additional coats, clean this sloped portion, old work, or previous coat.

Saturate the previous coat by a combination of air and water blasting. Do not place mortar unless the air temperature or the surface on which it is placed is 10 °C (50F) or higher.

**(g) Curing.** Immediately after initial hardening, saturate mortar and keep wet for a period of at least 96 hours. Protect pressure mortar pointing and surfacing on masonry surfaces, and where practical on structural steel, with burlap. Keep burlap wet during this curing period.

If allowed as an alternative to burlap curing, apply Liquid Membrane Forming Curing Compound, Clear, as specified in Section 1001.3(p)3.a.

Cure in cool and cold weather, as specified in Section 1001.3(p).

**(h) Backfilling.** For spaces excavated around areas being pointed and surfaced, backfill with acceptable embankment material in layers no more than 100 mm (4 inches) in depth. Thoroughly compact mechanically, as specified in Section 202.3(f).

## 1017.4 MEASUREMENT AND PAYMENT—

**(a) Pressure Mortar Surfacing.** Square Meter (Square Yard)

**(b) Pressure Mortar Pointing.** Meter (Linear Foot)

# SECTION 1018—REMOVAL OF EXISTING BRIDGES OR CULVERTS

**1018.1 DESCRIPTION**—This work is the removal and disposal of existing bridges, culverts, or superstructures.

**1018.2 MATERIAL—**

- Topsoil—Section 802.2
- Seeding and Soils Supplements—Section 804.2
- Mulching—Section 805.2

**1018.3 CONSTRUCTION—**

**(a) General.** Submit a plan to the District Executive showing or describing the demolition and removal methods to be used for the removal of an existing bridge or culvert, as indicated. Do not proceed with this demolition work until the plan has been reviewed and accepted. Within the plan, provide methods for the protection and safety of the general public and public utilities.

If the structure to be removed is over or under a railroad, submit the accepted demolition plan to the railroad company's Area Engineer. Do not proceed with the demolition work until written acceptance is received from the railroad company. Provide a copy of this written acceptance to the Department. Notify the railroad company 10 days before starting demolition work. Failure to obtain the railroad company's acceptance will require an alternate plan submittal to the Department and the railroad company for review and acceptance.

After removing the existing structure, backfill the area where the existing bridge or culvert was removed, as specified in Section 202.3(f). Grade into the existing topography. If directed, place topsoil. Seed and provide soil supplements, as specified in Section 804.3. Use a type and rate of seeding and soil supplements typical for project. Mulch with the type and rate of mulch typical for project, as specified in Section 805.3.

Where the removal area coincides with new construction, backfill voids below the elevation of the bottom of the proposed footings, using acceptable material, then compact, as specified in Section 202.3(f).

If indicated, leave in place portions of the existing substructure that do not interfere with new construction, landscaping, or other operations. Provide documentation (photographs, survey notes) for portions of the structure to remain in place if blasting is used as a method of removal.

**(b) Structures Retained by the Department.** If indicated, remove members or parts of the structure to be retained by the Department. Match-mark the members or parts, and place them within the right of way at an indicated or directed location, within 300 m (1,000 feet) of the existing structure. If indicated, load the members or parts, haul them to, and unload them at, the indicated location. If indicated, load the members or parts on railroad cars, ready for shipment.

**(c) Structures Retained by the Contractor.** If not otherwise indicated, the Department will not retain structures, or parts of structures. Remove and dispose of the structure, or parts of the structure, in a satisfactory manner.

**1018.4 MEASUREMENT AND PAYMENT—**

**(a) Removal of Existing Bridge.** Lump Sum

When removal area coincides with excavation area of new construction, the pay limit for removal extends 300 mm (1 foot) horizontally beyond the outer limits of the structure being removed.

The Department will pay for backfilling of voids below the indicated elevation of the bottom of proposed footings for new construction as specified in Section 1001.4(f).

**(b) Removal of Existing Culvert.** Lump Sum

When removal area coincides with excavation area of new construction, the pay limit for removal extends 300 mm (1 foot) horizontally beyond the outer limits of the structure being removed.

The Department will pay for backfilling of voids below the indicated elevation of the bottom of proposed footings for new construction as specified in Section 1001.4(f).

**(c) Removal of Existing Bridge Superstructure.** Lump Sum

# SECTION 1019—PROTECTIVE COATING FOR REINFORCED CONCRETE SURFACES

**1019.1 DESCRIPTION**—This work is applying a protective coating on concrete surfaces.

**1019.2 MATERIAL—**

**(a) Boiled Linseed Oil.** Section 503.2
Certify as specified in Section 106.03(b)3.

**(b) Epoxy Resin (For Abutments, Pier Caps, and Endwalls).** A two-component, epoxy resin system, as follows:

**1. General.** An epoxy-type base polymer, thermosetting resin as follows:

- Composed of 100% reactive constituents (condensation products of the reaction of epichlorohydrin with bisphenol A).
- Essentially pure, diglycidyl-ether of bisphenol A, containing no more than trace amounts of hydrolyzable chlorine.
- Epoxide equivalent between 465 and 530.
- Reacting system consisting of a blend of condensation polymers of dimerized and trimerized unsaturated, fatty-acids and an aliphatic polyamine.
- Pigmentation added so the cured coating conforms to the Federal Color Standard 595, No. 16357.
- Nonskid material added, if directed.

**2. Physical Requirements of the Mixed Epoxy System.**

- Viscosity—0.3 to 0.7 Pa·s (300 centipoises to 700 centipoises) at 22 °C (72F)
- Pot Life—a minimum of 7 hours at 24 °C (75F)
- Minimum solids content—48%
- A cured system that does not exhibit amine blushing or sweating.

When the pigmented finished coats are tested for abrasion, according to ASTM D 968, a minimum of 25 L of sand is required to abrade a 25 µm (1-mil) thickness of coating.

A 64 µm (2 1/2-mil) dry film thickness of the coating, tested by ASTM D 522, is required to pass a 3.2 mm (1/8-inch) diameter mandrel test, without splitting the film or causing loss of bond.

**3. Sampling.** A representative sample of each component will be taken for the required tests, either from a well blended bulk lot, before packaging or by withdrawing thief samples from no less than 5% of the containers comprising the lot or shipment. Unless the samples show evidence of variability, they may be blended into a single composite sample to represent that component. Package materials may be sampled by random selection of containers or each component from each lot. The entire lot of both components may be rejected if samples fail to meet any specified requirements.

**4. Packaging and Marking.** Furnish the two components in separate containers that are nonreactive with the contained materials. If directed, provide a container size so the recommended final mixture proportions can be obtained by combining one container of a component with one or more containers of the other component. Have containers marked as base polymer and reacting system, showing the mixing directions and usable temperature range. Have each container marked with the name of the manufacturer, the lot or batch number, the date of packaging, pigmentation, if any, and the quantity in kilograms (pounds) and liters (gallons).

Indicate the potential hazards on the package, according to the Federal Hazardous Products Labeling Act.

**5. Certification.** If directed, certify, as specified in Section 106.03(b)3. Provide either a copy of the manufacturer's dated test report or a statement, accompanied by a copy of the dated test results, showing the system has been sampled and tested.

**(c) Penetrating Sealers (For Reinforced Concrete Substructure Surfaces).** Furnish a penetrating sealer from a manufacturer listed in Bulletin 15 as follows:

- Silicates in Water.
- Epoxies Dispersed in Water. Only use on surfaces that the sealer does not totally encapsulate the structural unit being treated.
- Organo-Silicon Compounds in Solvent.
- Resins in Mineral Spirits.

Certify as specified in Section 106.03(b)3.

**(d) Penetrating Sealers (For Bridge Superstructure).** A one-component, penetrating sealer material, composed of a minimum of 40% silane or siloxane material, with no petroleum distillates meeting the following properties:

- **Water Absorption.** The final average percent water absorbed, for concrete coated with the protective sealer, not greater than 20.0% of the final average percent water absorbed by the uncoated reference concrete.
- **Moisture Vapor Transmission.** The final average percent moisture loss, for concrete coated with the protective sealer, not less than 75.0% of its final average percent water absorption.
- **Chloride Ion Penetration.** The final average absorbed chloride ion content, for concrete coated with the protective sealer, not greater than 15.0% of the final average absorbed chloride ion content of the uncoated reference concrete.
- **Durability.** The protective sealer does not show any signs of weathering, discoloration, or deterioration after 6 months of exposure to atmospheric conditions.

Certify as specified in Section 106.03(b)3.

## 1019.3 CONSTRUCTION—

### (a) Boiled Linseed Oil.

#### 1. Areas and Preparation.

**1.a General.** Thoroughly dry and clean the surfaces of dirt, debris, oil, grease, and foreign matter that would prevent protective coating penetration, adhesion, or drying. Do not use membrane-forming curing compound where linseed oil treatment is to be applied.

Apply the protective coating as soon as possible after completion of a structure or portion of a structure.

**2. Application.** Section 503.3(b)

**3. Safety Precautions.** Section 503.3(c)

**(b) Epoxy Resin.**

**1. Substructures (Subject to Staining).** If indicated, apply epoxy resin protective coating as follows:

**1.a Surface Preparation.** Clean sound, dry, new concrete surfaces, of laitance or other potential bond-inhibiting matter. Do not apply epoxy until 28 days after placing concrete, unless allowed to apply sooner. Do not use membrane-forming curing compounds where epoxy treatment is to be applied.

Clean old concrete surfaces of oil, grease, and potential bond-inhibiting matter by acid etching, using a 10% to 15% muriatic-acid solution. Spread the acid solution and allow it to react for 3 minutes to 5 minutes or until bubbling has subsided. Flush the surface with clear water and allow to dry. Where, in the Representative's opinion, acid etching is insufficient to clean the concrete, sandblast or use another acceptable method of mechanical abrading. Sandblast steel surfaces until bright metal is exposed. Then immediately apply the protective coating to prevent the reoccurrence of oxidation.

**1.b Mixing.** Measure and mix, as recommended by the manufacturer of the epoxy, in a clean mixing container. Thoroughly mix the epoxy using a 400 rpm to 600 rpm (low speed, ± 2-inch) electric drill, and paddle-type mixer. After mixing, let the material stand for an induction period of one hour before application.

**1.c Application.** Apply the mix by brush, roller, or spray. If applied by roller, use a first-quality, long-nap roller for rough surfaces and a short-nap roller for smooth surfaces. If applied by spray, use an externally atomized spray gun. For spray application, use a thinner of the type and quantity recommended by the manufacturer of the epoxy.

Apply two thin, uniform coats of the mixed material, each approximately 50 µm to 75 µm (2 mils to 3 mils) dry film thickness (100 µm to 125 µm (4 mils to 5 mils) wet thickness). Apply the second coat 24 hours after the application of the first coat. Use a rate of cover recommended by the manufacturer of the epoxy. Apply at temperatures between 16 °C and 32 °C (60F and 90F).

**(c) Penetrating Sealers.**

**1. Substructures.**

**1.a Surface Preparation.** Thoroughly dry and clean the surfaces of dirt, debris, oil, grease, and foreign matter that would prevent protective coating penetration, adhesion, or drying.

**1.b Application.** Apply penetrating sealer, which does not discolor the concrete, to areas indicated according to the manufacturer's instructions.

**2. Bridge Superstructure.** Apply protective coating as specified in Section 1019.2(d) and manufacturer's recommendations after concrete in the bridge deck has cured and has completed an initial drying period of a minimum of 14 days and the deck surface is dry. Apply to exposed concrete roadway surfaces of bridge decks; to curbs, sidewalks, divisors, and concrete median barriers; and to inside and top surfaces of barrier.

**1019.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

For the type indicated.

The Department will pay for additional maintenance and protection of traffic, if necessary for the application of additional protective coating to bridge decks experiencing excessive cracking, as specified in Section 110.03(d).

# SECTION 1020—TOOTH EXPANSION DAM WITH DRAIN TROUGH

**1020.1 DESCRIPTION**—This work is construction of a tooth expansion dam with fabric reinforced drain troughs for bridge joints.

**1020.2 MATERIAL—**

**(a) Fabricated Structural Steel.** Section 1105.02(a)2, shop painted as specified in Section 1060.

**(b) High Strength Bolts.** Section 1105.02(d)

**(c) Stainless Steel Bolts and Studs.** ASTM F 593. Certify as specified in Section 106.03(b)3.

**(d) Stainless Steel Washers and Lock-Nuts.** ASTM F 594. Certify as specified in Section 106.03(b)3.

**(e) Galvanizing.** Section 1105.02(s)

**(f) Polyester or Nylon Fabric.** Certify as specified in Section 106.03(b)3. Conform to the following requirements:

| | |
|---|---|
| • Number of plies | 2 |
| • Minimum fabric mass (weight), kg/m$^2$ (oz./sq. yd.) | 0.25 (7.5) |
| • Minimum tensile strength N/mm (lb./in.), ASTM D 378 | 74 (425) |

**(g) Rubberized Trough Material.** Certify as specified in Section 106.03(b)3. Furnish Butadiene Acrylonitrile Elastomer conforming to the following requirements:

| | |
|---|---|
| • Hardness shore 'A', ASTM D 2240, minimum – maximum | 60-70 durometer |
| • Minimum tensile strength, MPa (psi), ASTM D 412 | 9.7 (1400) |
| • Minimum elongation at break, %, ASTM D 412 | 300 |
| • Oven aging, 70 hours at 100 °C (212F), ASTM D 573 | |
| Maximum elongation loss, % | -25 |
| Maximum tensile strength loss, % | -35 |
| Maximum hardness points change | +10 |
| • Brittleness to heat aging, ASTM D 2137 | -18 °C (0F) |
| • Tear resistance, N/mm (lb./in.), Die C, ASTM D 624 | 21 (120) |

| | |
|---|---|
| • Resistance to ozone aging, ASTM D 1149 (Method B, bent loop) | No cracks, 70 hours @ 40°C (104F) and 50 ppm ozone, |
| • Oil swell, ASTM D 471, 70 hours @ 100 °C (212F) using IRM 903 oil, mass change % maximum | 45 |

**(h) Fabric Composite Properties.** Preformed fabric material consisting of the multi-ply polyester or nylon fabric and rubberized trough material, vulcanized to form a laminate, with the following properties:

| | |
|---|---|
| • Minimum thickness, mm (in.) | 3 (1/8) |
| • Minimum composite tensile strength of the fabric reinforced bridge trough, N/mm (lb./in.), ASTM D 378 | 140 (800) |
| • Maximum elongation @ ultimate tensile strength, % ASTM D 412 | 30 |
| • Maximum resistance to water absorption, (less than 10% mass (weight) gain for 7 days of water immersion @ 70 °C (150F), ASTM D 471 – Procedure for Change in Mass with Liquid on One Surface Only | 10 |

**1020.3 CONSTRUCTION**—Construct as shown on the Standard Drawings and as follows:

Prepare shop drawings as specified in Section 105.02(d). Obtain acceptance of the shop drawings before beginning fabrication.

Use a prequalified fabrication shop as specified in Section 1105.01(a).

Weld as specified in Section 1105.03(m).

Fabricate and erect the expansion dam according to the shop drawings and as appropriate for the bridge deck grade and crown. Preset the dam opening before shipment and assemble with temporary shipping angles.

Install the dam as indicated. After erection, remove the temporary shipping angles and grind plates smooth.

Place concrete under the expansion dams, vibrate until the concrete is forced through air holes, and strike off excess concrete. After the concrete has cured, clean air holes and fill with an approved sealer.

Do not splice the drain trough, unless indicated. If splices are indicated, use splices vulcanized by the manufacturer. Do not use longitudinal splices.

Before trough installation, apply the intermediate and finish coats of paint to all areas that will be inaccessible after the trough is installed.

Install the trough with stainless steel fasteners.

**1020.4 MEASUREMENT AND PAYMENT**—Kilogram (Pound)

# SECTION 1021—ARMORED PREFORMED NEOPRENE COMPRESSION DAM

**1021.1 DESCRIPTION**—This work is the furnishing and installation of armored preformed neoprene compression dams for bridge joints, including the necessary fabricated structural steel.

**1021.2 MATERIAL—**

**(a) General.** Use a prequalified fabrication shop, as specified in Section 1105.01(a).

**(b) Preformed Neoprene Compression Seal and Lubricant Adhesive.** Section 705.4(d), from a manufacturer listed in Bulletin 15.

**(c) Structural Steel.** Section 1105.02(a)2, painted as specified in Section 1060 or hot-dip galvanized as specified in Section 1105.02(s). The galvanization in the retainer extrusion must be of uniform thickness and free of excessive build-up, which would hinder the installation of the dam.

**(d) Studs.** Section 1105.02(e)

**1021.3 CONSTRUCTION**—As shown on the Standard Drawings and as follows:

Before fabrication, submit shop drawings, as specified in Section 105.02(d), showing complete details, dimensions, size, type, and compression-deflection characteristics of the seal, as well as other information and data necessary for the complete fabrication and erection of the dam. Obtain acceptance of shop drawings before beginning manufacture.

The seal may be installed in the shop, at the width determined for the erection temperature. For a shop-installed seal, make final width adjustment on the completed seal, if necessary, in the field for the temperature at the time when the dam is securely fastened to beams. No field adjustment will be needed for a ± 6 °C (± 10F) variation in temperature from the temperature for which the joint width was adjusted in the shop.

After width adjustment, the seal may be installed in the field.

Before installing the seal, clean metal surfaces in direct contact with the seal, to remove foreign material and to provide for proper bond between the seal and the metal surfaces. Clean, as specified in Section 1060.3(b).

Swab the lubricant-adhesive on the faces of the angles forming the groove, according to the material manufacturer's instructions. While the adhesive is wet, install the seal, as recommended by the manufacturer.

Do not splice the seal, unless indicated. If splices are indicated, use splices vulcanized by the manufacturer.

If stretching of the seal during installation is unavoidable, do not exceed 5% elongation.

Place the top of the seal at the walls, in contact with the deck joint structural steel, at a uniform depth of 5 mm (1/4 inch) minimum to 15 mm (1/2 inch) maximum below the deck surface.

The Department will not accept cocked or twisted seal installations.

Remove and replace seals that are damaged during installation.

**1021.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

For the movement specified.

Measured out-to-out along the centerline of the exposed surfaces of the seal and the steel plates, including sidewalks if applicable, following the vertical and sloped faces of curbs and barriers, resulting in a true length, not a horizontally projected length.

# SECTION 1022—STEEL BRIDGE HAND RAILING

**1022.1 DESCRIPTION**—This work is construction of a steel bridge hand railing.

**1022.2 MATERIAL—**

**(a) Railing.**

- Pipe for the Rails—ASTM A 53, Type F, Schedule 40, certified as specified in Section 106.03(b)3.
- Plates—AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36). Certify as specified in Section 106.03(b)3.
- Welding Material—Section 1105.02(t)

**(b) Toggle Bolts.** Use an acceptable galvanized type capable of supporting a 4.5 kN (1,000-pound) load in tension, when tested through a 19 mm (3/4-inch) round hole. Toggle bolts may be cadmium-plated to meet the requirements of ASTM B 766 (ASTM A 165), Class 5 (Type TS), in place of being galvanized.

Certify as specified in Section 106.03(b)3.

**(c) Malleable Iron Wedges, Shims, End Caps, Washers, and Nuts.** Certify as specified in Section 106.03(b)3.

**(d) Anchor Bolts, and Nuts and Washers for Anchor Bolts.** Section 1105.02(c)2

**(e) Caulking Compound.** Section 705.8

**(f) Galvanizing.** Section 1105.02(s)

**1022.3 CONSTRUCTION**—Construct as shown on the Standard Drawings and as follows:

**(a) General.** Submit shop drawings for review and acceptance before starting fabrication.

Before erection, coat the surface of posts in contact with concrete or masonry, using caulking compound. After erection and alignment, use caulking compound to seal openings between metal surfaces and concrete.

After the concreting and other operations have been completed, clean the railing. Use an acceptable solvent cleaner to remove accumulations of oil, grease, dirt, and foreign materials.

**(b) Assembly.** Remove blemishes and scratches from exposed surfaces. Assemble the rail members with the rails parallel to grade and with the posts normal to grade. Place joints as indicated.

Make cuts true, smooth, and free from burrs or ragged edges.

Fillet drill all re-entrant cuts before cutting.

**(c) Welding.** Section 1105.03(m)

**1022.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measured from center to center of end posts. The Department will not deduct gaps at lighting pole foundations.

# SECTION 1023—ALUMINUM BRIDGE HAND RAILING

**1023.1 DESCRIPTION**—This work is construction of an aluminum bridge hand railing.

**1023.2 MATERIAL—**

**(a) Railing.**

- Pipe for the Rails—ASTM B 241-Alloy 6061-T6, 6063-T6 or ASTM B 429-Alloy 6061-T6, 6063T6.

- Plates—Section 1103.04(a)

Certify as specified in Section 106.03(b)3.

**(b) Toggle Bolts.** Use an acceptable galvanized type capable of supporting a 4.5 kN force (1,000-pound) load in tension, when tested through a 12 mm (1/2-inch) round hole. Toggle bolts may be cadmium-plated to conform to the requirements of ASTM B 766 (ASTM A 165), Class 5 (Type TS), in place of being galvanized.

Certify as specified in Section 106.03(b)3.

**(c) Aluminum Wedges, Shims, End Caps, Washers, and Nuts.** Certify as specified in Section 106.03(b)3.

**(d) Anchor Bolts, and Nuts and Washers for Anchor Bolts.** Section 1105.02(c)2, galvanized as specified in Section 1105.02(s).

**(e) Caulking Compound.** Section 705.8

**1023.3 CONSTRUCTION**—Construct as shown on the Standard Drawings and as follows:

**(a) General.** Before fabrication, submit shop drawings for review and acceptance.

Before erection, coat surfaces of aluminum alloys in contact with other metals, stone masonry, or concrete, using caulking compound. After erection and alignment, seal openings between metal surfaces and concrete, using caulking compound.

After the other bridge construction operations have been completed, clean the aluminum bridge hand railing. Remove accumulations of oil, grease, dirt, or foreign materials, using an acceptable solvent cleaner.

**(b) Assembly.** Assemble the rail members. Place joints as indicated.

Make cuts true, smooth, and free from burrs or ragged edges. Fillet drill all re-entrant cuts before cutting. Do not flame cut. Weld according to AWS.

**1023.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measured from center to center of end posts. The Department will not deduct gaps at lighting pole foundations.

# SECTION 1025—MODIFICATION OF EXISTING BARRIERS

**1025.1 DESCRIPTION**—This work is the modification of existing bridge barriers for the type indicated.

**1025.2 MATERIAL**—

- Class AA Cement Concrete—Section 704
- Reinforcement Bars—Section 1002.2
- Concrete Bonding Compound—Section 706
- Threaded Rods and Couplings and Steel Plates—Section 1105.02(a)2.
- Galvanizing—Section 1105.02(s)
- Welding Material—Section 1105.02(t)
- Nuts and Washers—ASTM A 536 for nuts, certified as specified in Section 106.03(b)3, and Section 1105.02(c)2.b for washers.
- Dowel Holes—Section 1003
- Caulking Compound—Section 705.8
- Joint Backing Material—Section 705.9
- Overlay Material—Section 1042.2. Use material of the same type as the deck overlay material.

**1025.3 CONSTRUCTION**—In the field, verify sizes, dimensions, and types of materials, as necessary to satisfactorily complete work.

Before beginning barrier modification, submit plans for review and acceptance to the Chief Bridge Engineer. On the plans, show the method of modification proposed, including modification of open joints, expansion dam, and the deck at the existing scuppers.

Satisfactorily repair any damage done to the existing structure beyond the indicated removal limits.

Straighten existing reinforcement that is to remain in place, within the limits of removal. If necessary, cut and bend the existing reinforcement. Wire brush, clean, and paint the existing reinforcement with a coating of neat-cement (semi-liquid mixture of cement and water).

Satisfactorily dispose of debris resulting from the removal operation.

The Department will retain the bridge barrier railings, posts, and miscellaneous hardware. Remove and store within the right of way for removal from the project site by Department forces. When removing railings and posts from the structure, bundle and stack in piles. Store nuts, bolts, washers, and shims in boxes or barrels with the railing elements. Store the bundles and boxes or barrels in a manner to be picked up and moved with a fork lift.

If necessary, provide additional deck overlay. Modify the deck portions of the existing expansion dam, then warp the deck to existing scuppers, when indicated.

**1025.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

For the type indicated, measured from end to end along the inside face of the completed barrier, with no deductions for expansion dams or joint areas.

# SECTION 1026—NEOPRENE STRIP SEAL DAM

**1026.1 DESCRIPTION**—This work is the furnishing and installation of neoprene strip seal expansion dam for bridge joints, including the necessary fabricated structural steel.

**1026.2 MATERIAL—**

**(a) General.** Use a prequalified fabrication shop as specified in Section 1105.01(a).

**(b) Structural Steel.** Section 1105.02(a)2, painted as specified in Section 1060 or hot-dip galvanized as specified in Section 1105.02(s). The galvanization in the retainer extrusion must be of uniform thickness and free of excessive build-up, which would hinder the installation of the seal. Have the expansion dam fabricator demonstrate that the seal can be installed properly before shipment.

**(c) Anchor Bolts and Washers.** Section 1105.02(c)

**(d) Studs.** Section 1105.02(e)

**(e) Neoprene Strip Seal and Lubricant Adhesive.** Section 705.4(d), from a manufacturer listed in Bulletin 15.

**1026.3 CONSTRUCTION**—Construct as shown on the Standard Drawings and as follows:

Before fabrication, submit shop drawings, as specified in Section 105.02(d), showing complete details, dimensions, size, and type of seal as well as other information and data necessary for the complete fabrication and erection of the dam.

Before installing the seal, clean metal surfaces in direct contact with the seal to remove foreign material and to provide for proper bond between the seal and the metal surfaces. Clean as specified in Section 1071.3(c)1.

Do not splice the seal, unless indicated. If splices are indicated, use splices vulcanized by the manufacturer.

If stretching of the seal during installation is unavoidable, do not exceed 5% elongation.

The Department will not accept cocked or twisted seal installation.

Remove and replace seals that are damaged during installation.

**1026.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

For the movement specified.

Measured out-to-out along the centerline of the exposed surfaces of the seal and the steel plates, including sidewalks if applicable, following the vertical and sloped faces of curbs and barriers, resulting in a true length, not a horizontally projected length.

# SECTION 1031—TIMBER STRUCTURES

**1031.1 DESCRIPTION**—This work is the construction of all timber structures except hardwood glue-laminated (glulam) structures.

**1031.2 MATERIAL—**

**(a) Structural Timber.** Douglas Fir-Larch, Hem-Fir, Southern Pine, Beech, Birch, Hickory, Mixed Maple, Red Maple, Northern Red Oak, Red Oak, Mixed Oak, White Oak, and Yellow Poplar. Provide Select Structural, No. 1 or No. 2 grade lumber and timber. Provide sawn lumber and timber conforming to the Specifications for Structural Timber, Lumber and Piling, AASHTO M 168. Certify as specified in Section 106.03(b)3.

All material to be well manufactured. Accept only pieces consisting of sound wood, free from decay. Avoid boxed heart timber.

Use structural timber complying with the American Softwood Lumber (ASL) Standard PS 20-70 for manufacture of dressed-sized lumber and timber products. Grade Douglas Fir-Larch and Hem-Fir using West Coast Lumber Inspection Bureau (WCLIB) or Western Wood Products Association (WWPA) inspection rules. Grade Douglas Fir-Larch (North) and Hem-Fir (North) using National Lumber Grades Authority (NLGA) inspection rules. Grade Southern Pine according to Southern Pine Inspection Bureau (SPIB) inspection rules. Grade Beech-Birch-Hickory, Mixed Maple, Red Maple, Northern Red Oak, Red Oak, Mixed Oak, and White Oak according to Northeast Lumber Manufacturer's Association (NELMA) grade rules. Grade Yellow Poplar according to Northern Softwood Lumber Bureau (NSLB) rules.

Adequately protect structural timber during transport.

Accept only kiln dried dimension lumber at 15% average moisture content, and 19% maximum moisture content.

Accept only solid sawn timbers that have been air seasoned or dried to an average moisture content not exceeding 19%.

Accept only softwood glue-laminated timbers with a maximum 16% moisture content.

Preservative treat lumber and timber by pressure treatment process according to the AWPA C1, "All Timber Products - Preservative Treatment by Pressure Processes."

Treat structural timbers for highway/bridge construction according to AWPA C14, "Wood for Highway Construction - Preservative Treatment by Pressure Processes."

Minimum retention of creosote preservative for wood species not covered under AWPA C14 is 185 kg/m$^3$ (11.6 pounds per cubic foot).

Treat piles as specified in Section 1005.2(a) and according to the AWPA C3, "Piles - Preservative Treatment by Pressure Processes."

Provide treated lumber and timber products with permanent symbol imprints or documentation to identify the treating company, treatment type, year of treatment, and certification of conformance with AWPA. Certify as specified in Section 106.03(b)3.

Accept treated structural timber that conforms to appropriate recommended AWPA treatment requirements.

**(b) Adhesives (Glulam Fabrication).** Provide adhesives conforming to ANSI/AITC A190.1, "Structural Glued Laminated Timber," Section 4.4. Provide wet-use adhesives. Certify as specified in Section 106.03(b)3.

**(c) Hardware.** Furnish bolts, nuts, washers, timber connectors, drift pins, dowels, nails, screws, spikes, other metal fasteners, and wire rope as necessary. Provide bolts and nuts as specified in Section 1105.02(c)1. Provide machine head bolts and nuts of regular hex series and coarse thread series, Class 6g and 6H (Class 2) tolerances, all conforming to applicable ANSI Standards. Provide cast iron Ogee, malleable iron, plate, or cut washers, as indicated. Galvanize all hardware except cast and malleable iron. Certify as specified in Section 106.03(b)3.

**(d) Galvanizing.** Section 1105.02(s). Galvanize hardware after fabrication.

**(e) Structural Steel.** Section 1105.02(a)

**(f) Painting.** Paint all structural steel, except hot-dip galvanized material, as specified in Section 1060.

**(g) Laminated Girders and Deck Panels.**

**1. Fabrication.**

**1.a Mechanically Laminated Panels.** Perform all possible fabrication of mechanically laminated members before preservative treatment.

Treat mechanically laminated girders and deck panels for highway construction according to AWPA C14.

**1.b Glued laminated Members.** Fabricate structural glued laminated softwood timber according to ANSI/AITC 190.1, "Structural Glued Laminated Timber," and AITC-117, "Manufacturing, Standard Specifications for Structural Glued Laminated Timber of Softwood Species."

Treat glued laminated timbers for highway construction according to AWPA C14.

**2. Tolerances.** Provide laminated structural members with net width, depth, and length as indicated on the structural drawings, and with tolerances according to the ANSI/AITC A190.1 (AITC 113, "Standard for Dimensions of Structural Glued Laminated Timber") or tolerances as follows:

- **Width.** ±1.5 mm (±1/8 inch) of the indicated width.
- **Depth.** ±1 mm per 100 mm (±1/8 inch per foot) of indicated depth.
- **Length.** ±1.5 mm (±1/8 inch) up to 6 m (20-foot) length with a ±1.5 mm (±1/8-inch) allowance for every 6 m (20 feet) of additional length.
- **Squareness.** Provide a cross section for all glued laminated structural members which is square within ± 1 mm per 100 mm (±1/8 inch per foot) of depth of member unless a special shape is indicated.
- **Beam Camber.** ± 6 mm (±1/4 inch) for lengths up to 6 m (20 feet). Add ± 1.5 mm (±1/8-inch) allowance for each additional 6 m (20-foot) length.

Provide industrial appearance grade glued laminated timbers according to AITC 110, "Standard Appearance Grades for Structural Glued Laminated Timber."

Accept only glued laminated timbers in standard dressed widths according to AITC 113.

**(h) Membrane Waterproofing.** Section 680

**(i) Bituminous Wearing Course ID-2.** Section 420.2

**(j) Timber Piles.** Section 1005.2(a)

**(k) Cement Concrete.** Class A and Class AA. Section 704.

**(l) Wood Preservative.** AASHTO M 133. Certify as specified in Section 106.03(b)3. Use only oil-borne preservatives with hardwood lumber and timber.

## 1031.3 CONSTRUCTION—

**(a) Storing and Handling.** Store lumber and timber neatly in piles on skids above ground. Protect from exposure to the elements if stored for prolonged periods of time. Store material so that it can be readily inspected.

Handle in a manner that will avoid injury or breakage. Handle treated lumber with nylon or other non-damaging rope slings. Do not use cant hooks, peaveys, or other sharp instruments in handling treated timber. Provide corner protection for banded material. The Department will reject treated lumber unduly injured in handling.

**(b) Workmanship.** Cut all lumber and timber accurately, and frame to a close fit, to provide for even bearing of joints over the entire contact surfaces. Make joints without shimming. Field drill only as indicated or as allowed.

**1. Bored Holes.** Treat all bored, drilled, or reamed holes with approved field treatment according to AWPA M4, "Standard for the Care of Preservative-Treated Wood Products." Plug unfilled holes, after field treatment, with treated timber plugs.

Bore holes in untreated lumber 2 mm (1/16 inch) in diameter less than the pin or dowel. Bore holes 2 mm (1/16 inch) in diameter larger than the bolt. Bore holes for lag screws not larger than the base of the thread. Bore holes in small timbers with the same diameter as the spike shank when necessary to prevent splitting. Do not field drill or nail, except for railing.

**2. Installation of Connectors.** Provide one of the following timber connector types, as indicated: split ring, shear plate, or spike grid. Install split ring and shear plate types in precut grooves of dimensions as indicated or as recommended by the manufacturer. Force spike grids into the wood so that timbers will be in firm contact. Use pressure equipment that does not damage the wood. High-strength bolts or rods fitted with low friction ball-bearing washers made for this purpose may be used. Replace the high-strength bolts with specified bolts for the final installation. Embed all connectors of this type at a joint simultaneously and uniformly.

Cut connector grooves in timber concentric with the bolt hole, conforming to the cross-sectional shape of the rings, and providing a snug fit. Supply an inside groove diameter larger than nominal ring diameter so that the ring will expand slightly during installation. (See Table A)

**3. Bolts and Washers.** Use a washer of the size and type indicated under all bolt heads (except for timber bolts with economy type heads) and nuts that would otherwise come in contact with wood.

After final tightening, lock the nuts of all bolts.

**(c) Substructure.** Construct as indicated, and as follows:

**1. Bent Piles.** Drive piles as accurately as possible in the correct location, vertical or to the batter indicated, and as specified in Section 1005.3.

Make cut-offs accurately to ensure uniform bearing between the sills and piles of a bent. Treat cut pile ends according to AWPA M4.

**2. Framed Bents.** Bed mudsills firmly and evenly upon solid bearing material, and tamp into place. Construct concrete pedestals for the support of framed bents, as specified in the applicable portions of Section 1001.3. Finish pedestals carefully to provide full and even bearing for sills or posts.

Provide for true and even bearing of sills on mudsills, piles, or pedestals. If possible, remove all earth from contact with sills to provide for free air circulation around them.

**3. Bearing Sill Caps.** Place timber caps to secure an even and uniform bearing over the tops of the supporting posts or piles, and to secure an even alignment of their ends. Secure all sills as indicated. For sills secured using drift bolts, place drift bolts approximately in the center of the post or pile.

**4. Bracing.** Properly align bents before placing bracing. Bolt the ends of bracing through the pile, post, or cap. Furnish bracing of sufficient length to provide a minimum distance of 200 mm (8 inches) between the outside bolt and the end of the brace.

**TABLE A**
**Typical Dimensions of Timber Connectors**
**(dimensions in mm (in.))**

| **Split Rings** | | |
|---|---|---|
| Size | 65 mm (2 1/2 in.) | 100 mm (4 in.) |
| Split ring | | |
| Inside diameter at center when closed | 65 (2.500) | 100 (4.000) |
| Thickness of metal at center | 4.14 (0.163) | 4.90 (0.193) |
| Depth of metal (width of ring) | 19.05 (0.750) | 25.40 (1.000) |
| Groove | | |
| Inside diameter | 65 (2.56) | 105 (4.08) |
| Width | 4.57 (0.18) | 5.33 (0.21) |
| Depth | 9.53 (0.375) | 12.70 (0.50) |
| Bolt diameter | 12.7 (1/2) | 19.1 (3/4) |
| Bolt hole diameter | 14.3 (9/16) | 20.6 (13/16) |
| Washers, standard | | |
| Round, cast or malleable iron, diameter | 67 (2 5/8) | 75 (3) |
| Round, mild steel | | |
| Diameter | 35 (1 3/8) | 50 (2) |
| Thickness | 2.30 (3/32) | 4.00 (5/32) |
| Square plate, mild steel | | |
| Length of side | 50 (2) | 75 (3) |
| Thickness | 3 (1/8) | 5 (3/16) |

| **Shear Plates** | | | | |
|---|---|---|---|---|
| Size | 65 mm (2 1/2 in.) | 65 mm (2 1/2 in.) | 100 mm (4 in.) | 100 mm (4 in.) |
| Shear plate material | Pressed steel | Light gage | Malleable | Malleable |
| Diameter of plate | 66.6 (2.62) | 66.6 (2.62) | 102.4 (4.03) | 102.4 (4.03) |
| Diameter of bolt hole | 20.6 (0.81) | 20.6 (0.81) | 20.6 (0.81) | 23.9 (0.94) |
| Thickness of plate | 4.4 (0.172) | 3.1 (0.12) | 5.1 (0.20) | 5.1 (0.20) |
| Depth of flange | 10.7 (0.42) | 8.9 (0.35) | 16.3 (0.64) | 16.3 (0.64) |
| Use steel straps or shapes, for use with shear plates, designed according to accepted engineering practices. | | | | |
| Hole diameter in straps or shapes for bolts | 22 (13/16) | 22 (13/16) | 22 (13/16) | 24 (15/16) |
| Circular dap dimensions | | | | |
| A | 66.8 (2.63) | 66.8 (2.63) | 102.4 (4.03) | 102.4 (4.03) |
| B | — | 27.2 (1.07) | 39.4 (1.55) | 39.4 (1.55) |
| C | 20.6 (0.81) | 20.6 (0.81) | 20.6 (0.81) | 23.9 (0.94) |
| D | — | 16.5 (0.65) | 24.6 (0.97) | 24.6 (0.97) |
| E | 4.8 (0.19) | 3.3 (0.13) | 6.9 (0.27) | 6.9 (0.27) |
| F | 11.4 (0.45) | 9.7 (0.38) | 16.3 (0.64) | 16.3 (0.64) |
| G | 6.4 (0.25) | 3.6 (0.14) | 5.6 (0.22) | 5.6 (0.22) |
| H | — | 8.6 (0.34) | 12.7 (0.50) | 12.7 (0.50) |
| I | 57.2 (2.25) | 60.2 (2.37) | 88.7 (3.49) | 88.7 (3.49) |
| Bolt hole—diameter in timber | 22 (13/16) | 22 (13/16) | 22 (13/16) | 24 (15/16) |
| Washers, standard | | | | |
| Round, cast or malleable iron, diameter | 75 (3) | 75 (3) | 75 (3) | 90 (3 1/2) |
| Round, medium steel, minimum | | | | |
| Diameter | 50 (2) | 50 (2) | 50 (2) | 55 (2 1/4) |
| Thickness | 4.00 (5/32) | 4.00 (5/32) | 4.00 (5/32) | 4.60 (11/64) |
| Square plate | | | | |
| Length of side | 75 (3) | 75 (3) | 75 (3) | 75 (3) |
| Thickness | 5 (1/4) | 5 (1/4) | 5 (1/4) | 5 (1/4) |

**(d) Superstructure.** Construct as indicated, and as follows:

**1. Timber Stringers.** Place stringers for bridge decks better edge down. Provide for even bearing of the floor on the stringers. Use butt joints for outside stringers, centered over caps of floor beams. Lap interior stringers to take bearing over the full width of cap or floor beams at each end.

Frame cross-bridging between stringers neatly and accurately, and fasten securely. Provide for full bearing of each end of cross-bridging members against the sides of stringers. Unless otherwise directed, place cross-bridging at the center of each span and at supports.

**2. Glued laminated Timber Stringers.** Place stringers according to beam fabricators' "TOP" mark. Provide for even bearing of the deck on all stringers at piers as indicated, but allow no less than 15 mm (1/2 inch) clearance between butt ends to allow for air circulation.

Treat all field drilled holes or reamed holes before installation of hardware according to AWPA M4. Treat all field-drilled holes before installing diaphragms.

Provide for close fit (full bearing) of diaphragm between stringer beams. Place diaphragms or cross bracing as indicated.

**3. Wheelguards, Rail, and Barrier.** Frame and align wheel guards, rail posts, rails, and barriers accurately and as indicated.

**4. Panel-to-Panel Connections.** Provide a snug fit for all panel-to-panel connections on interconnected decks. Field drill or ream connections only if directed. Treat all field-drilled or reamed holes according to AWPA M4.

**(e) Surface Treatment of Timber.** Do not paint wood treated with oil-borne preservatives.

Using pressure process, treat portions of rail posts that are to be embedded in earth or concrete and where faces of timber bulkheads will be in soil contact, with a 190 kg/m$^3$ (11.9 pounds per cubic foot) retention of creosote preservative for softwoods and 185 kg/m$^3$ to 190 kg/m$^3$ (11.6 pounds per cubic foot to 11.9 pounds per cubic foot) retention of creosote for hardwoods.

Apply a two-coat finish sealer to treated structural timber railings where prolonged exposure to direct human contact is likely. Acceptable sealers include latex epoxy, urethane, shellac, or other finishes with effective coating agents that adhere to treated rails.

When framing, cutting, or boring of treated timber is performed after treatment, swab all cuts, daps, and holes thoroughly with two applications of accepted wood preservative treatments according to AWPA M4.

**(f) Post-Tensioning.** Perform post-tensioning operations as directed.

**(g) Bituminous Wearing Surface.** Clean the deck of the heavier excretions and surface residues of the treatment solution before constructing the bituminous leveling course.

Spread a blotter of fine material (silt and sandy silt) over the surface. Use a mixture consisting of 20% crushed material passing a 2.36 mm (No. 8) sieve and 80% material passing a 150 µm (No. 100) sieve. Spread at a rate of 5 kg/m$^2$ to 8 kg/m$^2$ (10 pounds per square yard to 15 pounds per square yard). Broom off the blotter material. Repeat process until the surface is free of exudates.

Construct the bituminous leveling course as indicated and as specified in Section 420.3. Use only non-vibratory rollers for compaction of the bituminous leveling course.

For stressed-laminated timber decks, prepare the bituminous leveling course surface and construct waterproofing membrane as indicated.

Construct the bituminous surface course as specified in Section 420.3. Use only non-vibratory rollers for compaction of the bituminous surface course.

Provide geotextile Class 4 fabric as specified in Section 735, for glued laminated timber decks. No leveling course is necessary for glued laminated decks.

**1031.4 MEASUREMENT AND PAYMENT**—Lump Sum

**(a) Fabricated Structural Steel.** Section 1050.4

**(b) Structural Timber.** Cubic Meter (Cubic Foot)

**(c) Membrane Waterproofing.** Section 680.4

**(d) Guide Rail.** Section 620.4

**(e) Geotextiles, Class 4.** Section 212.4

**(f) Piles.** Section 1005.4

**(g) Bituminous Wearing Course ID-2.** Section 420.4

**(h) Cement Concrete.** Section 1001.4

# SECTION 1032—HARDWOOD GLULAM TIMBER STRUCTURES

**1032.1 DESCRIPTION**—This work is the construction of structures with hardwood glue-laminated (glulam) timber.

**1032.2 MATERIAL—**

**(a) Structural Timber.** Section 1112.02(a)

**(b) Adhesives.** Section 1112.02(b)

**(c) Hardware.** Section 1031.2(c)

**(d) Galvanizing.** Section 1031.2(d)

**(e) Structural Steel.** Section 1105.02(a)

**(f) Painting.** Section 1031.2(f)

**(g) Geotextiles.** Section 212.2

**(h) Bituminous Wearing Course ID-2.** Section 420.2

**(i) Timber Piles.** Section 1005.2(a)

**(j) Cement Concrete.** Class A and Class AA. Section 704

**(k) Wood Preservative.** Section 1112.02(d)

**1032.3 CONSTRUCTION—**

**(a) Storing and Handling.** Section 1031.3(a)

**(b) Workmanship.** Section 1031.3(b)

**(c) Substructure.** Section 1031.3(c)

**(d) Superstructure.** Section 1031.3(d)

**(e) Surface Treatment of Timber.** Section 1031.3(e)

**(f) Bituminous Wearing Surface.** Section 1031.3(g)

**1032.4 MEASUREMENTS AND PAYMENT—**

**(a) Fabricated Structural Steel.** Section 1050.4

**(b) Structural Timber.** Cubic Meter (Cubic Foot)

**(c) Steel Guide Rails.** Section 620.4

**(d) Geotextile, Class 4.** Section 212.4

**(e) Piles.** Section 1005.4

**(f) Bituminous Wearing Course ID-2.** Section 420.4

**(g) Cement Concrete.** Section 1001.4

# SECTION 1040—CONCRETE BRIDGE DECK REPAIR

**1040.1 DESCRIPTION**—This work is removing and patching designated areas of deteriorated concrete of the bridge deck. Concrete Bridge Deck Repair is classified into three types as follows:

**(a) Type 1.** Areas where deteriorated concrete extends to a maximum depth of the top of the top mat of reinforcement bars, exposing no more than one-quarter bar diameter.

**(b) Type 2.** Areas where deteriorated concrete extends beyond the depth of the top of the top mat of reinforcement bars or where reinforcement bars are unbonded.

**(c) Type 3.** Areas where deteriorated concrete or patching extends to the full depth of the deck, including deck overhang areas; and areas where curb, barrier, or deck ends need to be patched as part of the repair. Type 3 repairs over adjacent box beams extend to the top of the beam.

**1040.2 MATERIAL—**

**(a) Patching Material.**

- Class AAA Cement Concrete—Section 704, except use No. 8 coarse aggregate.
- Concrete Bonding Compound—Type II, Grade 2, ASTM C 881 epoxy as specified in Section 706
- Wearing Surface Material for Patching—Section 1042.2

**(b) Reinforcement Bars.** Section 1002.2

**1040.3 CONSTRUCTION—**

**(a) Deck Sounding.** Provide a chain drag 1 m (3 feet) in width with chain drops spaced every 150 mm (6 inches) for Department use. As directed, provide assistance to the Representative for the purpose of sounding the entire deck surface with the chain drag before and after scarification.

**(b) Preparation of Surface.** The Representative will determine and delineate the type and extent of the repair areas. Outline the areas with a 20 mm (3/4-inch) deep vertical saw-cut before scarifying operations.

Repair work may begin before scarifying operations. If after scarifying, another area or areas of deteriorated concrete are found beyond the initial saw-cut peripheries, make new saw-cuts for repair limits.

Sandblast or waterblast to remove partially loosened chips of concrete. Sandblast, waterblast, or wire brush exposed reinforcement bars to remove rust and corrosion. Remove all portions of damaged or heavily corroded reinforcement bars, and replace with the same type of bars, as specified in Section 1002.3 and as directed.

For Type 2 repairs, remove concrete to a depth that provides a minimum of 20 mm (3/4-inch) clearance around all reinforcement bars in the top mat, regardless of concrete deterioration. If the removal reaches the top level of the lower reinforcing mat, continue the removal until full-depth removal is achieved and perform a Type 3 repair.

During removal for Type 3 repairs, provide shielding to prevent debris from falling below the deck. Prevent damage to underlying beams.

**(c) Equipment.** Power driven hand tools for removal of deteriorated concrete are required and are subject to the following restrictions:

- Do not use pneumatic hammers with more mass (weight) than nominal 15 kg (30-pound) class.

- Do not operate pneumatic hammers or mechanical chipping tools at an angle in excess of 45 degrees relative to the surface of slab.
- Do not place pneumatic tools in direct contact with reinforcing steel.
- Triple-headed tampers fitted with star drills not less than 50 mm (2 inches) in diameter in the tamper sockets may be used in the vertical position.

Use hand tools such as hammers and chisels, or small air chisels to remove final particles of unsound concrete or to provide necessary clearances around reinforcement bars.

**(d) Cleaning.** Blow all removal areas clean with oil-free compressed air and protect them against any contaminate detrimental to the bond of the patching material.

Satisfactorily repair any damage to the structure beyond the limits of this work due to the construction operations at no expense to the Department.

**(e) Concrete Bonding.** Coat contact surfaces of Type 1, Type 2, and Type 3 repairs with concrete bonding compound. Do not coat surface to receive a new surface course. Remove concrete bonding compound from surface to receive the surface course at no expense to the Department.

**1. Epoxy Bonding Compound.** Place concrete against contact surface while epoxy bonding compound is still tacky to ensure bond between contact surface and fresh concrete. Wire brush or sandblast hardened epoxy before recoating with fresh epoxy. Use epoxy-bonding compound as specified in 1040.2(a).

**2. Non-Epoxy Bonding Compound.** Place concrete against contact surface within the compound manufacturer's recommended time frame. When recommended time frame has expired, follow manufacturer's recommendations for recoating contact surfaces.

**(f) Patching.**

**1. Patching in Preparation of Latex Overlay Placement.**

**1.a Type 1.** Patch areas of repair with the material used for the overlay wearing surface and make the patch concurrently with the overlay operation. Place overlay as specified in Section 1042.3.

**1.b Type 2.** Construct Type 2 patches before the overlay operation unless allowed to patch simultaneously with the overlay.

**Method 1. Patching before Overlay Operation.** Patch areas of repair with modified Class AAA cement concrete. Vibrate material in repair areas internally with a pencil vibrator in addition to surface screed vibration.

After patches have attained a minimum compressive strength of 23 MPa (3,300 pounds per square inch), sandblast or waterblast patch surfaces to remove laitance.

Perform scarification either before or after patching, as directed. If scarification is performed before patching, rough-texture patch surfaces by shot-blasting. If scarification is performed after patching, do not begin scarification until the patches have attained a minimum compressive strength of 23 MPa (3,300 pounds per square inch).

If after scarifying , additional areas of deteriorated concrete are discovered, make repairs as directed. Take precautions to prevent contamination of the scarified deck surface.

**Method 2. Patching Simultaneously with Overlay Operation.** If allowed, patch Type 2 repairs up to 50 mm (2 inches) deep with overlay material, placed monolithically with the overlay. Place overlay as specified in Section 1042.3.

**1.c Type 3.** Patch areas of repair with modified Class AAA cement concrete. Use removable formwork of sufficient strength to prevent lateral or vertical deflection. Provide side forms including drip-strip and chamfering. Vibrate material in repair areas internally with a pencil vibrator in addition to surface screed vibration.

After patches have attained a minimum compressive strength of 23 MPa (3,300 pounds per square inch), sandblast or waterblast patch surfaces to remove laitance.

Perform scarification either before or after patching, as directed. If scarification is performed before patching, rough-texture patch surface by shot-blasting. If scarification is performed after patching, do not begin scarification until the patches have attained a minimum compressive strength of 23 MPa (3,300 pounds per square inch).

Do not place Type 3 patches simultaneously with overlay.

**2. Patching without Overlay Placement.**

**2.a Type 1.** Do not construct Type 1 patches. Remove concrete to a depth that provides a minimum of 20 mm (3/4 inch) clearance around all reinforcement bars in the top mat, regardless of concrete deterioration, and construct a Type 2 patch.

**2.b Type 2.** Patch areas of repair with modified Class AAA cement concrete. Vibrate material in repair areas internally with a pencil vibrator in addition to surface screed vibration. Finish patches to match the existing deck surface.

**2.c Type 3.** Patch areas of repair with modified Class AAA cement concrete. Use removable formwork of sufficient strength to prevent lateral or vertical deflection. Provide side forms including drip-strip and chamfering. Vibrate material in repair areas internally with a pencil vibrator in addition to surface screed vibration.

**(g) Curing Patches.** Cure patches made with modified Class AAA cement concrete as specified in Section 1001.3(p), but do not use liquid membrane curing unless allowed. Do not apply live loads to patches until concrete has reached a minimum compressive strength of 23 MPa (3,300 pounds per square inch).

## 1040.4 MEASUREMENT AND PAYMENT—

**(a) Patching.** Square Meter (Square Foot)
For the type indicated.

**(b) Reinforcement Bars.** Section 1002.4

# SECTION 1041—SCARIFICATION

**1041.1 DESCRIPTION**—This work is scarifying existing concrete bridge decks to a minimum 5 mm (1/4-inch) uniform depth and a maximum uniform depth as indicated, in preparation for placing a concrete or mortar wearing surface.

**1041.2 MATERIAL**—Not used.

**1041.3 CONSTRUCTION—**

**(a) General.** Saw cutting and chipping with pneumatic hammers may be used to remove surfaces on areas inaccessible to a scarifying machine. Do not use pneumatic hammers larger than nominal 15 kg (30-pound) class. Do not use triple-headed tampers fitted with star drills less than 50 mm (2 inches) in diameter.

Completely remove by hand, power broom, vacuum, or other approved means, all broken concrete and laitance resulting from the scarifying operation and satisfactorily dispose of this material. Do not flush debris. Remove debris at the end of each work day. Clean debris from scuppers and downspouts as needed. Do not allow construction vehicles or equipment, other than power brooms, on the scarified deck surface, unless the surface is adequately protected to prevent contamination.

**(b) Equipment.** Scarify using a self-propelled machine capable of preparing 850 $m^2$ (1,000 square yards) per day. The equipment used for scarification is required to remove 5 mm (1/4 inch) across the cutting path in one pass.

**1041.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

For 5 mm (1/4-inch) uniform depth of scarification satisfactorily completed. When depths greater than 5 mm (1/4 inch) are specified, the Department will pay for each 5 mm (1/4-inch) increment of depth separately, regardless of how many passes are made with the scarifier.

# SECTION 1042—LATEX MODIFIED MORTAR OR CONCRETE WEARING SURFACE

**1042.1 DESCRIPTION**—This work is construction of a one course wearing surface of latex modified mortar or concrete on in-service bridge decks. The indicated or specified depth of the wearing surface is the minimum.

**1042.2 MATERIAL—**

**(a) Cement.** Type I, IP, or II, Section 701.1.

**(b) Fine Aggregate.** Type A, Section 703.1.

**(c) Coarse Aggregate.** Type A, No. 8, Section 703.2.

**(d) Water.** Section 720.1

**(e) Latex Emulsion Admixture.** Section 711.3(e)

**(f) Latex Modified Mortar or Concrete Mix Design.** Use latex modified mortar for depths less than 30 mm (1 1/4 inches). Use latex modified concrete when the depth is 30 mm (1 1/4 inches) or more.

Provide a concrete technician as specified in Section 704.1(d)2. Provide testing facilities and equipment as specified in Section 704.1(d)3.

The term "latex," as used in this Section, refers to latex modified mortar or concrete, unless otherwise specified. Provide latex conforming to the following requirements:

**METRIC**

| | Requirements | |
|---|---|---|
| **Physical Properties** | **Mortar** | **Concrete** |
| | | |
| Cement Content, kg/m$^3$ | 446 | 390 |
| Latex Emulsion Admixture Modifier, L/kg of Cement | 0.31 | 0.31 |
| Air Content, % of Plastic Mix (AASHTO T 152) | 1 - 7 | 1 - 7 |
| Water/Cement Ratio, by Mass | 0.35 - 0.40 | 0.30 - 0.40 |
| Slump[(1)], mm (AASHTO T 119) | 100 - 150 | 75 - 175 |
| Percent Fine Aggregate as Percent of Total Aggregate, by Mass | 100 | 60 ± 5 |
| Cement/Fine Aggregate/Coarse[(2)] Aggregate Ratio, by Mass | 1:3.25 | 1:2.5:2.0 to 1:2.9:1.6 |
| 5-day Compressive Strength (MPa) (PTM Nos. 604 & 611) [(3)] | 21 | 21 |
| 28-day Compressive Strength (MPa) (PTM Nos. 604 & 611) [(3)] | 24 | 24 |

[(1)] Discharge the sample from the mixer and transport it to a point unaffected by vibration. Deposit the sample on the deck in a suitable container and do not disturb for five minutes. Then, remix the sample and perform the slump test.

[(2)] Dry basis, Aggregate Specific Gravity = 2.65. The dry mass ratios are approximate and should produce good workability, but due to gradation changes, the ratios may be adjusted within limits by the Representative.

[(3)] Cure specimens according to PTM No. 611, Section 11.1, except strip after the first 48 hours (± 2 hours), and air cure as specified in Section 1042.3(d) Table A.

**ENGLISH**

| Physical Properties | Requirements | |
|---|---|---|
| | Mortar | Concrete |
| | | |
| Cement Content, bags/cu. yd. | 8.0 | 7.0 |
| Latex Emulsion Admixture Modifier, gal/bag of Cement | 3.5 | 3.5 |
| Air Content, % of Plastic Mix (AASHTO T 152) | 1 - 7 | 1 - 7 |
| Water/Cement Ratio, by Weight | 0.35 - 0.40 | 0.30 - 0.40 |
| Slump[1], inches (AASHTO T 119) | 4 - 6 | 3 - 7 |
| Percent Fine Aggregate as Percent of Total Aggregate, by Weight | 100 | 60 ± 5 |
| Cement/Fine Aggregate/Coarse[2] Aggregate Ratio, by Weight | 1:3.25 | 1:2.5:2.0 to 1:2.9:1.6 |
| 5-day Compressive Strength (psi) (PTM Nos. 604 & 611) [3] | 3,000 | 3,000 |
| 28-day Compressive Strength (psi) (PTM Nos. 604 & 611) [3] | 3,500 | 3,500 |

[1] Discharge the sample from the mixer and transport it to a point unaffected by vibration. Deposit the sample on the deck in a suitable container and do not disturb for five minutes. Then, remix the sample and perform the slump test.

[2] Dry basis, Aggregate Specific Gravity = 2.65. The dry weight ratios are approximate and should produce good workability, but due to gradation changes, the ratios may be adjusted within limits by the Representative.

[3] Cure specimens according to PTM No. 611, Section 11.1, except strip after the first 48 hours (± 2 hours), and air cure as specified in Section 1042.3(d) Table A.

**1. Compatibility Testing During Mix Design.** Verify the compatibility of the mix components during mix design and ensure that the mix provides sufficient time of workability to satisfactorily finish and texture the surface. Re-verify compatibility whenever there is a change in mix components. Provide a technical expert from the latex manufacturer for the design process, if directed.

**(g) Mix Designs Using Potentially Reactive Aggregates.** Section 704.1(g)

## 1042.3 CONSTRUCTION—

**(a) Equipment.** Obtain acceptance of all equipment for the deck preparation, mixing, placing, and finishing of the latex wearing surface, before start of wearing-surface work. Include equipment specifications in the QC Plan specified in Section 1042.3(c).

**1. Surface Preparation Equipment.** Of the following types:

**1.a Sandblasting or Water Blasting Equipment.** Capable of removing partially loosened chips of concrete and removing rust and corrosion from reinforcement bars. Water blasting equipment must have a minimum rated capacity of 28 MPa (4,000 pounds per square inch).

**1.b Power-Driven Hand Tools.** Section 1040.3(c)

**2. Proportioning and Mixing Equipment.** Provide self-contained, mobile equipment, capable of continuous mixing, with the capacity to deliver a minimum of 5 $m^3$ (6 cubic yards) of latex per hour, and subject to the following:

**2.a Mixing Equipment.** Provide equipment with a metal plate or plates permanently attached in a prominent place, plainly marked with the gross volume of the unit in terms of mixed mortar, operating speed, auger mixing angle, and the weight-calibrated cement constant of the machine, in terms of a revolution counter or other output indicator, all as rated by the manufacturer.

**2.b Compartments.** Provide separate compartments to carry the necessary ingredients needed for the production of latex modified mortar or concrete. Cover aggregate bins at all times. Provide cement bins free of moisture and contamination at all times. Provide suitable means to carry water and additives on the truck and to incorporate the additives with the mixing water in the mix.

**2.c Feed Systems.** Provide a unit with a feeder system mounted under the compartment bins to deliver the ingredients to the mixing unit. Provide each bin with an accurately controlled, individual gate to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. Maintain belt feeders and scrapers to prevent leakage of materials onto the deck.

Set the cement bin feeding mechanism to discharge continuously, and at a uniform rate, a given volumetric mass (weight) equivalent to cement during the mixing operation. Coordinate the aggregate feeding mechanisms with the cement feeding mechanisms to deliver the required proportions.

**2.d Mixing Unit.** Provide an auger-type mixing unit, incorporated into the truck's discharge chute or other suitable mixing mechanism, capable of producing latex of uniform consistency and discharging the mix without segregation.

**2.e Dials and Measuring Devices.** Equip the unit with an accurate revolution counter indicator allowing the reading of the volumetric mass (weight) equivalent to cement discharged during the mixing operation. Equip the counter with a ticket printout to record this quantity. Use aggregate dials that allow the setting of required openings for volumetric proportioning.

Equip the unit with a cumulative water flow meter or gauge to accurately indicate the discharge rate of water by volume entering the mix. Provide an approved device on the unit for the Representative to use to check the rate of flow of the latex modified admixture entering the mix. Coordinate the water and additive measuring devices with the cement and aggregate feeding mechanisms. Equip the flow meters with scales appropriate for the type and amount of material being added.

Mount a tachometer on the unit to indicate the drive shaft speed.

Place all required indicating devices in full view and near enough to be accurately read or readjusted by the operator while latex is being produced. Provide the operator with convenient access to all controls.

**2.f Calibration.** Provide a unit constructed to allow convenient calibration of the gate openings and meters. Have the calibration conducted by the supplier of the latex in the presence of Representatives, and recalibrate after every 80 $m^3$ (100 cubic yards) of production for each unit. Have the supplier of the latex make satisfactory arrangements with the Representative at least 7 calendar days in advance of calibration. Provide platform scales calibrated annually.

Conduct a recalibration in the event of a change in source of aggregates. Conduct additional calibration as directed. Have each approved unit carry a copy of the calibration certificate. In addition to calibration, perform a yield test according to AASHTO T 121, C 136, if directed.

An additional check may be made using the following procedure:

With the cement meter set on zero and all controls set for the desired mix, activate the mixer discharging mixed material into a 0.19 $m^3$ (1/4 cubic yard) container (915 mm x 915 mm x 230 mm (36 inches by 36 inches by 9 inches)). When the container is level-struck full, making provision for settling the material into all corners, the cement meter is required to show a discharge of 85.2 kg (2 bags) of cement for modified mortar (446 kg/$m^3$ mix (8 bags per cubic yard mix)) or 74.6 kg (1.75 bags) of cement for modified concrete (390 kg/$m^3$ mix (7 bags per cubic yard mix)).

**2.g Mixing and Delivery Control.** Proportion, measure, and batch cement and aggregates by a volumetric mass (weight) equivalent method. In operation, the entire measuring and batching mechanism is required to produce the specified proportions of each ingredient. Establish volume/mass (volume/weight) relationships during the calibration of the measuring devices. Provide tolerances in proportioning the various ingredients as follows:

- Cement, mass (weight) % 0 to +4
- Fine Aggregate, mass (weight) % ±2

- Coarse Aggregate, mass (weight) % ±1
- Water, mass (weight) or volume % ±1
- Latex, mass (weight) or volume % ±2

During mixing, maintain the drive shaft speed as indicated by the tachometer at operating speed ± 50 rpm. Set the auger mixer angle in the range determined by the manufacturer. Do not exceed one-half hour for the interval between the continuous placement of successive batches. Equip the mixer to spray water.

**2.h Loading.** Charge aggregate bins no more than 12 hours before time of scheduled placement. Empty bins and recharge if not utilized within 12 hours or if conditions contribute to variable moisture content of the aggregate. Stock aggregates in a manner that prevents contamination.

**3. Placing and Finishing Equipment.** Provide hand tools for placing and brushing-in freshly mixed latex and for distributing latex overlay to approximately the correct level for striking off with the screed. Use approved hand-operated vibrators and screeds to place and finish small areas of work. Do not use gas-powered vibrators.

Use an approved finishing machine complying with the following requirements for finishing all large areas of work:

- Use a finishing machine that is self-propelled and capable of forward and reverse movement under positive control. Make provision for raising all screeds to clear the screeded surface for traveling in reverse.
- Use a revolving-drum type finishing machine with one or more rotating roller augers preceded by a 1,500 vpm to 2,500 vpm vibratory pan. Verify frequency with a tachometer.

For small placements. the finishing machine may be of the type designed to finish the overlay with a vibrating screed. Provide variable vibration frequency with positive control between 3,000 vpm and 11,000 vpm. Use screeds with a metal-covered bottom face no less than 100 mm (4 inches) wide. Provide the screeds with positive control of the vertical position. Consolidate latex with a hand-operated vibrator.

Use a suitable portable lightweight or wheeled work bridge behind the finishing operation.

**(b) Surface Preparation.** Remove unsound concrete and repair as specified in Section 1040.3. Not more than 7 days before the placement of the overlay, scarify the deck surface to a minimum depth of 5 mm (1/4 inch), as specified in Section 1041.

Not more than 24 hours before placement begins, clean the entire surface by an approved method, including edges of previously placed lanes of latex, to remove any trowel-cut surfaces and promote bond.

If necessary to remove rust from any exposed bars, or oil or other foreign materials detrimental to achieving bond, clean the surface thoroughly with a detergent waterblast and rinse, or sandblast and air blast using clean, oil-free compressed air. Protect the deck against contamination until the overlay operations are completed. Include cleaning methods in QC Plan, as specified in Section 1042.3(c).

Allow 48 hours of curing to elapse before scarifying or chipping is performed on adjacent concrete within 2000 mm (6 feet) of previously placed latex.

**(c) Placing and Finishing.** Submit a QC Plan, for approval, at least 15 days before the proposed start of placing the wearing surface. Do not proceed with latex placement until the QC Plan has been accepted. Include in the plan the method of operations and a sketch describing the equipment and showing complete details of supports for the equipment. Include a list of key personnel and relevant experience. Include provisions for an on-site technical representative from the manufacturer of the latex admixture during calibration and, if directed, during initial operations.

Raise expansion dams and scuppers as indicated before placing the wearing surface. Provide anchorage for supporting rails for horizontal and vertical stability. Do not treat screed rails with parting compound to facilitate their removal.

Provide all necessary finishing tools, equipment, and manpower at the site of work, and ensure that key personnel are experienced in the placement of latex wearing surfaces.

Adjust screeds to finished grade before placing the wearing surface. For superelevated bridges, adjust screed guides to compensate for the curvature.

Determine the finished grade by raising the existing grade by the amount indicated. Provide a final setting of the screeds such that a smooth riding surface is achieved. Do not lower the screed to compensate for any wear on the existing deck or for over scarifying.

Immediately before placement of the latex, thoroughly wet the clean surface for a period of not less than one hour. Vacuum or blow out all standing water in depressions, holes or areas of concrete removal with clean, oil-free compressed air. Maintain prepared deck in a damp, puddle-free condition.

First, brush latex grout on to the damp, prepared surface. When using latex concrete, collect and discard excess aggregate. Do not over-extract grout from the mix to the point that the grout becomes diluted. If directed, apply a second broomed coat of grout to areas where grout is diluted by excessive surface moisture. Immediately remove any material from the deck that is not properly mixed or proportioned, or lacks any component material, and regrout the area.

Ensure that all vertical and horizontal surfaces receive a thorough, even coating and that the rate of progress is limited so that the brushed material does not become dry before it is covered with additional material, as required for the final grade.

Place and strike-off the mixture to approximately 5 mm (1/4 inch) above final grade. Use spud vibration at the edges, adjacent to joint bulkheads and expansion dams, in depressions, and in areas of bridge deck repair. Finish to final grade with the approved finishing equipment. Hand-finishing with a float may be required along the edge of the placement or on small areas of repair. Edge-tooling is required at joints, except next to metal expansion dams, curbs, and previously placed lanes. Place latex continuously, and complete the finishing of each area within 15 minutes after the initial brooming. Provide finish with a closed surface, free of pock marks, ridges, tears, and other defects.

When placing latex against latex that has not achieved initial set, but has formed a surface crust or film, remove the surface crust until plastic latex is exposed, place fresh latex against the exposed surface and consolidate both until homogeneous.

Separate screed rails and construction bulkheads from the newly placed material by passing a pointing trowel along their inside face. Do not separate metal expansion dams from the wearing surface. Ensure that this trowel cut is made for the entire depth and length of rails after the mixture has stiffened sufficiently.

Conduct all operations behind the finishing machines or screeds from work bridges suspended above the wearing surface. Provide bridges of rigid construction. Do not allow work bridges to come into contact with the surface of the latex.

Straightedge and edge while the latex is still workable, as specified in Section 501.3(k)3. After the straightedge testing and surface corrections have been completed and before the latex becomes nonplastic, texture the surface as specified for concrete pavements in Section 501.3(k)4. Cure the wearing surface as soon as possible without marking the fresh latex. If mechanical texturing is indicated, wait 5 days after placing latex before applying texturing. After the latex has hardened, test the surface again as specified in Section 501.3(o). Resound the deck if directed.

**(d) Curing and Protection.** Cure as follows, and as specified in Section 1001.3(p), except do not use membrane-forming or monomolecular curing compounds:

Promptly cover the surface with a single layer of clean, wet burlap as soon as the surface will support it without deformation. Within one hour of covering with wet burlap, place a layer of white polyethylene film, 100 µm (4 mil) minimum thickness, on the wet burlap and cure the surface as specified in Table A. Secure edges of the polyethylene film to prevent wind intrusion. Keep the curing material saturated during the wet cure period. After wet-curing, remove the curing material and air-cure for an additional period, as specified in Table A. Wet, burlap-backed, white polyethylene sheets may be substituted for the polyethylene film with the approval of the Representative, but do not use them to replace the initial wet burlap.

**TABLE A**
**Curing Times and Application of Live Load**

| Depth | Wet Cure (hours) | Dry Cure (hours) | Live Load Application Total Cure Time (hours) | Live Load Application Comp. Strength MPa (psi) |
|---|---|---|---|---|
| ≤50 mm (≤2 inches) | 48 | 72 | 120 | 21 (3,000) |
| >50 mm (>2 inches) | 48 | 96 | 144 | 21 (3,000) |

**(e) Limitations of Operations.** Place the latex during periods where the ambient temperature is 8 °C (45F) or greater. Place latex at a plastic latex mixture temperature between 10°C and 27 °C (50F and 80F). Do not place latex above ambient temperatures of 29 °C (84F). Stop the placement at any time the Representative determines that a satisfactory surface finish is not being achieved.

Install a bulkhead in case of a major delay in the placement operation resulting in the formation of a surface film. During minor delays, protect the placement from drying with several layers of wet burlap.

Take adequate precautions to protect freshly placed latex from rain. Stop all placement operations when it starts to rain. The Representative may order removal of any material damaged by rainfall.

Do not place latex when the evaporation rate exceeds 0.5 kg/m$^2$/hour (0.10 pound per square foot per hour) as determined by ACI 305R-91, Figure 2.1.5. Wind breaks, sunshades, or fogging may be used to reduce evaporation to below the maximum allowable rate.

Discontinue any placement when the Representative determines that flash set of the latex does not provide a suitable placement or finish. Submit redesign and corrective action plan as directed.

**(f) Testing and Acceptance.**

**1. Concrete Technician** Section 704.1(d)2

**2. Testing Facilities and Equipment.** Section 704.1(d)3

**3. QC and Acceptance Testing.**

**3.a QC Sampling and Testing of Plastic Latex.** Perform testing according to the accepted QC Plan. Include in the QC Plan, testing and sampling frequencies, target points, and action points to initiate corrective measures. Furnish a copy of the QC Plan to be maintained in the Department's field office.

Test each 4 m$^3$ (5 cubic yards) of latex for plastic air content, temperature, and slump. Continue testing the load until control is established. Do not wait for the completion of the initial test before collecting subsequent samples. Perform slump tests as specified in Section 1042.2(f) and air content tests according to AASHTO T 196 or T 152. Notify the Inspector when sampling and QC testing are to be performed. The Inspector will witness the sampling and QC testing. Report test results to the Inspector promptly. Coordinate and facilitate changes as needed in a timely manner.

Do not incorporate any latex into the work that does not conform to specification requirements. Immediately separate and remove nonconforming material from the deck surface.

**3.b Acceptance Testing.** Latex will be accepted on a lot-by-lot basis. Test for plastic air content according to AASHTO T 152 or T 196; temperature; and compressive strength according to PTM No. 611 and PTM No. 604. Each lot will consist of 15 m$^3$ (20 cubic yards) or a day's placement, whichever is less.

The Inspector will select acceptance samples (n=1) according to PTM No. 1. Obtain samples of fresh latex at the point of placement under the direction and supervision of the Inspector and according to PTM No. 601. Acceptance testing of plastic concrete will be performed at a site near the point of placement, as selected by the Inspector. Latex will be tested for yield as directed. Latex not conforming to specification requirements at the point of placement will be rejected.

If the results of testing the plastic latex conform to specification requirements, mold a sufficient number of acceptance cylinders for 7-day compressive strength tests. Compressive strength cylinder molds of 100 mm (4-inch) diameter by 200 mm (8-inch) height may be substituted for cylinder molds of 150 mm (6-inch) diameter by 300 mm (12-inch) height. Perform compressive testing according to PTM No. 604. The Inspector will identify the cylinders as acceptance cylinders. Field cure cylinders as specified in Section 1042.2(f). The compressive strength of the sample will be determined as the average of the compressive strength of two individual cylinders. The lot will be accepted when the 7-day compressive strength meets or exceeds 21 MPa (3,000 pounds per square inch).

**(g) Application of Live Loads.** After latex placement, do not allow heavy equipment or vehicular traffic on the latex surface until the end of the period specified in Section 1042.3(d), Table A, and until the latex has achieved the minimum strength specified in Section 1042.3(d), Table A.

**(h) Defective Work.** Sections 105.12 and 1001.3(u), and as follows:

Unless directed in writing by the District Executive, remove and replace wearing surface deficient in surface tolerance as specified in Section 501.3(o); defective in air content as specified in Section 1042.2(f); defective in compressive strength as specified in Section 1042.3(f)3.b; failing to bond to the substrate; or showing surface defects resulting from the effects of rain, improper finish, or honeycombing, which, in the Representative's opinion, cannot be repaired.

Repair or replace any latex that exhibits cracks or surface tears, as directed. Repair surface cracks and tears with methyl-methacrylate penetrating crack sealer from a supplier listed in Bulletin 15, as directed.

**1042.4 MEASUREMENT AND PAYMENT**—Square Meter (Square Yard)

As indicated, for the type specified, for the item indicated.

The Department will pay for grade adjustments of expansion dams and scuppers, and scarification, separately.

The Department will pay for repairs to the bridge deck separately under the respective type of concrete bridge deck repair when such items are provided in the proposal, otherwise, repairs as directed, are incidental.

# SECTION 1050—STEEL BRIDGE SUPERSTRUCTURE

**1050.1 DESCRIPTION**—This work is the construction of a steel bridge superstructure.

**1050.2 MATERIAL—**

**(a) Deck and Barriers.**

- Cement Concrete Structures—Section 1001.2
- Preformed Neoprene Compression Joint Seal—Section 1008.2
- Pedestrian Railing—Section 1012.2
- Aluminum Bridge Hand Railing—Section 1023.2
- Steel Bridge Hand Railing—Section 1022.2
- Protective Barrier—Section 1015.2
- Protective Fence—Section 1016.2
- Protective Coating for Reinforced Concrete Surfaces—Section 1019.2(a)
- Armored Preformed Neoprene Compression Dam—Section 1021.2
- Tooth Expansion Dam with Drain Trough—Section 1020.2
- Reinforcement Bars—Section 1002.2
- Neoprene Strip Seal Dam—Section 1026.2

**(b) Fabricated Structural Steel.** Section 1105

**(c) Paint.** Section 1060.2

**(d) Neoprene Bearing Pads.** Sections 1113.02 and 1113.03(g)

**(e) High-Load Multi-Rotational Bearings.** Section 1111

**(f) Polymer Modified Mortar for Beam Seat Leveling.** Section 1080.2(e)

**1050.3 CONSTRUCTION—**

**(a) General.** The superstructure consists of all indicated portions of the bridge above the bridge seat and includes bearings, bearings and anchors set in the substructure, abutment backwalls, cheekwalls, bridge drainage down to but not including the drain box, and portions of wings and appurtenances above the horizontal construction joint nearest the bridge seat.

**(b) Superstructure.** Construct the superstructure, as indicated, as shown on the Standard Drawings, and as follows:

- Fabricated Structural Steel—Section 1105
- Cement Concrete Structures—Section 1001.3
- Reinforcement Bars—Section 1002.3
- Preformed Neoprene Compression Joint Seal for Bridges—Section 1008.3
- Tooth Expansion Dam with Drain Trough—Section 1020.3
- Neoprene Strip Seal Dam—Section 1026.3
- Armored Preformed Neoprene Compression Dam—Section 1021.3
- Pedestrian Railing—Section 1012.3
- Aluminum Bridge Hand Railing—Section 1023.3
- Steel Bridge Hand Railing—Section 1022.3
- Protective Barrier—Section 1015.3
- Protective Fence—Section 1016.3
- Protective Coating for Reinforced Concrete Surfaces—Section 1019.3(a)

**(c) Erection.**

**1. Handling and Storing Materials.** Place material stored at the job site on skids. Keep it clean and properly drained. Place girders and beams upright and shore them. Support long members, such as columns and chords, on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, check material turned over against the shipping lists and promptly report in writing any shortage or injury discovered. The Contractor is responsible for the loss of any material while in the Contractor's care, or for any damage caused to it after being received by the Contractor.

**2. Falsework Design and Construction.** Design and construct falsework according to AASHTO 11.2.2, 11.6.1, AASHTO Publications (Guide Design Specifications for Bridge Temporary Works and Construction Handbook for Bridge Temporary Works) and as specified in Section 105.03(c).

**2.a General.** Provide all tools, machinery, and equipment necessary to erect the falsework. Falsework is considered to be any temporary structure that supports structural elements of concrete, steel, masonry, or other materials during their construction or erection. Form travelers, as used in segmental cantilever construction, are considered to be a combination of falsework and forms. Have a Professional Engineer registered in the State sign and seal the working drawings for the falsework if the height of falsework exceeds 4.3 m (14 feet) or if traffic, other than workmen involved in constructing the bridge, will travel under the bridge. Furnish falsework of sufficient rigidity and strength to safely support all forces imposed, and to produce, in the finished structure, the lines and grades indicated.

**2.b Design Loads.** Ensure that the design load for falsework consists of the sum of dead and live vertical loads, and any horizontal loads. As a minimum, include in the dead loads the gravitational force of the falsework and all construction material to be supported. Assume the combined density of concrete, reinforcing and prestressing steel, and forms to be not less than 2570 kg/m$^3$ (160 pounds per cubic foot) of normal density concrete or 2090 kg/m$^3$ (130 pounds per cubic foot) of low-density concrete that is supported.

For live loads, include the actual force of any equipment to be supported, applied as concentrated forces at the points of contact and a uniform force of not less than 960 $N/m^2$ (20 pounds per square foot) applied over the area supported, plus 1100 N/m (75 pounds per linear foot) applied at the outside edge of deck overhangs.

For the design of the falsework bracing system, use the sum of the horizontal forces due to equipment, construction sequence, including unbalanced hydrostatic forces from fluid concrete, stream flow when applicable, and an allowance for wind. However, do not allow the horizontal force to be resisted in any direction to be less than 2% of the total dead load.

Do not exceed the load-carrying capacity of the structure, or portion of structure, as computed using AASHTO LRFD Specifications Article 3.4.2 by imposing forces on existing, new, or partially completed portions of structures due to construction operations. For the compressive strength of concrete, f'c, in computations of the load-carrying capacity, use the lesser of the actual compressive strength at the time of loading or the specified compressive strength of the concrete.

**2.c Clearances.** Unless otherwise provided for roadways that are to remain open to traffic, supply minimum dimensions for clear openings through falsework at least 1.5 m (5 feet) wider than the width of the approach traveled way, measured between barriers when used, and 4.3 m (14 feet) high, except over interstate routes and freeways use 4.4 m (14.4 feet) for the minimum vertical clearance.

**2.d Erection Drawings.** Submit drawings illustrating the proposed method of erection. Show details on the drawings of all falsework bents, bracing, guys, dead-men, lifting devices, and attachments to the bridge members. Show the sequence of erection, location of cranes and barges, crane capacities, location of lifting points on the bridge members, and masses (weights) of the members. Supply plans and drawings complete in detail for all anticipated phases and conditions during erection. If required, furnish calculations to demonstrate that allowable stresses are not exceeded and that member capacities and final geometry will be correct. Do not proceed with erection until the drawings have been accepted.

**2.e Construction.** Construct falsework and set it to grades that allow for its anticipated settlement and deflection, and for the vertical alignment and camber indicated or ordered by the Representative for the permanent structure. Use variable depth camber strips between falsework beams and soffit forms to accomplish this, if directed.

Use suitable screw jacks, pairs of wedges or other devices at each post to adjust falsework to grade, to allow minor adjustments during the placement of concrete or structural steel should observed settlements deviate from those anticipated, and to allow for the gradual release of the falsework. Provide tell-tales attached to the forms and extending to the ground, or other means, for accurate measurement of falsework settlement during the placing and curing of the concrete.

Support falsework or formwork for deck slabs on girder bridges directly on the girders so that there will be no appreciable differential settlement during placing of the concrete. Brace and tie girders to resist any forces that would cause rotation or torsion in the girders caused by the placing of concrete for diaphragms or deck. Do not weld falsework support brackets or braces to structural steel members or reinforcing steel unless specifically allowed.

**2.f Removal.** Section 1001.3(q)

**3. Erection Procedure.**

**3.a Conformance to Drawings.** Ensure that the erection procedure conforms to the erection drawings submitted as specified in Section 1050.3(c)2.d. Any modification to or deviations from this erection procedure will require revised drawings and verification of stresses and geometry.

**3.b Erection Stresses.** Account for any erection stresses that are induced in the structure as a result of the use of a method of erection or equipment which differs from that indicated or specified, and which will remain in the finished structure as locked-in stresses. Provide additional material, at no additional cost to the Department, to keep both temporary and final stresses within the allowable limits used in design.

Provide temporary bracing or stiffening devices to accommodate handling stresses in individual members or segments of the structure during erection.

**3.c Maintaining Alignment and Camber.** During erection, support segments of the structure in a manner that will produce the proper alignment and camber in the completed structure. Install cross frames and diagonal bracing, as necessary during the erection process, to provide stability and ensure correct geometry. Provide temporary bracing, if necessary, at any stage of erection.

**4. Bearings and Anchorage.**

**4.a General.** This work consists of furnishing and installing bridge bearings. Bearing types include, but are not limited to, elastomeric pad, rocker, roller, pot, spherical, disk, and sliding plate bearings. Included as components of bearings are masonry, sole and shim plates, bronze or copper-alloyed bearing and expansion plates, anchor bolts, PTFE sheets or surfacing, lubricants and adhesives. The furnishing and installation of bedding materials used under masonry plates is also included in this work.

Construct bearings according to the indicated details. If complete details are not provided, furnish bearings that conform to the limited, indicated details and provide the design capacities for loads and movements shown or specified and the performance characteristics specified.

**4.a.1 Working Drawings.** If complete details for bearings and their anchorages are not indicated, prepare and submit working drawings for the bearings. Show all details of the bearings and of the materials proposed for use on such drawings, and have the drawings approved before fabrication of the bearings is begun.

**4.a.2 Packaging, Handling, and Storage.** Before shipment from the point of manufacture, package bearings in such a manner to ensure that during shipment and storage the bearings will be protected against damage from handling, weather, or any normal hazard. Clearly identify each completed bearing's components; securely bolt, strap, or otherwise fasten its components to prevent any relative movement; and mark on its top its location and orientation in each structure in the project, in conformity with the plans. Do not dismantle bearings at the site unless absolutely necessary for inspection or installation.

Store all bearing devices and components at the work site in an area that provides protection from environmental and physical damage. Ensure that bearings are clean and free of all foreign substances when installed.

**4.a.3 Manufacture or Fabrication.** Unless otherwise specified or indicated, furnish the surface finish of bearing components that come into contact with each other or with concrete, but are not embedded in concrete, as specified in Section 1105.03(q).

**4.a.4 Construction and Installation.** Install bearings to the positions indicated. At the time of installation, set bearings to the dimensions prescribed by the manufacturer, the Representative, or as indicated. Adjust bearings as necessary to take into account the temperature and future movements of the bridge.

Set bridge bearings level, in exact position, and to have full and even bearing on all bearing planes.

For bearing surfaces located at improper elevations or set not level and true to plane, either grind the surface, grout pack bearings, or modify the bearing such that intended bearing placement is as originally designed with the least amount of bearing modification.

Use a filler or fabric material as specified in Section 1113.03(h) to bed on the concrete metallic bearing assemblies not embedded in the concrete.

Set elastomeric bearing pads directly on properly prepared concrete surfaces without bedding material.

For bearings seated directly on steel work, machine the supporting surface so as to provide a level and planar surface to place the bearing.

**4.b Preparation of Bearing Areas.** Prepare bearing areas as specified in Section 1001.3(k)9 and furnish bedding material as specified in Section 1113.03(h).

**4.c Elastomeric Bearings.** Elastomeric bearings include unreinforced pads (consisting of neoprene only) and reinforced pads with steel or fabric laminates. Furnish bearings with the dimensions, material properties, neoprene grade and type of laminates indicated.

**4.c.1 Setting Bearing Pads.** Set bearing pads as specified in Section 1080.3(c)2 and as indicated. Where elastomeric bearings are used at piers of continuous bridges, provide full contact between the beam, the bearing pad, and the beam seat, unless the plans indicate that a lift-off condition is expected when the beam is initially set on the pad.

**4.c.2 Resetting Bearing Pads.** If indicated, reset expansion bearings after all dead loads have been placed. Submit a plan showing and describing the jacking procedure for review and acceptance at least 2 weeks before proceeding with the jacking operations. Provide calculations showing actual and allowable bearing stresses in the bearing plates and bearing areas at the jacking locations. Have the plans and calculations sealed and signed by a Professional Engineer registered in the State.

Before resetting, truck mixers and slip-forming equipment, necessary for placement of barriers and sidewalks, will be allowed on the structure. Do not allow other construction equipment or traffic on the structure until the bearings are reset. Coordinate the resetting operation with the installation of on-bridge hardware, including conduits, utilities, expansion dams, and drainage, to prevent damage to these components when the beams are jacked and lowered.

Furnish jacks with a working capacity at least equal to the jacking forces indicated. Jack beams at expansion bearings to achieve a 2 mm (1/16-inch) gap between the bottom of beam or sole plate and the top of the entire bearing pad. Place jacks at jacking points indicated. Unless indicated otherwise, jack all beams simultaneously. Limit the differential rise between all beams to 3 mm (1/8 inch) during jacking. After jacking, center the pad beneath the sole plate or beam bearing area as indicated. Lower the beams onto the bearings in the same manner as they were jacked.

Reset bearings when the ambient temperature is above -7 °C (20F) and below 30 °C (85F).

**4.d Anchor Bolts.**

**4.d.1 Fabrication.** Furnish swedged or threaded anchor bolts to secure a satisfactory grip upon the material used to embed them in the holes.

**4.d.2 Setting Anchor Bolts.** Set by template to the indicated elevation and alignment. As an alternate, set in preformed holes 50 mm (2 inches) larger than the bolt diameter. Clean the holes, set and fix the bolts, and fill the holes with nonshrink grout, as specified in Section 1001.2(e). Use drilled holes, as a substitute for preformed holes, in abutments and solid piers only. Protect the holes against water entry during freezing periods.

Limit the threaded projection above the nut to between 5 mm and 25 mm (3/16 inch and 1 inch).

**4.e Setting Bearings.** As shown on the Standard Drawings and as follows:

Align masonry plates and set them so they will be centered with the rockers, rollers, sole plates, and bearing plates, at 20 °C (68F) and under full dead load. Make adjustment for the difference in temperature, from 20 °C (68F), at time of erection. Compensate for the change in length of the bottom chord, or flange, due to the later addition of dead loads.

Maximum deviation of the top of rockers from a vertical position, and maximum eccentricity of the parts of sliding bearings, is 0.0001(X) + 5 mm, where X, in millimeters (0.0001(L) + 0.25 inch, where L, in inches), is the horizontal distance between the expansion bearing and the fixed bearing.

**4.f Spherical Bearings.** Fabricate, test, and install spherical bearings as indicated.

**4.g Separate Contracts for Substructure and Superstructure.** If the substructure and superstructure are built under separate contracts, proceed as follows:

**4.g.1 Substructure Contractor.** Accurately place the anchor bolts and grind the bearing areas to the correct plane and elevation.

At the completion of the substructure, make an as-built survey to accurately show the as-built versus the plan location of all substructure centerlines, girder centerlines, anchor bolt group centerlines, anchor bolts, bearing elevations, and any other elements or items that may affect the layout or placement of the work to be furnished by the superstructure contractor. Show all of the pertinent as-built survey information, including dimensions, elevations, and angles on suitable drawings, as specified for shop drawings, together with the corresponding design drawing information

for direct comparison. Submit the original drawings, or equal, to the Department as soon as practical after completion of the survey. Conduct the survey and have the survey drawings signed by a Surveyor or Professional Engineer registered in the State.

Provide documented evidence to show that the bearings can be set properly within the tolerances specified in Section 1050.3(c)4.d.

**4.g.2 Superstructure Contractor.** Use the as-built survey information, furnished by the substructure contractor, for the accurate layout of the connecting parts of the work.

Verify location, level, and elevation of all bearing seats and anchor bolts as soon as possible. Verify, before the fabrication of any metal work, in cases where the substructure is completed before award of the superstructure contract, or before erection of the metal work, in cases where fabrication has been started before completion of the substructure.

Furnish and install bedding, bearings, and nuts and washers for anchor bolts.

**4.h High-Load Multi-Rotational Bearings.** If required, construct as follows:

Provide complete erection and installation procedures for acceptance before installation.

Evenly support bearings over their upper and lower surfaces under all erection and service conditions.

Lift bearings by undersides only or by specially designed lifting lugs.

Take care to avoid damage to and contamination of bearing surfaces during installation.

Align the centerlines of the bearing assembly with those of the substructure and superstructure. On guided bearings take special care to properly align the guiding mechanism with the designated expansion direction of the structure.

Leave bearing straps or retaining clamps in place as long as possible to ensure parts of bearing are not inadvertently displaced relative to each other. Take care to remove straps or clamps before any normal structural movement takes place, such as post-tensioning.

Set offsets of upper and lower bearing parts as indicated. Under dead load, the distance between the upper and lower bearing plates is not to be out of parallel by more than 3 mm (1/8 inch) measured from edge to edge.

Make the mating surface of the superstructure level within a slope of 1:100 (100:1). Have no local irregularities exceeding 1.5 mm (1/16 inch).

During welding of sole plates to girders, limit the temperature of the metal adjacent to neoprene and PTFE to a maximum of 150 °C (300F). Use temperature indicating markers.

**4.h.1 Bearing Seats.** Provide bedding material for steel bearings as specified in Section 1113.03(h).

**5. Straightening Material.** If allowed, straighten plates, angles, other shapes, and built-up members. Use methods that will not produce fracture or other injury to the metal. Straighten distorted members by mechanical means or, if allowed, by carefully planned procedures and supervised application of a limited amount of localized heat. Heat-straighten Grades 485W, 690, and 690W (Grades 70W, 100, and 100W) steel members only under rigidly controlled procedures, each application subject to approval. Do not allow the maximum temperature to exceed the following values:

| Steel Grade | Distance from Weld | Max. Temp. |
|---|---|---|
| 485W (70W) | > 150 mm (6 inches) | 580 °C (1,050F) |
| 485W (70W) | < 150 mm (6 inches) | 480 °C (900F) |
| 690 (100) or 690W (100W) | > 150 mm (6 inches) | 610 °C (1,100F) |
| 690 (100) or 690W (100W) | < 150 mm (6 inches) | 510 °C (950F) |

In all other steels, do not allow the temperature of the heated area to exceed 650 °C (1,200F) as controlled by temperature indicating crayons, liquids, or bimetal thermometers.

Ensure that parts to be heat-straightened are substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Evidence of fracture following straightening of a bend or buckle will be cause for rejection of the damaged piece.

**6. Field Assembly.** Accurately assemble the parts as indicated or shown on the erection drawings, and follow any match-marks. Carefully handle the material so that no parts will be bent, broken, or otherwise damaged. Do not hammer members if it will injure or distort them. Clean bearing surfaces and surfaces to be in permanent contact before the members are assembled. Fill one-half of the holes of splices and field connections with bolts and cylindrical erection pins (half bolts and half pins) before installing and tightening the balance of high-strength bolts. Fill three-fourths of the holes of splices and connections carrying traffic during erection before installing and tightening the balance of high-strength bolts.

Fitting-up bolts may be the same high-strength bolts used in the installation. If other fitting-up bolts are used, supply fitting-up bolts of the same nominal diameter as the high-strength bolts, but supply cylindrical erection pins 1 mm (1/32 inch) larger.

**7. Connections Using High-Strength Bolts.** Make connections as specified in Section 1105.03(j) and as follows:

**7.a General.** Obtain the "snug tight" condition as defined in Section 1050.3(c)7.d for any method of final tightening except direct-tension-indicator (DTI) tightening.

Assemble fasteners of appropriately assigned lot numbers together when installed. Protect such fasteners from dirt and moisture at the job site. Take only as many fasteners as are anticipated to be installed and tightened during a work shift from protected storage. Return fasteners not used to protected storage at the end of the shift. Do not clean lubricant from fasteners that is required to be present in as-delivered condition. Before installation, clean and relubricate fasteners for slip-critical connections, which accumulate rust or dirt resulting from job site conditions. If relubrication is required, use a lubricant recommended by the fastener manufacturer.

Provide a Skidmore-Wilhelm Calibrator, or other equivalent bolt tension measuring device, at each job site, during erection. Perform periodic testing (at least once each working day if calibrated wrench method is used) to ensure compliance with the installation test procedures specified herein for turn-of-nut tightening, calibrated wrench tightening, installation of alternate design bolts, and direct tension indicator tightening. Bolts that are too short for the Skidmore-Wilhelm Calibrator may be tested using DTI devices. In that case, calibrate the DTI devices in the Skidmore-Wilhelm Calibrator using longer bolts.

Install fasteners together with washers of size and quality specified, located as required below, in properly aligned holes, and tighten by any of the methods specified in Sections 1050.3(c)7.d through 1050.3(c)7.g to at least the minimum tension specified in Table A, when all the fasteners are tight. When it is impractical to turn the nut, tighten the fastener by turning the bolt while the nut is prevented from rotating. If impact wrenches are used, provide adequate wrench capacity and sufficient air supply to perform the required tightening of each bolt in approximately 10 seconds.

Do not reuse galvanized AASHTO M 164 (ASTM A 325) fasteners. Reuse other AASHTO M 164 (ASTM A 325) bolts only if approved. Do not consider as reuse touching up or retightening previously tightened bolts that may have been loosened by the tightening of adjacent bolts provided the snugging up continues from the initial position and does not require greater rotation, including the tolerance, than that required by Table B.

**7.b Rotational-Capacity Tests.** Perform the rotational capacity test on each bolt/nut/washer assembly lot, as specified in Section 1105.02(d)7, immediately before the start of bolt installation in the fabrication shop or at the project site. Document test results according to PTM No. 427. If testing and installation is performed in the fabrication shop, submit test results to MTD. If testing and installation is performed at the project site, submit test results to the Representative. All job-site rotational capacity tests are to be performed by the Contractor and witnessed by the Inspector.

Hardened steel washers are required as part of the test, although they may not be required in the actual installation. Mark fastener containers for each assembly lot after testing to indicate their acceptance.

**7.c Requirement for Washers.** Where the outer face of the bolted parts has a slope greater than 1:20 (20:1) with respect to a plane normal to the bolt axis, use a hardened beveled washer to compensate for the lack of parallelism.

For American Standard Beams and Channels use hardened beveled washers that are square or rectangular, that conform to AASHTO M 293 (ASTM F 436M), and that taper in thickness.

Where necessary, clip washers on one side to a point not closer than 7/8 of the bolt diameter from the center of the washer.

Hardened washers are not required for connections using AASHTO M 164 (ASTM A 325) bolts except as follows:

- Use hardened washers under the element turned in tightening when the tightening is to be performed by calibrated wrench method.

- Hardened steel washers are required as part of rotational-capacity tests, even if they are not required in the actual installation.

- Where AASHTO M 164 (ASTM A 325) bolts are to be installed in a long slotted hole in an outer ply, provide a plate washer or continuous bar of at least 8 mm (5/16-inch) thickness with standard holes. Furnish washers or bars of sufficient size to completely cover the slot after installation. Use a single hardened washer conforming to ASTM F 436, but with a minimum thickness of 8 mm (5/16 inch), or use a washer or bar of structural grade material. Do not use multiple hardened washers to achieve a thickness of 8 mm (5/16 inch).

- As an alternate satisfying the requirements for washers, use alternate design fasteners conforming to the requirements specified in Section 1050.3(c)7.c.1, with a geometry that provides a bearing circle on the head or nut with a diameter equal to or greater than the diameter of hardened washers conforming to the requirements of ASTM F 436. Such fasteners may be used without washers.

**7.c.1 Alternate Fasteners.** If alternate fasteners are allowed, proceed as specified in Section 1050.3(c)7.h and as follows:

If allowed, use other fasteners or fastener assemblies that conform to the materials, manufacturing, and chemical composition requirements of AASHTO M 164 (ASTM A 325) and that conform to the mechanical property requirements of the same specification in full-size tests, and that have body diameter and bearing areas under the head and nut, or their equivalent, not less than those provided by a bolt and nut of the same nominal dimensions specified in Section 1105.02(d). Such alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

**7.d Turn-of-Nut Tightening.** If turn-of-nut tightening is used, hardened washers are not required except as specified in Section 1050.3(c)7.c.

Check a representative sample of not less than three bolt and nut assemblies of each diameter, length and grade to be used in the work at the start of work in a device capable of indicating bolt tension.

Using the test, demonstrate that the method for estimating the snug tight condition and controlling the turns from snug tight to be used by the bolting crew develops a tension not less than 5% greater than the tension required by Table A. Perform periodic retesting if ordered by the Representative.

Install bolts in all holes of the connection and bring them to a snug tight condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. Use a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench to attain the snug tight condition.

Snug tighten the bolts of the connection by progressing systematically from the most rigid part of the connection to the free edges, and then retighten the bolts in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted. Following this initial operation further tighten all bolts in the connection by the applicable amount of rotation specified in Table B. During the tightening operation, do not allow rotation of the part not turned by the wrench. Systematically tighten the bolts progressing from the most rigid part of the joint to its free edges.

**7.e Calibrated-Wrench Tightening.** Use calibrated wrench tightening only if installation procedures are calibrated on a daily basis and if a hardened washer is used under the element turned in tightening. Standard torques determined from tables or from formulas, which are assumed to relate torque to tension, are not acceptable.

When calibrated wrenches are used for installation, set them to provide a tension not less than 5% in excess of the minimum tension specified in Table A. Calibrate the installation procedures at least once each working day for each bolt diameter, length, and grade, using fastener assemblies that are being installed in the work. Perform calibration in a device capable of indicating actual bolt tension by tightening three typical bolts of each diameter, length, and grade, from the bolts being installed and with a hardened washer, from the washers being used in the work, under the element turned in tightening. Recalibrate wrenches if significant difference is noted in the surface condition of the bolts, threads, nuts, and washers. Verify during actual installation in the assembled steel work that the wrench adjustment selected by the calibration does not produce a nut or bolt head rotation from snug tight greater than that specified in Table B. If manual torque wrenches are used, turn nuts in the tightening direction when torque is measured.

When calibrated wrenches are used to install and tension bolts in a connection, install bolts with hardened washers under the element turned in tightening bolts in all holes of the connection and bring them to a snug tight condition. Following this initial tightening operation, tighten the connection using the calibrated wrench. Tighten the bolts by progressing systematically from the most rigid part of the joint to its free edges. Use the wrench to again tighten previously tightened bolts that may have been relaxed as a result of the subsequent tightening of adjacent bolts, until all bolts are tightened to the prescribed amount.

**7.f Installation of Alternate Design Bolts.** When fasteners that incorporate a design feature intended to indirectly indicate the bolt tension or to automatically provide the tension specified in Table A and that have been qualified under Section 1050.3(c)7.c.1 are to be installed, check a representative sample of not less than three bolts of each diameter, length, and grade, at the job site in a device capable of indicating bolt tension. Include flat, hardened washers in the test assembly, if required in the actual connection, arranged as those in the actual connections to be tensioned. Use the calibration test to demonstrate that each bolt develops a tension not less than 5% greater than the tension specified in Table A. Follow the manufacturer's installation procedure for installation of bolts in the calibration device and in all connections. Perform periodic retesting when ordered by the Representative.

When alternate design fasteners that are intended to control or indicate bolt tension of the fasteners are used, install bolts in all holes of the connection and initially tighten them sufficiently to bring all plies of the joint into firm contact but without yielding or fracturing the control or indicator element of the fasteners. Then further tighten all fasteners, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, to properly tension the bolts, perform more than a single cycle of systematic partial tightening before final twist-off of the control or indicator element of individual fasteners. Replace any individual fastener assembly if twist off occurs before the final tensioning cycle.

**7.g Direct Tension Indicator Tightening.** When tightening of bolts using DTI devices is used, assemble a representative sample of not less than three devices, for each diameter and grade of fastener to be used in the work, in a calibration device capable of indicating bolt tension. Include flat-hardened washers in the test assembly, if required in the actual connection, arranged as those in the actual connections to be tensioned. Use the calibration test to demonstrate that the device indicates a tension not less than 5% greater than that specified in Table A.

After tightening in the calibrating device, use a torque wrench to verify the torque required for proper tightening. Tighten the nut of each assembly five degrees past the initial required tension, record the respective load reading on the torque wrench dial, and determine the average of the sample assemblies. This average torque will be the inspection torque used on completed connections and is to be determined each day that inspection of completed connections is performed.

Follow manufacturer's installation procedure for installation of bolts in the calibration device and in all connections. Give special attention to proper installation of flat-hardened washers when DTI devices are used with bolts installed in oversize or slotted holes and when the load indicating devices are used under the turned element.

When bolts are installed using DTIs conforming to the requirements of ASTM F 959, install bolts in all holes of the connection and bring them to snug tight conditions. Snug tight is indicated by partial compression of the direct tension indicator protrusions. Provide a maximum gap of 0.125 mm (0.005 inch) after installation. Then tighten all fasteners, progressing systematically from the most rigid part of the connection to the free edges, in a manner that will minimize relaxation of previously tightened fasteners.

**TABLE A (Metric)**
**Required Fastener Tension**
**Minimum Bolt Tension in Kilonewtons***

| Bolt Size mm | AASHTO M 164 (ASTM A 325) |
|---|---|
| 12.7 | 53.4 |
| 15.9 | 84.5 |
| 19.1 | 124.5 |
| 22.2 | 173.5 |
| 25.4 | 226.8 |
| 28.6 | 249.1 |
| 31.8 | 315.8 |
| 34.9 | 378.1 |
| 38.1 | 458.1 |

* Equal to 70% of specified minimum tensile strength of bolts (according to ASTM Specifications for tests of full-size ASTM A 325 bolts with UNC profile threads loaded in axial tension) rounded to the nearest tenth of a kilonewton.

**TABLE A (English)**
**Required Fastener Tension**
**Minimum Bolt Tension in Pounds***

| Bolt Size inches | AASHTO M 164 (ASTM A 325) |
|---|---|
| 1/2 | 12,000 |
| 5/8 | 19,000 |
| 3/4 | 28,000 |
| 7/8 | 39,000 |
| 1 | 51,000 |
| 1-1/8 | 56,000 |
| 1-1/4 | 71,000 |
| 1-3/8 | 85,000 |
| 1-1/2 | 103,000 |

* Equal to 70% of specified minimum tensile strength of bolts (according to ASTM Specifications for tests of full-size ASTM A 325 bolts with UNC profile threads loaded in axial tension) rounded to the nearest kip.

**TABLE B**
**Nut Rotation from the Snug-Tight Condition(1),(2) Geometry of Outer Faces of Bolted Parts**

| Bolt length measured from underside of head to end of bolt | Both faces normal to bolt axis | One face normal to bolt axis and other face sloped not more than 1:20 (20:1). Bevel washer not used. | Both faces sloped not more than 1:20 (20:1) from normal to bolt axis. Bevel washers not used. |
|---|---|---|---|
| Up to and including 4 diameters | 1/3 turn | 1/2 turn | 2/3 turn |
| Over 4 diameters but not exceeding 8 diameters | 1/2 turn | 2/3 turn | 5/6 turn |
| Over 8 diameters but not exceeding 12 diameters(3) | 2/3 turn | 5/6 turn | 1 turn |

(1) Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be ±30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

(2) Applicable only to connections in which all material within grip of the bolt is steel.

(3) No research work has been performed by the Research Council Riveted and Bolted Structural Joints to establish the turn-of-nut procedure if bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests, in a suitable tension device, simulating the actual conditions.

In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening before final tightening to deform the protrusion to the specified gap.

**7.h Lock-Pin and Collar Fasteners.** Install lock-pin and collar fasteners using approved methods and procedures.

**7.i Inspection.** In the presence of the Inspector, inspect the tightened bolts using a calibrated torque wrench. At the Representative's option, this inspection can be performed either by the Inspector or the Contractor.

Individually place three bolts of the same grade, size, and condition as those under inspection in a device calibrated to measure bolt tension. Perform this calibration operation at least once each inspection day. Provide a washer under the part turned in tightening each bolt, if washers are used on the structure. If washers are not used on the structure, furnish the material used in the tension measuring device which abuts the part turned of the same specification as that used on the structure. In the calibrated device, tighten each bolt to the specified tension by any convenient means. Apply the calibrated torque wrench to the tightened bolt to determine the torque required to turn the nut or head five degrees (approximately 25 mm (1 inch) at a 300 mm (12-inch) radius) in the tightening direction. Take the average of the torque required for all three bolts as the job-inspection torque.

For final acceptance of connections installed using high-strength bolts, inspect 10% (2 minimum) of the bolts in the connection using a calibrated torque wrench. Select bolts to be inspected according to PTM No. 1. Then apply the job-inspection torque to each with the calibrated torque wrench turned in the tightening direction. If this torque turns no bolt head or nut, the bolts in the connection will be considered to be properly tightened. But if the torque turns one or more bolt heads or nuts, apply the job-inspection torque to all bolts in the connection. Tighten and reinspect any bolt whose head or nut turns at this stage, or retighten all the bolts in the connection and resubmit it for inspection.

**8. Pin Connections.** Use pilot and driving nuts in driving pins. Drive pins so that the members will take full bearing on them. Screw pin nuts up tight and burr the threads at the face of the nut with a pointed tool.

**9. Misfits.** The correction of minor misfits involving minor amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, errors in the shop fabrication or deformation resulting from handling and transporting will be cause for rejection.

The Contractor is responsible for all misfits, errors, and damage. Make the necessary corrections and replacements to correct misfits, errors, and damage.

**(d) Painting.** Apply intermediate and finish coats of paint, as specified in Section 1060.3.

**1050.4 MEASUREMENT AND PAYMENT**—Lump Sum. The price includes the following component items.

- **Fabricated Structural Steel.** Kilogram (Pound)
  The cost of welds in excess of those indicated and allowed by the Chief Bridge Engineer, due to the Contractor's request, is incidental to the other fabricated structural steel work. The cost of all nondestructive testing, including equipment, supplies, and technicians is also incidental to the other fabricated structural steel work.

- **Cement Concrete Structures.** Section 1001.4
- **Preformed Neoprene Compression Joint Seal.** Section 1008.4
- **Pedestrian Railing.** Section 1012.4
- **Aluminum Bridge Hand Railing.** Section 1023.4
- **Steel Bridge Hand Railing.** Section 1022.4
- **Protective Barrier.** Section 1015.4
- **Protective Fence.** Section 1016.4
- **Protective Coating for Reinforced Concrete Surfaces.** Section 1019.4
- **Armored Preformed Neoprene Compression Dam.** Section 1021.4
- **Tooth Expansion Dam with Drain Trough.** Section 1020.4
- **Reinforcement Bars.** Section 1002.4
- **Neoprene Strip Seal Dam.** Section 1026.4
- **High Load Multi-Rotational Bearings.** Each
  For the type indicated.
- **Neoprene Bearing Pads.** Each
  For the type indicated.
- **Reset Expansion Bearings, Steel Superstructure.** Each

# SECTION 1051—DOWNSPOUTING

**1051.1 DESCRIPTION**—This work is the furnishing and installation of downspouting.

**1051.2 MATERIAL**—As shown on the Standard Drawings and as follows:

- Fabricated Structural Steel—Section 1105, galvanized as specified in Section 1105.02(s).
- Fiberglass Pipe and Fittings—ASTM D 2996 RTRP with a 207 MPa (30,000 pounds per square inch), minimum short-time rupture strength hoop tensile stress. Use concrete gray as the final color of the reinforced fiberglass pipe, unless otherwise specified. Use a coating that protects the pipe from ultraviolet damage. Use manufacturer recommended paint and fittings.
- PVC Schedule 40 Pipe—ASTM D 1785

**1051.3 CONSTRUCTION**—Install downspouting, including the drain box, as indicated and as shown on the Standard Drawings.

**1051.4 MEASUREMENT AND PAYMENT**—Lump Sum or Meter (Linear Foot)

# SECTION 1052—METAL CURB DRAIN

**1052.1 DESCRIPTION**—This work is construction of an aluminum or steel drain facility to dispose of bridge deck drainage by free drop through curb barrier.

**1052.2 MATERIAL—**

**(a) Aluminum.** ASTM B 308/B 308M, Alloy 6061-T6. Certify as specified in Section 106.03(b)3.

**(b) Structural Steel.** Section 1105.02(a)2

**(c) Coating Compound, Bituminous Solvent Type, Mineral Filled and Aluminum Pigmented.** Bulletin 26. Certify as specified in Section 106.03(b)3.

**(d) Galvanizing.** Section 1105.02(s)

**1052.3 CONSTRUCTION—**

**(a) General.** Fabricate the drain from either C203 x 6.3 (C8 by 4.25) aluminum channels, or C200 x 17 (C8 by 11.5) steel channels, welded together with full penetration welds to form a rectangular section. Alternatively, fabricate a rectangular section, 200 mm x 110 mm (8 inches by 4 1/2 inches) out of 5 mm (3/16-inch) steel plates.

**(b) Aluminum Drain.** Coat all surfaces of the drain to be in contact with concrete with two coats of bituminous solvent type coating compound.

**(c) Steel Drain.** Galvanize the entire drain after welding according to ASTM A 123.

**1052.4 MEASUREMENT AND PAYMENT**—Metal curb drain is incidental to other structure items of work.

# SECTION 1056—FABRICATED STRUCTURAL STEEL

**1056.1 DESCRIPTION**—This work is the furnishing and installation of fabricated structural steel for repair, rehabilitation, or modification of steel structures.

**1056.2 MATERIAL—**

**(a) Fabricated Structural Steel.** Section 1105

**(b) Paint.** Section 1060.2

**1056.3 CONSTRUCTION**—As indicated and as specified in the applicable parts of Section 1050.3.

**1056.4 MEASUREMENT AND PAYMENT**—Kilogram (Pound)

The Department will not pay for cuts, copes, bolt holes, or other material not incorporated into the finished work.

The Department will not pay for welds or weld material.

# SECTION 1060—SHOP PAINTING STRUCTURAL STEEL

**1060.1 DESCRIPTION**—This work is the cleaning and priming of structural steel in the shop, using a self-curing, inorganic, zinc-rich primer, and the application of intermediate and finish coats in the shop in the field.

**(a) Prequalification.** When shop painting structural steel, use only Bulletin 15 approved paint shops that are certified by the AISC under its Sophisticated Paint Endorsement (SPE) quality program or by the Society for Protective Coatings (SSPC) under its QP3 quality program. Use Shops certified to the "enclosed shop" category. Use shops that are fully certified for the duration of time they are performing surface preparation and coating application. Apply complete coating system in an "enclosed shop" except for touch up painting.

For shop removal and disposal of hazardous coating, including but not limited to lead based paint, use only shops certified to SSPC-QP3 and listed in Bulletin 15 as approved paint shops.

**1060.2 MATERIAL—**

**(a) Coating System for Plain Carbon Steel.** Use an approved, proprietary, self-curing, inorganic, zinc system, from a manufacturer listed in Bulletin 15, consisting of a self-curing, inorganic zinc primer, an epoxy or urethane intermediate coat, and an aliphatic urethane finish coat, Do not mix components or coats from different systems. Use the products of one manufacturer for the entire system.

**1. Submittal Requirements.** Submit the following information to the District Executive:

- Infrared curves (2.5 µm to 15 µm (2.5 microns to 15 microns)) for the zinc primer, intermediate coat, and finish coat including curves for the vehicle (binder) of each component and for the mixed paint;
- Mass per liter (weight per gallon), at 25 °C (77F), for zinc primer vehicle and the intermediate and finish coat paints;
- Viscosity in Krebs Units, at 25 °C (77F), for the zinc primer vehicle and the intermediate and finish coat paints;
- Percent solids by mass (weight) of the zinc primer vehicle and the intermediate and finish coat paints;
- Percent of metallic zinc by mass (weight) in the cured zinc primer coat, dry film;
- Percent of metallic zinc by mass (weight) in the zinc pigment component;
- Finish coat color chips for selection of color by the District Bridge Engineer; and
- Technical data sheets, safety data, and specific application instructions for all coats. In the event of a conflict between the data/instruction sheets and these Specifications, the Specification requirements will govern. Work will not be allowed to proceed until this information is received.

**2. Technical Representation.** Furnish the services of a paint or a painting technical representative from the paint manufacturer at the beginning of operations and when required.

**3. Damage Prevention and Repair Procedures.** Furnish a damage prevention plan with the structural steel shop drawings that describes the procedures and protective materials to be used to prevent damage to paint coats. Have the plan cover the period of time from when paint coats are applied in the shop until erection is completed in the field.

Furnish the manufacturer's recommended surface preparation, coating application, and coating repair procedures. Include the manufacturer's recommended surface preparation methods, coating material, application methods, and application conditions. Include the manufacturer's recommended methods for correction of damage to one or more coats, including correction of damage caused in handling, shipping, and erection; correction of deficient or excessive coating thickness; correction of runs, sags, peeling, and poorly adhered coating; and removal of zinc salts and other contaminants that would be detrimental to succeeding coats.

**(b) Coating System for Galvanized Steel.** Use an approved two-coat paint system, from a manufacturer listed in Bulletin 15, consisting of an epoxy polyamide as an intermediate coat and an aliphatic urethane as a finish coat. Select colors for the intermediate and finish coat before fabrication. Do not use the system prime coat. Do not mix components from different systems. If a wash primer is used, provide the manufacturer's certification of compatibility with the selected paint system.

- Furnish submittals as specified in Section 1060.2(a)1 for intermediate and finish coats. Furnish technical representation as specified in Section 1060.2(a)2. Furnish damage prevention and repair procedures as specified in Section 1060.2(a)3.

## 1060.3 CONSTRUCTION—

### (a) General.

**1. Protection of Structure, Persons, and Property.** When applying the full intermediate and finish coats in the field or when repairing coating damage in the field, protect pedestrians, vehicles, and other traffic, upon or under the bridges; the bridge superstructure and substructure; and surrounding property surfaces, buildings, and grounds. Protect against damage or disfigurement from surface preparation media and spatters, splashes, overspray, and smirches of paint or material. As necessary, furnish adequate canvas or other suitable containment materials, for protection.

For field coating work, remove paint dropped on surfaces not designated to be coated. Remove debris from cleaning operations, empty paint containers, and other refuse.

**2. Pollution Controls.** Prevent environmental pollution including stream and air pollution caused by paint, paint sprays, paint chips, dust, or other harmful materials.

Comply with the regulations of the DEP and the State Fish Commission.

Do not proceed with work until the Department receives written acknowledgement that the regional office of the DEP was contacted and is aware of the controls to be exercised to complete the work in compliance with its regulations. No extension of contract time will be allowed for delays caused by failure to make a timely submission for this acknowledgement. Do not claim for costs to comply with requirements of regulatory agencies.

Conviction of a criminal summary complaint issued by the DEP may be cause for suspension of prequalification.

### (b) Surface Preparation.

**1. Solvent Cleaning.** Where oil and grease are present remove according to the SSPC Surface Preparation Specification using No. 1 Solvent Cleaning (SSPC-SP1). Perform cleaning before blasting. If contamination remains after blasting, reclean with solvent.

**2. Other Cleaning.** Remove soil, concrete spatter, drawing compounds, salts, or other foreign matter by brushing with stiff fiber or wire brushes; by scraping; by cleaning with solutions of biodegradable cleaners, provided such cleaners are followed by a fresh water rinse or by a combination of these methods. Satisfactorily remove detrimental deposits from new weld areas. When directed remove water soluble salts, by high pressure water blast cleaning (gage pressure of 6 MPa (800 psig), minimum).

**3. Blast Cleaning.** Blast clean all steel to a near-white condition, as defined in SSPC-SP 1085. Determine the near-white blast condition by use of a Maryland Pictorial Standard, if shot blast is used; or SSPC-VIS 1-89, if sand or grit is used. Blast clean to leave an anchor pattern, from 40 µm to 90 µm (1 1/2 mils to 3 1/2 mils) deep, in a dense, uniform pattern of depressions and ridges. Determine pattern depth by the Keane-Tator Surface Profile Comparator, or Testex Replica Tape. Grind laminations raised by the blasting operation to a flush surface and reblast the ground area to obtain the specified anchor pattern.

**4. Preparing Galvanized Surfaces for Painting.** Prepare entire surface according to SSPC-SP1. Remove unsightly areas including rough and/or heavy galvanizing as directed according to SSPC-SP2 and SSPC-SP3. Apply wash primer, compatible with galvanizing and selected paint system, or brush-off blast the entire surface as indicated on the approved drawings. Do not use steel shot for brush-off blast. Use a blast media with a low level of aggressiveness, such as crushed walnut shells, corn cobs or bi-carbonate of soda for example, but not inclusive.

**5. Cleaning Concrete.** After completing the superstructure work, remove rust stains on the substructure concrete, using an acceptable concrete rust remover, in the manner recommended by the manufacturer of the rust remover. Flush with water after application of rust remover.

**(c) Painting.**

**1. Mixing Paints.**

**1.a Primer.** Mix the primer with a high shear mixer (such as a jiffy mixer), according to the manufacturer's recommendations to a smooth, lump free consistency. Do not use paddle mixers or paint shakers. Mix in the original containers. Continue mixing until all of the metallic powder or pigment is in suspension. Ensure that all of the coating solids that might have settled to the bottom of the container are thoroughly dispersed.

**1.b Subsequent Coats.** Mix each subsequent coat to achieve and to maintain a homogeneous mixture.

**1.c** Strain the mixture through 500 µm to 250 µm (30 mesh to 60 mesh) screen openings to remove large particles. Equip paint containers with a mechanical agitator so the mixture is in motion throughout the application period.

**2. Thinning Paint.** Thin the paint, only as recommended by the manufacturer.

**3. Conditions for Painting.** Apply paint only on clean and dry surfaces and only during periods of favorable weather. Do not paint when the temperature of the air, paint, or metal is below 5 °C (40F), and at no time below that described in the technical data sheet; when the air is misty; or when conditions are otherwise unsatisfactory. Do not paint damp or frosted surfaces or surfaces hot enough to cause the paint to blister, to produce a porous paint film, or to cause the vehicle to separate from the pigment. Paint only when the surface temperature is at least 3 °C (5F) above the dewpoint. Determine the dewpoint with the use of a psychrometer and psychrometric tables.

Allow each coat of paint to dry before applying the succeeding coat. Follow the manufacturer's recommendations for drying time, unless a longer drying time is required.

In damp or cold weather, keep the shop work under cover until thoroughly dry, or until weather conditions allow exposure.

**4. Application.** Apply primer and subsequent coats immediately after inspection and acceptance of the surface. Apply primer the same day the metal is cleaned. If the metal is blast cleaned and remains unpainted overnight, blast clean it again before priming.

Spray apply inorganic zinc-rich primer according to the manufacturer's recommendations. Striping of the inorganic zinc-rich primer is not required.

For application of the intermediate and finish coats, wet stripe all edges, bolts, welds, rivets, corners, crevices, and other irregularities either by brush or by a separate and distinct spray operation, before the application of the full coat. Provide safe access for inspection, as requested by the Representative, before application of the full coat over the striped areas. Do not apply the full coat until approval of the striping is provided.

Apply intermediate and final coats to areas of steel that will be inaccessible before the stage of construction that prevents access.

Apply the complete project site. Other types of prime coats may be substituted for the galvanized coating only if prior approval is received from the Department. Submit the written approval request at the preconstruction conference. Follow the paint manufacturer's recommendations to ensure compatibility between the prime coat and the intermediate coat and to ensure adhesion when the surface of the prime coat has been contaminated, for example, by bolt/nut lubrication.

**5. Shop Painting.** Apply the primer after shop fabrication, inspection and acceptance, but before shipment. Do not apply primer to galvanized surfaces.

Paint field contact surfaces and surfaces to be in contact with concrete with primer only. Do not paint within 50 mm (2 inches) of location of design field welds.

Coat machine-finished metal surfaces, subjected to movement, with either corrosion-preventive compound, conforming to the requirements of Military Specification MIL-C-16173D, Grade 2, or other acceptable material, as soon as possible after acceptance and before removal from the shop. Paint other surfaces of metal, either milled or finished, with primer. Certify the coating material as specified in Section 106.03(b)3.

Paint or stencil the required dates, weight markings, and erection markings only on previously primed or painted surfaces. Use a suitable paint that does not react with other primer or paint coats, and one that is not visible after the final field paint coat.

Allow the paint to dry completely before loading and shipping.

Protect the paint from damage and from contamination. Use coverings and proper storage, handling, shipping and erection techniques.

Repair damaged and contaminated coatings according to the manufacturer's recommendations.

**6. Field Painting.** Before paint is applied, clean dust and dirt and other contamination from the freshly painted surfaces.

If concreting or other operations have damaged the coatings, reclean and, if directed, repaint the damaged areas.

Clean unpainted surfaces, including bolts and field welded areas, as specified in Section 1060.3(b) and prime according to the recommendations of the manufacturer of the self-curing, inorganic zinc-rich system.

Painting of shear connectors is not required.

Do not apply field coats between October 31 and April 1 unless otherwise permitted in writing by the District Executive.

Apply intermediate and final coats according to the manufacturer's recommendations consistent with environmental constraints. Use acceptable brushes, rollers, spray equipment, or any combination of equipment that gives satisfactory results.

**6.a Spray Painting.** If air spray is used, provide suitable traps or separators to exclude oil and water from the air. Keep the paint thoroughly mixed by continuous mechanical agitation.

**6.b Roller Painting.** Use rollers that do not leave a stippled texture in the paint film. Use rollers only on flat, even surfaces to produce a paint film of even thickness with no skips, runs, sags, or thin areas.

**6.c Brush Painting.** Use flat brushes, not wider than 110 mm (4 1/2 inches), or round or oval brushes.

Manipulate the paint under the brush to produce a uniform, even coat. Work the paint into corners and crevices. Move the brush in a series of small circles to thoroughly fill irregularities in the surface, then brush out and smooth by a series of parallel strokes until the paint film has an even thickness.

**6.d Painting Inaccessible Areas.** Thoroughly cover surfaces inaccessible to normal painting methods by use of sheepskin daubers, spray, or other means to ensure thorough coverage.

**6.e Stenciling.** After the final coat of paint has dried, stencil the following information on the inside face of the right fascia member at the near abutment ends unless directed otherwise:

- The bridge identification number,
- The month and year of completion,
- The specification identification of the cleaning method, and
- The list identification of the paint system.

Stencil using suitable black paint to provide uniform block lettering 50 mm to 75 mm (2 inches to 3 inches) high.

**7. Thickness of Coats.** The cumulative dry film thickness will be determined by use of a Magnetic Dry Film Thickness Gage, or the thickness of each coat will be determined by the use of a Tooke gage, or equal. Increase the thickness of coating, if directed by the Inspector-in-Charge, to ensure a finish that is uniform in color and appearance.

Apply the three-coat system as follows:

**7.a Primer.** Spray apply, as recommended by the manufacturer, in a single application, employing multiple spray passes, to a dry film thickness of 75 µm to 130 µm (3 mils to 5 mils) above the anchor pattern. The thickness will be determined with a Magnetic Dry Film Thickness Gage, and measured according to SSPC-PA2-73T. A dense and uniform appearance is required after the applied coating has cured. For areas deficient in coating thickness and areas exhibiting mudcracking, repair, as recommended by the manufacturer.

**7.b Intermediate Coat.** For an epoxy/urethane system apply the intermediate coat to a minimum dry film thickness of 100 µm (4 mils).

For all other systems apply the intermediate coat to a minimum dry film thickness of 25 µm (1 mil).

Use a color that contrasts with the colors of the zinc and finish coats.

**7.c Finish Coat.** For an epoxy/urethane system apply the finish coat to a minimum dry film thickness of 50 µm (2 mils).

For all other systems apply the finish coat to a minimum dry film thickness of 75 µm (3 mils).

**8. Removal of Unsatisfactory Paint.** The painting is unsatisfactory if rusting occurs; the paint coat lifts, blisters, wrinkles, has excessive runs or sags, or shows evidence of application under unfavorable conditions; the workmanship is poor; impure or unauthorized paint has been used; or for other reasons determined by the Representative. Remove unsatisfactory paint, clean the metal, and repaint, as specified.

**1060.4 MEASUREMENT AND PAYMENT**—Painting structural steel is incidental to the items of work painted.

# SECTION 1070—PAINTING EXISTING STRUCTURAL STEEL

**1070.1 DESCRIPTION**—This work is the cleaning and painting of existing bridges using a three-coat system, including an organic zinc-rich primer. This work includes abrasive blasting/paint removal, waste disposal, soluble salt/chloride remediation, and application of the three-coat paint system.

**1070.2 MATERIAL—**

**(a) Coating System.** Obtain material from a paint system listed in Bulletin 15, listed under "Approved Three-Coat Organic Zinc-Rich Systems." Use a system conforming to the following requirements:

- **Prime Coat**–Organic zinc primer (epoxy or urethane), with pigment primarily consisting of zinc dust.
- **Intermediate Coat**–Epoxy or urethane, formulated without using any heavy metal materials listed in the Resource Conservation and Recovery Act (RCRA) regulations for toxic characteristics.
- **Finish Coat**–Aliphatic urethane, formulated without using any heavy metal materials listed in the RCRA regulations for toxic characteristics.

Obtain the three parts of the three-coat system from one manufacturer. Do not mix components or coats from different systems of the same manufacturer or other manufacturers.

**(b) Submittal Requirements.** Provide submittals to the District Executive a minimum of 20 calendar days before beginning the painting. Do not begin painting until submittals have been accepted. Include the following:

**1. Finish Coat Color Chips.** Provide color chips of the indicated color.

**2. Coating Certifications.** Provide the brand names of the products selected for the system in use. For each batch delivered, provide the production lot number of the batch on the certification specified in Section 1070.2(d). Copies of the certification will be provided to the Representative and Chief Chemist of BOCM.

**3. Manufacturers' Data Sheets and Instructions.** Provide current technical data sheets and MSDS for each coat. Provide specific application instructions for all coats including thinning; coating repair procedures, as specified in Section 1070.3(d)6; and recoat times at various temperatures.

In the event of a conflict between the data/instruction sheets or procedures and the specifications, the specifications will govern unless directed otherwise.

**4. DEP Notification.** Provide written acknowledgement that the regional office of the DEP was notified of the painting and that it is aware of the controls that will be exercised.

**5. Soluble Salt Remediation.** Provide a written procedure for the removal of chloride and other soluble salts and the steps that will be taken to properly clean the steel before painting if wet methods are employed.

**6. QC Plan.** Submit a QC Plan, as specified in Section 106.03(a)2. Include written procedures for review and acceptance of the quality of surface preparation, cleaning, and the application of the paint coats. Include the procedure and inspection points for each inspection specified in Section 1070.3(d)8.

**7. Concrete Rust Remover.** Provide the name of the product that will be used to remove rust stains from concrete and the procedures that will be followed to use and remove the product, including containment and disposal of the waste.

**(c) Technical Representation.** Furnish the services of a technical representative from the paint manufacturer at the beginning of operations and when required during operations.

**(d) Certification.** Section 106.03(b)3 modified as follows:

- Submit a dated certification, Form CS-4171, from the manufacturer, that each batch of the coating system meets specifications. Include in the certification the product name for each coat of the system being supplied and the production lot number of the batch being certified.

## 1070.3 CONSTRUCTION—

**(a) General.**

**1. Protection of Structure, Persons, and Property.** Conduct activities associated with the coating work according to applicable Federal (OSHA), EPA, State and local (based on bridge location) safety regulations and SSPC-PA Guide 3, "A Guide to Safety in Paint Application."

Use scaffolding and rigging conforming to OSHA regulations and providing safe and ready access to work areas for inspection purposes.

Protect pedestrian, vehicular, and other traffic upon or under bridges, bridge superstructures and substructures, surrounding property, surfaces, and buildings against damage or disfigurement from surface preparation media, spatters, splashes, overspray, and smirches of paint or material. Furnish canvas or other suitable containment materials, for protection, as necessary.

Remove paint dropped on surfaces not designated to receive coatings, debris from the cleaning operations, empty paint containers, and other refuse. Correct damage resulting from the painting operations.

**2. Pollution Controls.** Prevent environmental pollution including stream and air pollution caused by surface preparation media, paint spills or overspray, paint chips, dust, or other harmful materials.

Comply with the regulations of the DEP and the Pennsylvania Fish Commission.

Do not begin work until the Department receives written acknowledgement that the regional DEP office was contacted and is aware of the controls to be exercised to complete the work in compliance with DEP regulations. The Department will not extend the contract time for delays caused by a failure to make a timely submission of this acknowledgement.

Conviction of a criminal summary complaint issued by DEP may be cause for suspension of prequalification.

**(b) Surfaces to be Painted.** Unless otherwise specified, paint all surfaces previously painted and all surfaces of new metal. Do not paint aluminum and galvanized metal surfaces, unless otherwise specified. Do not apply intermediate and finish coats to surfaces that will be in contact with concrete. Coat those surfaces with a single coat of organic zinc primer only. If new pre-galvanized bolts are used, proceed as specified in Section 1070.3(d)4 for galvanized surfaces.

**(c) Surface Preparation.**

**1. Solvent Cleaning.** Remove oil and grease present on bare steel according to SSPC Surface Preparation Specification No. l, "Solvent Cleaning" (SSPC-SP1) before blasting. If contamination remains after blasting, re-clean with solvent before painting. If grease, oil, or similar contaminants become deposited on any coat that will receive another coat, remove according to SSPC-SP1 before the application of the subsequent coat.

**2. Other Surface Cleaning.** Remove soil, concrete spatter, drawing compounds, salts, and other foreign matter by brushing with stiff fiber or wire brushes; by scraping; by cleaning with solutions of biodegradable cleaners, provided such cleaners are followed by a fresh water rinse; or by a combination of these methods. Satisfactorily remove detrimental deposits from new weld areas.

**3. Weld Spatter, Sharp Edges, Flame-Cut Steel, and Holes.** Remove slag, flux deposits, and weld spatter from newly installed steel. Grind any resulting burrs smooth, including burrs around holes.

**4. Pack Rust and Rust Scale.** Remove heavy corrosion (rust scale) and loose pack rust (e.g., as found in crevice areas) by hand and power tool cleaning before abrasive blast cleaning. Exercise extreme care to avoid nicking or gouging the steel during removal. If nicks or gouges occur, the Representative may suspend activities until appropriate adjustments are made to prevent a recurrence.

Caulk areas as directed.

**5. Test Areas.** Before proceeding with the production blast cleaning operation, prepare test sections on each structure of at least 1 $m^2$ (9 square feet), in locations considered by the Inspector to be representative of existing surface conditions and structural characteristics.

Blast clean test section areas using the same equipment, materials, and procedures that will be used for the production blast cleaning. Provide safe access for close visual inspection and testing. Do not proceed with the production blast cleaning operation until the Inspector agrees that the surface of each test section is acceptable.

**6. Blast Cleaning and Abrasives.** Blast clean all steel to a near-white condition, as defined in SSPC-SP10, except that a slight residue of paint or rust in seams between plates and around rivet heads is acceptable.

Determine the near-white blast condition by use of SSPC-VIS 1-89. In the event of a conflict between the pictorial standard and the written SSPC definition, follow the written definition.

Utilize clean, dry compressed air for abrasive blast cleaning. Conduct blotter test(s) according to ASTM D 4285 a minimum of one time each shift for each compressor system in use to verify that the air supply is free of moisture and oil contamination. Conduct the tests in the presence of the Inspector.

Select abrasive size and type based on the type, grade, and surface condition of the steel to be cleaned and based on the finished surface condition to be attained for the paint that is to be applied. Select abrasives that are sized to create a surface profile from 40 µm to 90 µm (1 1/2 mils to 3 1/2 mils) deep in a dense, uniform pattern of depressions and ridges. Determine the surface profile depth by the Keane-Tator Surface Profile Comparator (G/S or SH disc as appropriate), or Testex Replica Tape according to ASTM D 4417. If the profile is outside of the specified range, obtain different abrasives and reclean the steel.

Use abrasives that are clean and dry. Use recyclable abrasives to create the least amount of waste that is practicable. Acceptable recyclable abrasives are aluminum oxide, silicon carbide, zirconium aluminum oxide, steel grit, and steel shot. Use non-recyclable abrasives only if allowed. When the use of non-recyclable abrasives is allowed, use low dust abrasives such as coal slag (e.g., Black Beauty) or Staurolite (e.g., Star Blast) and use the abrasive only once. Do not use silica sand. Select the non-recyclable abrasives according to SSPC-AB1.

Use a reclamation system to clean the recyclable abrasive and return it for reuse. Confirm the cleanliness of the recycled abrasive during use according to SSPC-AB2. Equip the reclamation system with dust collectors to ensure that the discharge meets air quality requirements.

Grind laminations raised by the blasting operation to a flush surface and reclean the ground area to obtain the specified anchor pattern. Upon approval, restore the profile in limited areas according to SSPC-SP11.

**7. Chloride/Ferrous (Soluble) Salt Removal.** In the presence of the Inspector, remove chloride and other water-soluble salts to level SC-2 of SSPC-SP12. These thresholds are:

| | |
|---|---|
| Chloride | $< 7 \mu g/cm^2$ |
| Ferrous Ion | $< 10 \mu g/cm^2$ |
| Sulfate | $< 17 \mu g/cm^2$ |

Conduct tests across the structure with special attention to pitted areas. Use the cell method of SSPC-TU4 to collect the samples. Conduct this testing after abrasive blasting.

Provide the proposed method of chloride removal (e.g., fine abrasive mix of grit/shot, low- or high-pressure water cleaning according to SSPC-SP12) in the QC Plan specified in Section 1070.2(b)6. Include the process that will be used for recleaning the steel.

If the chloride/ferrous salts are removed using wet methods after blast cleaning is performed, remove the resulting flash rust before applying the coating.

**8. Cleanliness Before Painting.** Before painting, remove abrasive residue and dust from the surface. Pay specific attention to pockets and corners. Unless directed otherwise (e.g., in the case of lead-containing paint), conduct the cleaning using clean bristle, fiber, or hair brushes; vacuuming; blowing with clean, dry, compressed air; or a combination thereof.

Apply primer within 10 hours after the metal is cleaned. If the metal is blast-cleaned and remains unpainted for longer than 10 hours, or if cleaned steel exhibits evidence of rust back, analyze for chloride contamination as specified in Section 1070.3(c)7. If chloride is present, remediate as specified in 1070.3(c)7. If chloride is not present, blast clean it again before priming. Apply primer only after the Inspector has accepted the prepared surface.

**9. Cleaning Concrete.** After completing the superstructure work, provide a concrete rust removal method. This can be by abrasive blasting to obtain a condition conforming to SSPC-SP-7. Brush, blast, or use an acceptable concrete rust remover, in the manner recommended by the manufacturer of the rust remover, to remove rust stains from the substructure concrete. Flush with water after application of rust remover. Provide for the Representative's review and acceptance, the name of the product proposed for use and the procedures that will be followed to apply, remove, contain, and dispose of the waste.

**(d) Painting.**

**1. Storage and Mixing of Paints.** Store all paints under cover, out of direct sunlight and between 4 °C and 38 °C (40F and 100F). If the storage requirements of the manufacturer are more restrictive, comply with the more restrictive requirements. Mix the coatings as follows:

**1.a Prime Coat.** Mix primer according to the requirements of the coating manufacturer. Unless prohibited by the manufacturer, mix the coating with a high shear mixer (e.g., a jiffy mixer). When the manufacturer prohibits the use of a high-speed mixture (e.g., in the case of moisture-cured urethanes), comply with the manufacturer's instructions. Mix the coating to achieve a smooth, lump-free consistency. Mix in the original containers. Continue mixing until all of the metallic powder or pigment is in suspension. Ensure that all of the coating solids that might have settled to the bottom of the container are thoroughly dispersed.

**1.b Intermediate and Finish Coats.** Mix each coat according to the manufacturer's instructions to achieve and maintain a homogeneous mixture.

**1.c Thinning Paint.** Thin paint using thinners provided by the manufacturer, and in proportions as recommended by the manufacturer. Do not exceed local VOC regulations for any coat at the time of application.

**1.d Straining.** Strain the mixture through a 500 µm to 250 µm (30 mesh to 60 mesh) screen to remove large particles.

**2. Weather Conditions for Painting.** Apply coating to clean and dry surfaces during periods of favorable weather. Do not apply coating if any of the conditions specified in Sections 1070.3(d)2.a-e are present. If the requirements of the coating manufacturer, are more stringent, comply with those requirements.

**2.a. Calendar.** Do not apply coating in the field between October 31 and April 1 unless otherwise allowed in writing by the District Executive.

**2.b Temperature.** Do not apply coatings if the temperature of the air, paint, or metal is below 4 °C (40F) or greater than 43 °C (110F) or is forecasted to drop below 4 °C (40F) before the coating dries according to the times specified in the manufacturers' technical data sheet.

**2.c Dew Point.** Do not apply coatings if the temperature of the surface is less than 2.8 °C (5F) greater than the dew point.

**2.d Relative Humidity.** Do not apply coatings if the relative humidity is below or above the thresholds established in the manufacturer's written product data sheets.

**2.e Dampness.** Do not apply coatings if the air is misty, the surfaces are damp or frosted, or if weather conditions are otherwise unsatisfactory.

In damp or cold weather, keep the coating work protected until thoroughly dry according to the manufacturer's instructions, before exposing the steel to the elements.

**3. Methods of Application.** Apply all coats using equipment that is acceptable to the manufacturer, that is consistent with environmental constraints, and that provides a finish that is acceptable to the Department. Use brushes, rollers, spray equipment, or any combination of equipment that gives satisfactory results.

**3.a Spray Painting.** If air spray is used, provide suitable traps or separators to exclude oil and water from the air. Conduct blotter test(s) according to ASTM D 4285 a minimum of one time each shift for each compressor system in use to verify that the air supply is clean and dry. Conduct tests in the presence of the Inspector. Unless prohibited by the manufacturer, equip paint containers with a mechanical agitator so the mixture is in motion throughout the application period.

**3.b Roller Painting.** Use rollers that do not leave a stippled texture in the paint film. Use rollers only on flat, even surfaces to produce a paint film of even thickness with no skips, runs, sags, or thin areas. Do not use rollers if prohibited by the manufacturer.

**3.c Brush Painting.** Manipulate the paint under the brush to produce a uniform, even coat. Work the paint into corners and crevices. Move the brush in a series of small circles to thoroughly fill irregularities in the surface. Then brush out and smooth by a series of parallel strokes, until the paint film has an even thickness. Do not use brushes if prohibited by the manufacturer.

**3.d Painting Inaccessible Areas.** Use sheepskin daubers, spray, or other means to thoroughly paint surfaces inaccessible to normal painting methods. Do not use daubers if prohibited by the manufacturer.

**4. Application and Recoating Requirements.**

**4.a Removal of Contaminants.** If concrete, salts, grease, oil, diesel smoke, or other surface contamination are present on prime, intermediate, or finish coats, clean the surface as specified in Sections 1070.3(c)1, 2, and 7, and the manufacturer's recommendations. Clean the bare steel, prime, and intermediate coats before the application of subsequent coats. Clean the finish coat as directed.

**4.b Stripe Coats** Before application of the prime coat, apply a wet stripe coat to all edges, bolts, welds, rivets, corners, crevices, and other irregularities. Apply the wet stripe coat by brush and/or spray. The purpose of the stripe coat is to increase the build of the film on projecting surfaces, such as edges, and to ensure that the coating is thoroughly worked into and covers all irregular surfaces, such as crevices.

Extend the stripe coat approximately 25 mm (1 inch) from edges, corners, rivets, and other irregularities that are stripe-coated.

Allow a minimum of 15 minutes for inspection of each stripe coat before applying each full coat. Do not apply the full coat until the inspector accepts the respective stripe coat.

Before the application of the intermediate coat, apply a wet stripe coat of the intermediate coating, using the same procedure as for the prime coat. Do not apply the intermediate stripe coat until the prime coat has dried according to the manufacturer's instructions.

A stripe coat is not required for the finish coat, but pay particular attention to providing complete coverage of all surfaces including edges, bolts, welds, rivets, corners, crevices, and other irregularities.

**4.c Galvanized Bolts and Nuts.** Remove grease, oil, dirt, dust, and similar interference material from the surfaces of galvanized bolts and nuts according to SSPC-SP1 and SSPC-SP2. Provide SP-2 to an overall wire-brushed condition. Use bolts and nuts that are prime-coated before delivery. Apply only intermediate and finish coats to the bolts and nuts.

**5. Coating Thickness and Continuity.** Apply the three-coat system to the dry film thicknesses specified in Sections 1070.3(d)5a to c. Achieve a surface that is free of shadow-through, runs, sags, overspray, dryspray, pinholes, skips, misses, and other film discontinuities.

Determine the cumulative dry film thickness of each coat using a Magnetic Dry Film Thickness Gage according to SSPC-PA2, except measure each 9 $m^2$ (100-square foot) increment of the surface. Determine the thickness of each coat by subtracting the thickness of the underlying coats from the cumulative readings. If questions are raised regarding the thickness of an individual coat, use the Tooke Gage, or equal. Repair damage created by the Tooke Gage.

If the thickness of any coat is less than specified, unless otherwise allowed, apply additional coating according to the manufacturer's instructions and as specified before applying the next coat. Provide inspection access so that the work can be corrected and inspected before the expiration of recoat times

If the thickness of any coat exceeds the specified maximum, or the surface exhibits runs, sags, dry spray, overspray, or other discontinuities, remove the excessive thickness or discontinuity by power tool cleaning or abrasive blast cleaning. If the thickness is reduced to below the specified minimum, recoat the area. If the excessive thickness or discontinuity being removed is in the finish coat, apply a thin coat of finish material to seal the surface and to smooth out any surface irregularities resulting from the removal process.

**5.a Prime Coat.** Apply the primer coating to a total dry film thickness (above the surface profile) in a single application, employing multiple spray passes, of 75 µm to 130 µm (3 mils to 5 mils) above the anchor pattern. The Inspector will determine thickness with a Magnetic Dry Film Thickness Gage, and measure thickness according to SSPC-PA2-73T.

Obtain a dense and uniform appearance of the cured coating. The Inspector will assess cure by coin rub or Methyl Ketone (MeK) wipe testing. For areas deficient in coating thickness and areas exhibiting mudcracking, repair, according to the manufacturer's recommendations.

**5.b Intermediate Coat.** Apply intermediate coating to a dry film thickness (above the primer) of 75 µm to 130 µm (3 mils to 5 mils), or a manufacturer's specified dry film thickness, if greater than 75 µm to 130 µm (3 mils to 5 mils).

Use an intermediate coat color that contrasts with the colors of the prime and finish coats.

**5.c Finish Coat.** Apply the finish coat (above the intermediate) to a dry film thickness of 50 µm to 100 µm (2 mils to 4 mils) or a manufacturer's specified dry film thickness, if greater than 50 µm to 100 µm (2 mils to 4 mils).

**6. Removal/Repair of Defective Paint.** A paint coat is defective if: it is damaged; it lifts, blisters, or wrinkles; it has excessive runs or sags; it shows evidence of application under unfavorable conditions; it does not meet the coating thickness and continuity requirements specified in Section 1070.3(d)5; rusting occurs; the workmanship is poor; or impure or unauthorized paint has been used.

Remove defective paint and repair and recoat damaged or defective areas. When the defective paint or damage extends to bare steel or bare steel is exposed, clean the surface by SSPC-SP10 or SSPC-SP11 as approved.

When the damage or defective paint does not expose the underlying steel, clean the surface according to SP3 to remove the defective material and loose coating, and re-apply the affected coats. If, in the opinion of the Representative, the damage is too extensive for localized power tool cleaning, clean the surface according to SSPC-SP7 to remove all loose and defective material, and reapply the effected coats.

For all repairs, roughen the coating in overcoat areas to ensure good adhesion of the repair material to the underlying coating. Feather the surrounding coating to expose a minimum of 12 mm (1/2 inch) of each coat and to provide a smooth transition into intact, adherent material, for all coats.

**7. Stenciling of Final Product.** After the final coat of paint has dried, stencil the following information on the inside face of the fascia member at the near and far abutment ends, unless directed otherwise:

- The bridge identification number,
- The month and year of completion,
- The specification identification of the cleaning method, and
- Identification of the paint system (Bulletin 15 PEQ #).

Stencil using suitable black paint to provide uniform block lettering 50 mm to 75 mm (2 inches to 3 inches) high.

**8. Contractor Inspection and QC Program.** Perform inspections and tests as described in the QC Plan specified in Section 1070.2(b)6. Document inspections and provide a copy to the Representative.

Before beginning surface preparation work, perform inspections as a record of initial conditions. During work, perform the QC inspections necessary to ensure that work is performed in strict compliance with the specifications and the manufacturer's instructions.

At a minimum, inspect the following:

- Ambient conditions/compressed air cleanliness;
- Suitability of protective coverings;
- Surface cleanliness and profile;
- Chloride removal;
- Coating storage, mixing, and application;
- Dry film thickness and continuity of each coat;
- Dry time, curing, and cleanliness of each coat; and
- Touch up and repair of damaged or defective coats.

**9. Access for Representative Inspection.** Provide safe access and allow time for Department inspections, as requested by the Representative, for all phases of the work, including surface preparation; the application of each coat, including stripe coats; and inspection of the completed system.

**1070.4 MEASUREMENT AND PAYMENT**—Lump Sum.

The price includes abrasive blasting/paint removal, waste disposal, soluble salt/chloride remediation, and application of the three-coat paint system. The price also includes removal of coatings from surfaces not designated to be painted; repair of any damage resulting from the painting operation; removal of coating that does not meet specifications and recoating of the surfaces; and controls necessary to comply with the requirements of regulatory agencies.

The price does not include caulking.

# SECTION 1071—SPOT/ZONE MAINTENANCE PAINTING OF EXISTING STRUCTURAL STEEL

**1071.1 DESCRIPTION**—This work is the painting of existing bridges using an approved surface tolerant coating system.

**1071.2 MATERIAL—**

**(a) Coating System.** An approved proprietory coating system selected from the list "Approved Surface Tolerant Coating Systems" in Bulletin 15. Do not mix components from different systems.

**(b) Technical Representation.** Section 1060.2(a)2

**(c) Technical Data.** Submit copies of the manufacturer's current Technical Data, Safety Data, and Recommended Repair Procedures for the coating system. Also, include the manufacturer's color designation for the color of finish coat to be used. Identify this information for each bridge for each coating system used. Work will not be permitted to proceed until this information is received.

In the event of a conflict between the manufacturer's technical data and these specifications, the specifications will govern.

**1071.3 CONSTRUCTION—**

**(a) General.** Section 1060.3(a)

**(b) Surfaces to be Painted.** Unless otherwise specified, paint all surfaces previously painted and all surfaces of new metal. Do not paint aluminum and galvanized metal surfaces, unless otherwise directed.

Do not apply mastic to areas that will be in contact with concrete. Paint areas in contact with concrete with an approved inorganic zinc rich prime coat.

**(c) Surface Preparation.** Sections 1060.3(b)1, 2, and 4; and as follows:

**1. Blast Cleaning.** Blast clean all steel to a commercial blast condition, as defined in SSPC-SP6-85, using acceptable abrasives propelled through nozzles. Resultant anchor pattern to be 40 µm to 90 µm (1 1/2 mils to 3 1/2 mils) as measured by a Keane-Tator Surface Profile Comparator or Testex Replica Tape.

Before proceeding with the production blast cleaning operation, prepare test sections on each structure of at least 1 $m^2$ (9 square feet) in locations considered by the Inspector to be representative of existing surface conditions and structural characteristics. Blast clean test section areas using the same equipment, materials, and procedures that will be used for the production blast cleaning. Provide safe access for close visual inspection and testing. Do not proceed with the production blast cleaning operation until the Inspector agrees that the surface of each test section has been prepared to conform with specified requirements.

Determine the commercial blast condition by use of SSPC-VIS 1-89.

Remove all mill scale from steel to be painted.

If the surface is pitted, slight residues of primer may remain in the bottom of pits.

Slight residue of paint or rust in seams between plates and around rivet heads is acceptable and need not be completely removed.

Clean dry-blasted surface with clean bristle, fiber or hair brushes; with compressed air; or with vacuum. Remove traces of blast residue from the surface and from pockets and corners. Equip compressors with separators or traps to remove water and oil. If water is used in the cleaning procedure, assure that surfaces, pockets, and corners are dry and clean before applying paint. Allow a minimum of 48 hours of ambient air drying; then, remove rust bloom by dry blasting and clean to remove blast residue from surfaces, pockets, and corners. Do not use rust inhibitors.

**2. Acceptable Abrasives.** Section 1070.3(c)6

**(d) Painting.**

**1. Mixing Paint.** Mix paint as recommended by the manufacturer.

**2. Thinning Paint.** Thin paint only as recommended by the manufacturer.

**3. Conditions for Painting.** Section 1060.3(c)3

**4. Application.** Before paint is applied, clean dust and dirt and other contamination from the surfaces to be painted. Apply coatings that are free of runs, sags, embedded foreign matter, and any other imperfections indicative of improper application.

Apply paint according to the manufacturer's recommendations consistent with environmental and physical constraints.

Use acceptable brushes, rollers, spray equipment, or any combination of equipment that gives satisfactory results.

Do not apply field coats between October 31 and April 1, unless otherwise permitted in writing by the District Executive.

**4.a Spray Painting.** Section 1060.3(c)6.a

**4.b Roller Painting.** Section 1060.3(c)6.b

**4.c Brush Painting.** Section 1060.3(c)6.c

**4.d Surfaces Inaccessible to Normal Painting Methods.** Section 1060.3(c)6.d

**4.e Primer.** Apply immediately after cleaning, inspection, and acceptance of the surface. Apply primer the same day the metal is cleaned. If the blast cleaned metal remains unpainted overnight, blast clean it again before priming.

**4.f Intermediate and Finish Coats.** For application of the intermediate and finish coats, wet stripe all edges, bolts, welds, rivets, corners, crevices, and other irregularities, either by brush or by a separate and distinct spray operation, before application of the full coat. Provide safe access for inspection, as requested by the Representative, before application of the full coat over the striped areas. Do not apply the full coat until approval of the striping is provided.

**4.g Stencilling.** Section 1060.3(c)6.e

**5. Repair.** Reclean and, if directed, repaint areas damaged by concreting or other operations.

**6. Thickness of Coats.**

**6.a Primer.** Apply in a manner recommended by the manufacturer, in a single application, to a minimum dry film thickness of 125 µm to 175 µm (5 mils to 7 mils) above the anchor pattern, so that a dense and uniform appearance is obtained after the coating is cured. Use a color that contrasts with the color of the cleaned based metal.

**6.b Intermediate Coat.** Apply in a manner recommended by the manufacturer, in a single application, to a minimum dry film thickness of 125 µm to 175 µm (5 mils to 7 mils), so that a dense and uniform appearance is obtained after the coating is cured. Use a color that contrasts with the primer and finish coats. Repair areas deficient in thickness as recommended by the manufacturer.

**6.c Finish Coat.** Apply in a manner recommended by the manufacturer, in a single application, to a minimum dry film thickness of 50 µm to 75 µm (2 mils to 3 mils). Provide a finish that is uniform in color and appearance.

The cumulative dry film thickness will be determined by use of a Magnetic Dry Film Thickness Gage, or the thickness of each coat will be determined by the use of a Tooke gage, or equal. Increase the thickness of coating, if directed by the Inspector-in-Charge, to ensure a finish that is uniform in color and appearance.

Correct coatings deficient in thickness as directed and according to the manufacturer's recommendations.

**7. Removal of Unsatisfactory Paint.** Section 1060.3(c)8

**1071.4 MEASUREMENT AND PAYMENT**—Lump Sum

# SECTION 1080—PRESTRESSED CONCRETE BRIDGE SUPERSTRUCTURE

**1080.1 DESCRIPTION**—This work is the construction of a prestressed concrete bridge superstructure.

**1080.2 MATERIAL—**

**(a) Deck and Barriers.**

- Cement Concrete Structures—Section 1001.2
- Preformed Neoprene Compression Joint Seal for Bridges—Section 1008.2
- Pedestrian Railing—Section 1012.2
- Aluminum Bridge Hand Railing—Section 1023.2
- Steel Bridge Hand Railing—Section 1022.2
- Protective Barrier—Section 1015.2
- Protective Fence—Section 1016.2
- Protective Coating for Reinforced Concrete Surfaces—Section 1019.2(a)
- Armored Preformed Neoprene Compression Dam—Section 1021.2
- Tooth Expansion Dam With Drain Trough—Section 1020.2
- Reinforcement Bars—Section 709.1
- Neoprene Strip Seal Dam—Section 1026.2

**(b) Beams and Bearings.**

- Prestressed Concrete Bridge Beams—Section 1107.02
- Plain Steel Bars—Section 709.1(a)2
- Closed Cell Neoprene Sponge—Sections 1107.02(p)1 and 1107.03(e)3
- Neoprene Bearing Pads—Sections 1113.02 and 1113.03(g)
- Bedding Material for Bridge Shoes—Section 1113.03(h)
- Steel Bearings—Section 1107.02(j)
- Post Tensioning, when required—Section 1108.02

- Nonshrink Grout for Shear Keys—Section 1080.2(c)
- Nonshrink Grout for Studs, Dowels, and Anchor Bolts—Section 1001.2(e)
- Epoxy Resin Protective Coating—Section 1019.2(b)
- High Load Multi-Rotational Bearings—Section 1111

**(c) Nonshrink Grout for Shear Keys in Adjacent Prestressed Concrete Box Beam Bridges.** Use either a premixed, nonshrink grout, from a manufacturer listed in Bulletin 15 and certified as specified in Section 106.03(b)3, or mix as follows:

- One part Non-shrink Grout Admixture—Bulletin 15. Certify as specified in Section 106.03(b)3.
- Two parts Cement, Type IP, IS or II—Section 701
- Three parts Fine Aggregate, Type A—Section 703.1
- Water—Section 720.1

Required grout compressive strength:

- 7 MPa (1,000 psi) at 24 hours
- 28 MPa (4,000 psi) at 28 days

Combine dry materials in the mixer, then agitate to mix. Add water slowly and mix for 3 minutes or less, or according to the manufacturer's instructions.

Mix as closely as possible to the site of the work and use each batch within 20 minutes. Do not retemper. Mold daily test cylinders according to PTM No. 521. Test cylinders according to PTM No. 604.

**(d) Fabricated Structural Steel.** Section 1105. At least 2 weeks before the start of fabrication, furnish to the Inspector-in-Charge a complete list of the names and addresses of firms that are to fabricate or supply incidental, fabricated structural steel items to be used in conjunction with, or as a part of, the prestressed concrete members.

**(e) Modified Mortar for Beam Seat Leveling.** Use mortar from a manufacturer listed in the Miscellaneous Section – Polymer Modified and Special Cements, Mortars, and Concrete in Bulletin 15 conforming to the following specifications:

- Polymer modified
- Non-shrink
- Non-sag consistency
- Application thickness range 3 mm to 12 mm (1/8 inch to 1/2 inch)

- Properties

| | |
|---|---|
| Initial set time (AASHTO T 131) | 1/2 hour minimum |
| Compressive strength (AASHTO T 106) | 17 MPa (2,500 psi)—24 hours<br>24 MPa (3,500 psi)—7 days<br>35 MPa (5,000 psi)—28 days |
| Slant shear bond test (ASTM C 882, Modified) | -14 MPa (2,000 psi)—7 days |
| Freeze-thaw resistance (PTM No. 633) | 8%—maximum loss by mass (weight) |

Certify as specified in Section 106.03(b)3.

**(f) Post-Tensioning Strand.** Section 1108.02(g)

**1080.3 CONSTRUCTION—**

**(a) General.** The superstructure consists of all indicated portions of the bridge above the bridge seat and includes bearings, bearings and anchors set in the substructure, abutment backwalls, cheekwalls, shear blocks, bridge drainage down to, but not including, the drain box, and portions of wings and appurtenances above the horizontal construction joint nearest the bridge seat.

**(b) Superstructure.** Construct the superstructure as indicated, as shown on the Standard Drawings, and as follows:

- Fabricated Structural Steel—Section 1105
- Cement Concrete Structures—Section 1001.3
- Preformed Neoprene Compression Joint Seal for Bridges—Section 1008.3
- Pedestrian Railing—Section 1012.3
- Aluminum Bridge Hand Railing—Section 1023.3
- Steel Bridge Hand Railing—Section 1022.3
- Protective Barrier—Section 1015.3
- Protective Fence—Section 1016.3
- Tooth Expansion Dam with Drain Trough—Section 1020.3
- Reinforcement Bars—Section 1002.3
- Neoprene Strip Seal Dam—Section 1026.3

- Armored Preformed Neoprene Compression Dam—Section 1021.3
- High Load Multi-Rotational Bearings—Section 1050.3(c)4.h

**(c) Erection.**

**1. General.** Erect prestressed concrete beams, as shown on submitted and accepted shop drawings. At the bridge site, beams will be inspected for possible damage**,** cracking, and twisting during shipment**,** and for camber, tolerances, and dimensions. Replace beams damaged by improper storing, handling, transporting, erecting, or any other reason.

**2. Bearings.** When elastomeric bearings are used under beams, determine if there is full contact between the bearing pad and bearing surfaces just after the beams are set in place. Temporarily remove or relocate waterproofing and other material as required to expose all sides of the pad. If a gap between the pad and bearing surfaces is present, proceed as follows unless the contract plans indicate that a lift-off condition is expected when the beam is initially set on the pad:

- **Gap Thickness > 10 mm (3/8 inch).** If a gap along any edge of the pad exceeds 10 mm (3/8 inch), grind the bearing surface of the substructure to eliminate the gap, except gaps along the front edge of the pad (edge toward the midspan of the beam) will be allowed as specified in Steps 1 and 2 below. Provide a rough textured bearing surface after grinding. Verify that the minimum required vertical clearance to the bottom of beams, as indicated, will be provided after grinding.

- **Gap Thickness ≤ 10 mm (3/8 inch).** If gaps along any edge of the pad are less than or equal to 10 mm (3/8 inch), proceed as follows:

  **Gap Along Rear Edge of Pad Only.** If a gap occurs anywhere along the rear edge of the pad (edge toward the end of the beam), eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.

  **Gap Along Side Edges of Pad.** If a gap occurs along the side edges of the pad, and there is full contact at the front and rear edges, eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.

  **Gap Along Front Edge of Pad.** If a gap occurs along the front edge (edge toward the midspan of the beam of the bearing pad), proceed as follows:

  **Step 1:** Determine the area of non-contact between the pad and beam. If the amount of non-contact is less than 20% of the pad area, proceed to Step 2; otherwise eliminate gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a.

  **Step 2:** Measure the maximum gap thickness along the front edge and proceed as follows:

| | |
|---|---|
| **Spans < 30 000 mm (100 feet)** | |
| Gap Thickness ≤ 2.5 mm (3/32 inch): | Leave gap in place. |
| 2.5 mm (3/32 inch) < Gap Thickness ≤ 10 mm (3/8 inch): | Eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a. |
| **Spans ≥ 30 000 mm (100 feet)** | |
| Gap Thickness ≤ 3 mm (1/8 inch): | Leave gap in place. |
| 3 mm (1/8 inch) < Gap Thickness ≤ 10 mm (3/8 inch): | Eliminate the gap by placing a leveling bed of polymer-modified mortar beneath the pad as specified in Section 1080.3(c)2.a. |

**2.a Leveling Bed of Polymer-Modified Mortar, Placement Procedure.**

1. Immediately before lifting beam, prepare mortar according to the manufacturer's recommendations. Do not extend mortar by adding coarse aggregate.
2. Lift beam as necessary.
3. Remove pad.
4. Apply a bed of mortar to the beam seat, covering an area approximately 50 mm (2 inches) beyond the perimeter of the bearing pad. Apply the mortar in a thickness approximately 3 mm (1/8 inch) greater than the maximum actual gap thickness.
5. Place the pad on the mortar.
6. Reset the beam on the pad while the mortar remains plastic.
7. Cure the mortar, as applicable, according to the manufacturer's recommendation.

Place mortar according to temperature restrictions recommended by the manufacturer.
Do not place a leveling bed of mortar before the initial setting of beams.

**(d) Shear Key Joints Between Adjacent Box Beams.**

**1. General.** Check shear keys for widths. Maximum allowable gap between beams will be the tolerance for horizontal alignment plus 15 mm (1/2 inch), as specified in Section 1107.03(e)1.b.

**2. Preparation of the Joints.** Before shipping, sandblast the entire shear key area providing a rough texture, and completely remove all oil, grease, dirt, or material that would prevent bonding. Just before erection, clean the blasted surface with compressed air, clean stiff-bristle fiber brushes, or vacuum. Caulk joints below the keys with suitable backer rod and soak joints with water 1 hour before grouting.

**3. Filling Joints.** Fill the longitudinal joints between adjacent beams with nonshrink grout. Place grout quickly and continuously into the joints. Spade, but do not vibrate. Overfill the joints, let stand for 1/2 hour, then strike off, flush with the top of the beams. Follow the manufacturer's recommendations for filling in hot or cold weather.

Do not allow construction activity or other loadings on the bridge for at least 24 hours after the grout has been placed. For vehicular loading, Section 1080.3(d)5 applies.

**4. Curing.** Start curing immediately after the grout has been placed. Use a double thickness of water-saturated burlap. Keep the burlap wet during the curing period for at least 24 hours. During cold weather, prevent freezing of the grout. Provide curing temperatures of 10 °C (50F) or above.

**5. Opening to Traffic.** For non-composite adjacent box beam construction: after grouting shear keys, do not allow any traffic on a span until 5 days have elapsed and grout compressive strength is 22 MPa (3,200 pounds per square inch) minimum.

**(e) Protective Coating for Prestressed Concrete Beams.** Where indicated, apply an epoxy-resin protective coating, as specified in Section 1019.3(b), to the beam tops and to grouted shear keys before the construction of a bituminous surface course. Apply coating as specified in Section 1019.3(b). Cure the coating according to the manufacturer's recommendations.

**(f) Waterproofing at Abutments.** As indicated, place closed cell neoprene sponge on top of abutments, then erect the beams.

Use a wire brush and clean vertical end notches in beams of adjacent box beam bridges, then seal by caulking with a suitable backer rod. Wet the backer rod 1 hour before grouting. Fill the notches with nonshrinking grout. Cure with wet burlap for at least 24 hours.

**(g) Resetting Expansion Bearings.** Where indicated, reset expansion bearings as specified in Section 1050.3(c)4.c.2.

**(h) Post-Tensioning Adjacent Box Beams.** Post-tension adjacent box beams as indicated and as specified in Section 1108.03.

**1080.4 MEASUREMENT AND PAYMENT**—Lump Sum. The price includes the following component items.

- **Prestressed Concrete Bridge Beams.** Meter (Linear Foot)
- **Preformed Neoprene Compression Joint Seal for Bridges.** Section 1008.4
- **Pedestrian Railing.** Section 1012.4
- **Aluminum Bridge Hand Railing.** Section 1023.4
- **Steel Bridge Hand Railing.** Section 1022.4
- **Protective Barrier.** Section 1015.4
- **Protective Fence.** Section 1016.4
- **Protective Coating for Reinforced Concrete Surfaces.** Section 1019.4
- **Tooth Expansion Dam with Drain Trough.** Section 1020.4
- **Armored Preformed Neoprene Compression Dam.** Section 1021.4

- **Reinforcement Bars.** Section 1002.4
- **Neoprene Strip Seal Dam.** Section 1026.4
- **Cement Concrete Structures.** Section 1001.4
- **Fabricated Structural Steel.** Section 1050.4
- **High Load Multi-Rotational Bearings.** Section 1050.4
- **Reset Expansion Bearings, Prestressed Concrete Superstructure.** Each

# SECTION 1085—PRECAST REINFORCED CONCRETE BOX CULVERT

**1085.1 DESCRIPTION**—This work is the manufacture, storage, delivery, installation, and assembly of precast reinforced concrete box culvert segments into one continuous unit.

**1085.2 MATERIAL—**

**(a) Class A Cement Concrete.** Section 704

**(b) Deformed Welded Wire Fabric.** Section 709.4

**(c) Galvanized Specialized Assembly and Tightening Hardware, Sleeves, Lug Plates, Bolts, Nuts, and Washers.** Section 1105.02(d)

**(d) Nonshrink Grout.** Section 1080.2(c)

**(e) Precast Reinforced Concrete Box Culvert Segments.** From a manufacturer listed in Bulletin 15. Provide cement concrete as specified in Section 704; except, with a minimum 28-day compressive strength of 35 MPa (5,000 pounds per square inch). AASHTO M 259/M 259M or M 273/M 273M; except, modify Section 11, Permissible Variations as follows:

- **11.1 Internal Dimensions**—Do not allow the internal dimensions to vary from design by more than 1% with a maximum variation of 25 mm (1 inch). Do not allow the internal diagonal dimensions to vary by more than 25 mm (1 inch). Do not allow the haunch dimensions to vary more than 6 mm (1/4 inch) from design dimensions.

- **11.2 Slab and Wall Thickness**—Do not allow slab and wall thickness to vary from design dimensions by more than minus 5 mm (3/16 inch).

- **11.3 Length of Opposite Surface**—Do not allow laying length of two opposite surfaces of the box section to vary more than 10 mm/m (1/8 inch/foot) of the internal span, with a maximum of 16 mm (5/8 inch).

- **11.5 Position of Reinforcement**—Do not allow the position of the reinforcement to vary from the approved shop drawings by more than 13 mm (1/2 inch) in any direction. Place reinforcement so the indicated cover clearance does not deviate more than ± 6 mm (± 1/4 inch). Provide 38 mm (1 1/2 inch) minimum cover at the mating surface, as measured to the end of the joint.

Certify as specified in Section 106.03(b)3.

**(f) Reinforcement Bars.** Section 1002.2

**(g) Waterproofing.** Section 680.2

**(h) Selected Borrow Excavation - Structure Backfill.** As shown on the Standard Drawings.

**(i) Concrete Bonding Compound.** Section 706

**(j) Rock Protection, Class R-5.** Section 850.2(a)

**(k) Joint Sealing Compound.** Section 705.4(e)

**(m) Neoprene Joint Material.** Identify neoprene material according to the type, class, and grade. Print, stencil, or otherwise affix this code to each pad at intervals of not more than 600 mm (24 inches) and in letters and numerals of not less than 5 mm (1/4-inch) height. Additional information such as lot or batch numbers, date, plant and place of manufacture, trademark, or name of manufacturer may also be added. Certify as specified in Section 106.03(b)3.

**1. Closed-Cell Neoprene Sponge.** Pads may be manufactured as sponge neoprene or expanded neoprene and may be composed of laminations. Use material conforming to the following:

- ASTM D1056, Type 2, Class C, Grade 5, including the requirements of suffixes B3 and F1
- ASTM D 1171, Quality Retention Rating of 100% after 6 weeks exposure

**(n) Post Tensioning Strands.** Section 1108.02(g)

**1085.3 CONSTRUCTION**—Construct as indicated and according to Article 12.11 of the AASHTO LRFD Specifications.

**(a) Design.** Design according to AASHTO specifications, as supplemented by PENNDOT Design Manual, Part 4.

**(b) Shop Drawings.** Obtain approval of shop drawings before fabricating precast box culverts.

Show segment length on drawing. Provide segments of maximum length compatible with hauling equipment in order to minimize the number of joints.

Provide shop drawings as specified in Section 105.02(d).

Provide shop drawings clearly showing all items incorporated into the box culvert including all reinforcing. List items such as chairs and inserts by source, type, and supplier.

**(c) Inspection.** The Department will inspect precast segments during the entire fabrication process. The necessary facilities for inspection include a plant office as specified in Section 714.5(a).

**(d) Plant Acceptance.** Section 714.4, except, register and certify the plant under either the National Precast Concrete Association (NPCA), American Concrete Pipe Association (ACPA) box culvert or Prestressed Concrete Institute (PCI), box culvert plant certification program. Submit an annual endorsed copy to the Structural Materials Engineer for continued qualification.

**(e) Handling and Storage.** Handle and store precast reinforced concrete box culvert segments so that damage will not occur to the concrete or reinforcing steel.

**(f) Delivery.** Replace precast reinforced concrete box culvert segments damaged by improper storing, handling, transporting, or erection.

The Representative will inspect the segments at the site for possible damage and cracking during shipment and for tolerances and other dimensions required for acceptance.

Do not ship segments until the 28-day minimum compressive strength is attained.

Provide 24-hour advance notice of loading and shipping schedule. Have the Department representative verify Form CS-4171 and properly tag segments before shipping. Do not ship unapproved items.

**(g) Installation Requirements.**

**1. Foundation Material.** Construct foundation as specified in Section 206, excluding Section 206.2(a)1.e. If unsuitable foundation material or rock is encountered, remove all unsuitable material or rock at least 300 mm (12 inches) below bottom of box culvert and backfill with No. 2A or AASHTO No. 8 Coarse Aggregate, as shown on the Standard Drawings, graded in close conformity with the stream bed grade to provide proper bedding conditions. Accurately shape bedding material with a template to provide uniform contact (90% of bearing).

**2. Grouting.** Grout hand holes, pockets, bolt sleeves, tie rod holes, and lifting lugs after joints are sealed and hardware is installed.

**3. Placement.** Place box culverts as indicated. Do not disturb the bedding or damage the box culvert.

**4. Backfill.** Backfill reinforced concrete box culverts to limits shown on Standard Drawing RC-12M. Backfill trench as specified in Section 601.3(f).

**5. Compaction of Cover.** If cover or fill is indicated, do not traverse top of box culverts with construction equipment until after cover or fill has been placed, unless cover exceeds 1500 mm (5 feet). Do not use vibratory rollers to compact cover or fill over, or directly adjacent to, box culverts.

**6. Waterproofing.** Apply waterproofing as specified in Section 680.3 and as shown on the Standard Drawings.

**(h) Guide Rails.** If indicated, install guide rail over box culverts as follows:

For fill heights greater than 600 mm (24 inches) at post locations, provide guide rail as shown on Standard Drawing RC-52M, "Type 2 Strong Post Guide Rail."

For fill heights 600 mm (24 inches) or less at post locations, provide structure mounted guide rail as shown on Standard Drawing BD-632M, "R.C. Box Culvert Precast," and furnish a Class A cement concrete headwall.

**(i) Cutoff Walls.** If indicated, provide cast-in-place or precast cutoff walls of 300 mm (12-inch) thick by 1050 mm (42-inch) deep Class A cement concrete, or less if directed, and install upstream and downstream.

**(j) Wingwalls.** If indicated, provide cast-in-place Class A cement concrete wing walls.

**(k) Aprons.** If indicated, provide aprons of 150 mm (6-inch) thick Class A cement concrete, reinforced as shown on the Standard Drawings.

**(l) Concrete Bonding Compound.** If cutoff walls or wing walls are indicated, bond to box culvert by coating the contact surfaces with concrete bonding compound.

**(m) Protective Coating.** If indicated, apply two spray coats of coal tar epoxy, conforming to the requirements of SSPC-PS 16-82, to the top of the box and exposed end faces and to the entire height of the outside walls.

**(n) Curing.** Section 714.8; except, maintain box culvert segments, after stripping and during secondary curing, in a minimum 10°C (50F) environment until they have reached a compressive strength of 70% of the required 28-day minimum concrete design strength shown on the approved shop drawings.

**(o) Post-Tensioning.** Install precast culvert segments as shown on the Standard Drawings, as indicated, and as specified in Section 1108.

**1085.4 MEASUREMENT AND PAYMENT—**

**(a) Precast Reinforced Concrete Box Culvert.** Lump Sum
The price includes the following component items:

- **Class A Cement Concrete.** Section 1001.4(a)
- **Deformed Welded Wire Fabric.** Kilogram (Pound)
  Annealed iron wire, chairs, and ties are incidental to the deformed wire fabric.
- **Precast Reinforced Concrete Box Culvert Segments.** Meter (Linear Foot)
  The unit price includes post-tensioning, if indicated.
- **Reinforcement Bars.** Section 1002.4
- **Membrane Waterproofing.** Section 680.4
- **Selected Borrow Excavation - Structure Backfill.** Section 1001.4(g)
- **Rock Protection.** Section 850.4(a)
- **Protective Coating (Coal Tar Epoxy).** Square Meter (Square Yard)

Work to divert running water according to the accepted Erosion and Sedimentation Control Plan is incidental to box culvert construction.

**(b) Guide Rail.** Section 620.4

**(c) Excavation for Unsuitable Material or Rock.** Section 204.4

**(d) Backfill for Unsuitable Material or Rock Excavation.** Cubic Meter (Cubic Yard)
The Department will pay as specified in Section 110.03.

# SECTION 1086—SOUND BARRIERS

**1086.1 DESCRIPTION**—This work is the construction of either structure mounted or ground supported sound barriers.

**1086.2 MATERIAL—**

**(a) Wall Posts.**

**1. Steel H-beam Posts.**

- Fabricated Structural Steel—Section 1105.02(a)2
- Anchor Bolts, Nuts, and Washers—Section 1105.02(c)2
- Epoxy Protection for Structural Steel—Section 1092.2

**2. Precast Reinforced Concrete Posts.** Section 714

- Class AA Cement Concrete—Section 704
- Reinforcement Bars—Section 1002
- Deformed Welded Wire Fabric, Epoxy Coated—Section 709.4

**3. Timber Posts.** Sections 1031.2(a) and (b)

**4. Nonshrink Grout.** Section 1001.2(e)

**5. Galvanizing.** Section 1105.02(s)

**6. Caulking Compound.** Section 705.8

**(b) Wall Panels.**

**1. Precast Reinforced Concrete Panels.** Section 714

- Class AA Cement Concrete—Section 704
- Reinforcement Bars—Section 1002
- Steel Welded Wire Fabric—Section 709.3
- Steel Welded Wire Fabric, Epoxy Coated (when indicated)—Section 709.3(a)

**2. Timber Panels.** Sections 1031.2(a) and (b)

**(c) Epoxy Resin Protective Coating.** Section 1019.2(b)

**(d) Anti-Graffiti Coating.** See special provision in the proposal.

**(e) Finish.** Texture and color of panels and posts to be as indicated and uniform from panel to panel and from post to post.

**(f) Foundation.**

**1. Drilled Caissons.** Section 1006.2

**2. Spread Footings.**

- Class A Cement Concrete—Section 704
- Reinforcement Bars, Epoxy Coated—Section 1002

**(g) Unreinforced (Plain) Neoprene Bearing Pads.** Section 1113.02(a). Sample the completed pads according to PTM No. 312, except reduce the sampling rate to three pads per structure.

**1086.3 CONSTRUCTION**—Before fabrication, obtain acceptance of shop drawings. Construct as indicated, as shown on the approved shop drawings, and as follows:

**(a) Design.** Determine final groundline elevations for ground mounted sound barrier wall. Furnish these elevations to the wall supplier to develop the shop plans including a complete elevation view of each wall section indicating top and bottom elevations and roadway grade. Protect final ground elevations, established in the field, for the duration of the project and do not adjust without prior approval.

Provide fire hydrant openings and other highway access as indicated. Provide adequate reinforcement around panel openings to preclude cracking. Show reinforcement details on the shop drawings.

**(b) Shop Drawings.** Before beginning construction, submit, for acceptance, shop drawings showing fabrication details; and handling, transportation, and construction procedures for all wall elements including connections.

**(c) Installation Requirements.**

**1. Foundations.**

**1.a Caisson Foundations.** Construct drilled caisson foundations as specified in Section 1006.3, and as follows:

- Provide vertical and tie reinforcement for the full height of the shaft.
- Provide test holes and probe holes only as indicated.

- When permanent casing is used, drill, drive, or vibrate casing so soil is in full contact with the outside of the casing. Alternatively, place casing in an oversized hole and grout the annular space between the permanent casing and the surrounding soil to establish lateral support. Grout after the concrete has obtained its initial set but no later than 24 hours after placement of the concrete. Where excavation is stable and not subject to rapid degradation, the 24 hour period may be extended to 72 hours, as permitted. Use a pressurized grouting method capable of completely filling the open area. Provide grout as specified in Section 1108.3(f)1, except testing is not required.

- When temporary casing is used, remove casing as specified in Section 1006.3(i). If unexpected construction conditions require the casing to remain in place, perform grouting as specified for permanent casing to fill cavities surrounding the casing.

- Place caisson concrete within 24 hours of the completion of excavation and within 3 hours of final inspection of the drilled shaft. Where excavation is stable and not subject to rapid degradation, the 24 hour period may be extended to 72 hours, as permitted.

**1.b Spread Footings.** Construct cement concrete spread footings as indicated. Excavate and backfill foundation area as specified in Section 204.3, and compact using a mechanical tamper.

**2. Fabrication.** Fabricate concrete posts and panels as specified in Section 714, except, maintain units in secondary curing until they have reached a compressive strength of 70% of the 28-day minimum compressive strength. Fabricate two full-sized samples of each for approval of the acceptable range of color and texture variations, surface blemishes and overall appearance. Fabricate samples using the same process and materials that will be used for all production. Erect approved sample posts/panels at the place of manufacture and store outdoors to allow proper lighting for comparisons during manufacturing and inspection. Architectural treatment for both sample posts/panels and subsequent production will be approved at a viewing distance of 10 m (30 feet). Acceptable samples fabricated according to the approved shop drawings may be incorporated into the project in the final stage of construction, after all production has been completed and approved.

For precast concrete construction, obtain casting approval before construction of any sound barrier wall. Grout all holes in precast concrete posts and panels, resulting from fabrication. Ensure that precast concrete panels and posts are cast in one continuous lift to eliminate cold joints. When precast concrete posts and panels are used, and the panels slip down into the post flanges, fabricate and erect wall sections in a manner that will produce a secure and vibration free installation. Provide a smooth finish on the portions of panels that will be placed in post flanges. Furnish full height panels, or, if allowed, panel sections with tongue and groove or interlocking joints that provide "light tight" conditions at the joints and prevent direct transmission of sound. Furnish top panels finished flush on the top side. Replace cracked or damaged panels and posts. Maintain erected wall in acceptable condition until the project is accepted.

When steel H-beam wall posts are used, furnish posts epoxy-coated as specified in Section 1092.3.

**3. Erection.** Install sound barrier wall as indicated, as shown on approved shop drawings, and according to the manufacturer's recommendations.

Secure panels to provide a vibration free installation, and provide joints and connections with no visible openings to decrease sound attenuation.

Cut all exposed bars and cables, used in the lifting and erection of precast concrete wall components, flush with the surface. Clean and coat these areas with an approved epoxy as specified in Section 1019.3(b).

Apply anti-graffiti coating to indicated exposed wall surfaces.

Construct finished ground as indicated or directed.

**4. Removal of Falsework and Bracing.** Keep falsework and bracing that supports posts in place for at least two days after placing the final portion of the foundation.

**(d) Tolerances.**

**1. Fabrication Tolerances.**

**1.a Reinforced Precast Concrete Posts and Panels**—ACI 117.

**1.b Structural Steel Posts**—ASTM A 6

**1.c All Others.**

**METRIC**

| Panels | (mm) |
|---|---|
| Height: | ±6 |
| Length: | ±6 |
| Thickness: | ±6 |
| Out of Flatness: | |
| -Lengths to 2400 mm: | 3 |
| -Lengths over 2400 mm: | 6 |

| Posts | (mm) |
|---|---|
| Length: | ±6 |
| Width: | ±6 |
| Depth: | ±6 |
| Slot Depth: | ±3 |
| Slot Depth: | ±3 |
| Out of Flatness: | |
| -Lengths to 2400 mm: | 3 |
| -Lengths over 2400 mm: | 6 |

**ENGLISH**

| Panels | (inch) |
|---|---|
| Height: | ±1/4 |
| Length: | ±1/4 |
| Thickness: | ±1/4 |
| Out of Flatness: | |
| -Lengths to 8 feet: | 1/8 |
| -Lengths over 8 feet: | 1/4 |

| Posts | (inch) |
|---|---|
| Length: | ±1/4 |
| Width: | ±1/4 |
| Depth: | ±1/4 |
| Slot Depth: | ±1/8 |
| Slot Depth: | ±1/8 |
| Out of Flatness: | |
| -Lengths to 8 feet: | 1/8 |
| -Lengths over 8 feet: | 1/4 |

**2. Erection Tolerances.**

- Vertical alignment for walls and posts to be 6 mm (1/4 inch) for wall heights to 3100 mm (10 feet), 12 mm (1/2 inch) for wall heights to 6100 mm (20 feet), and 20 mm (3/4 inch) for wall heights greater than 6100 mm (20 feet).

- Horizontal alignment to be as indicated.

- Posts to be set within ±13 mm (±1/2 inch) of the indicated location.

## 1086.4 MEASUREMENT AND PAYMENT—

**(a) Wall Posts.** Each
The price includes foundation, bearing pads, and all associated hardware.

**(b) Wall Panels.** Square Meter (Square Foot)
Measured to equal the total area of the panel including areas concealed by posts or finished ground.
The unit price includes all associated hardware.

**(c) Anti-Graffiti Coating.** The Department will pay as specified in the special provision in the proposal.

# SECTION 1087—PA HT BRIDGE BARRIER RAILING

**1087.1 DESCRIPTION**— This work is the construction of a PA HT Bridge Barrier Railing.

**1087.2 MATERIAL**— Unless otherwise specified, galvanize steel materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings as specified in Section 105.02(d) for review and acceptance.

**(a) Railing.**

- Steel Rails. ASTM A 53/A 53M, Type E or S, Grade B, or A.P.I. 5LX52
- Steel Rail Sleeve Member. ASTM A 53/A 53M, Type E or S, Grade B; ASTM A 36/A 36M or ASTM A 500, Grade B, or A.P.I - 5LX52
- Sidewalk Rail Tubes. Section 1022.2(a)
- Toggle Bolts for Sidewalk Rail Tube. Section 1022.2(b)
- Sidewalk Rail Rod. ASTM A 35/A 36M
- Sidewalk Rail Rod Splice. ASTM A 513 or A 519
- Railing Posts and Base Plates. Section 1105.02(a)2
- Miscellaneous. Section 1105.02(a)2

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c), galvanized as specified in Section 1105.02(s).

**(c) Caulking Compound.** Section 705.8.

**1087.3 CONSTRUCTION**—As shown on the Standard Drawings, the Contract Drawings, and as follows:

Before erection, use caulking compound and thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound and seal openings between metal surfaces and concrete.

Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, paint with two coats Zinc Dust-Zinc Oxide Primer, Bulletin 26.

Place joints, as indicated.

At bend areas, do not vary the diameter of rail tubes by more than 5% of the outside dimension when rail tubes are bent to the radii indicated.

Do not open bridge to traffic until bridge railing is placed.

**1087.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot), measured from end to end of barrier railing.

# SECTION 1088—PA TYPE 10M BRIDGE BARRIER RAILING

**1088.1 DESCRIPTION**— This work is the construction of a PA Type 10M Bridge Barrier Railing.

**1088.2 MATERIAL**— Unless otherwise specified, galvanize steel materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings as specified in Section 105.02(d) for review and acceptance.

**(a) Railing.**

- Steel Cold Formed Tubes. ASTM A 500, Grade B
- Sidewalk Rail Tubes. Section 1022.2(a)
- Toggle Bolts for Sidewalk Rail Tube. Section 1022.2 (a)
- Railing Posts and Base Plates. Section 1105.02(a)3.b
- Test Requirements for Post Welds. At least 10% of the posts in a lot as defined in AWS DI.5-95, Section 6.7.1(c), will be inspected. A visual inspection and magnetic particle testing will be performed over the full length of the welds on all posts inspected. Ultrasonic testing of the complete joint penetration welds will also be performed. If unacceptable discontinuities are found in more than 20% of the welds tested, an additional 10% of the posts in the same lot will be inspected. If unacceptable discontinuities are found in more than 20% of the welds tested in the second group of posts, all of the remaining posts in the lot will be inspected.
- Miscellaneous. Section 1105.02(a)2

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c), galvanized as specified in Section 1105.02(s).

**(c) Barrier Mount Delineation Devices.** Section 937.3(b)

**(d) Caulking Compound.** Section 705.8

**1088.3 CONSTRUCTION**—As shown on the Standard Drawings, the Contract Drawings, and as follows:

Before erection, use caulking compound and thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound and seal openings between metal surfaces and concrete.

Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, paint with two coats Zinc Dust-Zinc Oxide Primer, Bulletin 26.

Place joints, as indicated.

At bend area, do not vary the diameter of rail tubes by more than 5% of the outside dimension when rail tubes are bent to the radii indicated.

Do not open bridge to traffic until bridge railing is placed.

**1088.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot), measured from end to end of barrier railing.

# SECTION 1089—PA BRIDGE BARRIER RAILING

**1089.1 DESCRIPTION**— This work is the construction of a PA Bridge Barrier Railing.

**1089.2 MATERIAL**— Unless otherwise specified, galvanize steel materials as specified in Section 1105.02(s). Before fabrication, submit shop drawings as specified in Section 105.02(d) for review and acceptance.

**(a) Railing.**

- Steel Cold Formed Tubes. ASTM A 500, Grade B
- Threaded Welded Anchor Studs for Barrier Rail Tube. ASTM A 108
- No Thread Welded Anchor Studs for Barrier Rail Splice. ASTM A 108
- Sidewalk Rail Tubes. Section 1022.2(a)
- Threaded Welded Anchor Studs for Sidewalk Rail Tube. ASTM A 108
- Sidewalk Rail Rod. Section 1105.02(a)2
- Sidewalk Rail Rod Splice. ASTM A513 or A519
- Railing Posts and Base Plates. Section 1105.02(a)3.d, Type 1, 2, or 3 only.
- Test Requirements for Post Welds. All welds on all posts will be visually inspected. In addition, at least 10% of the posts in a lot as defined in AWS DI.5-2002, Section 6.7.1.2(2)(c), will be inspected as follows: Magnetic particle testing will be performed over the full length of the welds on all posts inspected. Ultrasonic testing of the complete joint penetration welds will also be performed. If unacceptable discontinuities are found in more than 20% of the welds tested, an additional 10% of the posts in the same lot will be inspected. If unacceptable discontinuities are found in more than 20% of the welds tested in the second group of posts, all of the remaining posts in the lot will be inspected.
- Miscellaneous. Section 1105.02(a)2

Certify as specified in Section 106.03(b)3.

**(b) Anchor Bolts, Nuts, and Washers.** Section 1105.02(c)3, galvanized as specified in Section 1105.02(s).

**(c) U-Shaped Washer.** Section 1105.02(a), galvanized as specified in Section 1105.02(s).

**(d) Barrier Mount Delineation Devices.** Section 937.3(b)

**(e) Caulking Compound.** Section 705.8

**1089.3 CONSTRUCTION**—As shown on the Standard Drawings, the Contract Drawings, and as follows:

Before erection, use caulking compound and thoroughly coat surfaces of posts in contact with concrete. After erection and alignment, use caulking compound and seal openings between metal surfaces and concrete.

Remove blemishes and scratches from exposed surfaces. For areas that have been damaged, exposing base metal, repair galvanizing in accordance with ASTM A 780.

Place joints, as indicated.

At bend area, do not vary the diameter of rail tubes by more than 5% of the outside dimension when rail tubes are bent to the radii indicated.

Do not open bridge to traffic until bridge railing is placed.

**1089.4 MEASUREMENT AND PAYMENT**—Meter (Linear Foot)

Measure from end to end of barrier railing.

# SECTION 1091—EPOXY INJECTION CRACK SEAL

**1091.1 DESCRIPTION**—This work is the preparation and sealing of cracks with epoxy resin mixture, excluding overhead sealing.

**1091.2 MATERIAL—**

**(a) Epoxy Resin System.** Provide a system conforming to the strength requirements of ASTM C 881, Type I, Grade 1, Section 706.1, for epoxy injection and from a manufacturer listed in Bulletin 15.

**(b) Surface Seal.** Provide a surface seal as recommended by the manufacturer and of adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.

**(c) Injection Fittings.** As recommended by the manufacturer.

**(d) Certification.** Section 106.03(b)3

**1091.3 CONSTRUCTION**—Construct as directed and as follows:

**(a) Preliminary Work.** The Representative will mark areas to be sealed.

**(b) Preparation for Sealing.** Thoroughly clean the surfaces of rust, scale, grease, loose and disintegrated particles, and material. Remove unsound concrete and mortar as directed. Glue injection ports in place at spacings as recommended by the manufacturer. Bevel cracks, as directed, to facilitate installation of injection ports. Seal the surface and areas surrounding the entry ports with surface seal. Apply seal so that the epoxy injection resin is sealed until initially cured.

**(c) Mixing Epoxy Resin System.** Mix the epoxy resin system according to the manufacturer's instructions with a minimum 180 second mixing time using a low speed (400 rpm to 600 rpm) electric drill with an approved mixing paddle. The mixing may also be accomplished by an injection machine capable of metering and mixing the specific proportions of components within a tolerance of ± 5%.

**(d) Injection Procedure.** Do not inject the cracked area until after the surface sealer has hardened. Inject the epoxy with a hand held gun, pressure pot, or injection machine or as recommended by the manufacturer. Start injection at the lowest point on the crack. When the material begins to flow from the next higher entry port, remove the nozzle, plug the port, and insert the nozzle in the next higher entry port. Continue the operation until the crack is completely filled. After the epoxy material has achieved an initial cure, remove the entry ports and, if necessary, patch the areas with the same material used to seal the rest of the crack surface.

**(e) Application Limitations.** Do not apply or inject epoxy materials if the ambient or concrete temperature is below 10 °C (50F).

**1091.4 MEASUREMENT AND PAYMENT—**

**(a)** Meter (Linear Foot) or

**(b)** Dollar

The proposal will include an item and a predetermined amount of money for Epoxy Injection Crack Seal. The contract item will have a unit of measure of Dollar, a unit price of $1.00, and a quantity equal to the predetermined amount.

Due to the contingent or unpredictable nature of the work being performed, the provisions of Section 110.02(d) are not applicable to this item.

Measured and paid for, under the Epoxy Injection Crack Seal item as follows:

1. **Negotiated Price.** At an agreed upon price. This price will be agreed upon with the Department, before performing the work. When applicable, agreement is also required with the FHWA.

2. **Force Account Basis.** Section 110.03(d)

# SECTION 1092—EPOXY PROTECTION FOR STRUCTURAL STEEL

**1092.1 DESCRIPTION**—This work is the coating of surfaces of structural steel with an electrostatically applied, fusion-bonded epoxy.

**1092.2 MATERIAL—**

**(a) Coating System.** Use powdered epoxy coating material from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

Provide fusion-bonded epoxy coating that is a one-part, heat-curable, thermosetting, powdered coating conforming to AASHTO M 284/M 284M, modified as follows:

- Wherever the terms "deformed steel reinforcing bar(s)," "plain steel reinforcing bar(s)," "reinforcing steel," "bar(s)," or "reinforcing bar(s)" appear, substitute the terms "structural steel member(s)," "structural steel," or "member(s)" as applicable.

- Unless otherwise indicated, coating color to match Federal Standard No. 595, Color No. 14223 (Foliage green).

- Section 4—Reinforcing Steel. Revise the title of the section and the section to read:

  4. Structural Steel.

  4.1 Furnish structural steel to be coated conforming to the requirements of applicable AASHTO standard specifications, as indicated or specified, and free of contaminants such as oil, grease, paint, and silvers. Structural steel exhibiting any silver-like defects after the heating and coating process will be rejected unless satisfactorily repaired. A single recorded coated steel member thickness measurement is defined as the average of three individual readings obtained from three immediately adjacent areas on the body of the member. Obtain a minimum of five recorded measurements approximately evenly spaced along each side of the test specimen (i.e., a minimum of ten recorded measurements per specimen). The film thickness limits do not apply to patched areas.

- Section 7.3—Adhesion. Delete this section.

- Section 8—Test Methods. Revise this section as follows:

  Revise the first sentence in Subsection 8.1 to read:

  Measure the thickness of the coating on the body of the member as specified in Section 4.1.

  Subsection 8.3—Adhesion of Coating. Delete this section.

- Section 12—Repairs Due to Handling. Revise Subsection 12.2 to read:

  Satisfactorily repair damage to the epoxy coating that occurs during fabrication, shipping, or installation either according to Section 11.1 or by mechanical wire brush cleaning and painting with an approved epoxy paint using the paint manufacturer's approved procedure. Repair any member with visible signs of rust according to Section 11.1. Do not cover more than 5% of the total surface area with patching material.

- Section 15—Fabrication of Steel Reinforcing Bars After Coating. Delete this section.

- Section A1.3—Specimens for Test. Revise this section as follows:

  Revise Subsection A1.3.1 to read:

  Submit the following type and number of test specimens for test:

  (1) Two steel plates 100 mm x 100 mm x 12 mm (4 inches by 4 inches by 1/2 inch), cleaned, and uncoated.

  (2) Four steel plates 100 mm x 100 mm x 12 mm (4 inches by 4 inches by 1/2 inch), and coated with a film thickness of 250 µm (10 mils).

  (3) Three films of epoxy (of the minimum thickness proposed for use during production coating of structural steel) for the chloride permeability test.

  Revise the last sentence in the first paragraph in Subsection A1.3.3 to read:

  Measure the thickness of the film on the body of the member.

- Section A1.4.4—Flexibility of Coating. Delete this section.

- Section A1.4.5—Bond Strength to Concrete. Delete this section.

- Section A1.4.7—Impact Test. Revise the third sentence to read:

  Have impact occur on those areas that will be subject to impact when member is used for its intended purpose, if this can be determined. Otherwise, have impact occur on any areas.

- Section A1.4.8—Hardness Test. Revise the last sentence to read:

  Meet or exceed a Knoop Hardness Number of 16 when averaging four individual hardness measurements made on at least two specimens.

## 1092.3 CONSTRUCTION—

**(a) General.** Apply coating in an environmentally controlled plant that is fully enclosed. Provide a fully automatic coating system with the capability of preheating and post-baking. Use a fully automatic grit-blast cleaning machine, enclosed in an environmentally controlled plant.

**(b) Surface Preparation.** Free all surfaces of oil or any mill coating.

Gritblast the steel to white metal, as defined in SSPC-SP5, using a mixture of steel shot and grit. Protect clean surfaces from conditions of high humidity, rainfall, or surface moisture. Do not allow the steel to flash rust before coating. Provide a uniform, angular anchor blast profile from 50 µm to 125 µm (2 mils to 5 mils) deep. Determine anchor pattern depth by the Keane-Tator Surface Profile Comparator or Testex Replica Tape.

**(c) Application of Coating.** Apply the coating material according to the manufacturer's recommendation as to application procedure and curing schedule. In no case allow the over temperature, or temperature of the steel during any part of the curing process, to exceed 260 °C (500F).

Provide a cured coating of uniform color, gloss, and thickness, and free of blisters, pinholes, fish eyes, sags, runs, and other irregularities.

Provide a finished coating thickness of 250 µm ± 50 µm (10 mils ± 2 mils) tested according to ASTM G 12.

**(d) Inspection.** The coater is responsible for all QC checks including visual inspection, thickness measurements, and holiday testing, and for keeping records on the results of all such inspections in an approved form.

Provide access to each part of the process to the Inspector. Allow the Inspector to witness any QC tests, and perform such tests himself or herself on a random sampling basis, if requested by the Inspector.

After cure, check the coating for continuity using a 67.5 V wet sponge detector to check for holidays, pinholes, and voids. Allow no more than an average of 6 holidays per meter. Satisfactorily repair all defects.

**(e) Touch-Up System.** Provide a compatible two-part epoxy touch-up system designed and color-matched for patching the epoxy coating used on the structural steel. Satisfactorily patch all defects in the epoxy coating, areas damaged during erection, and all visible uncoated areas. Do not cover more than 5% of the total surface area with patching material.

**1. Surface Preparation.** Apply coating directly to the metal for maximum performance. Ensure that metal is clean, dry, and free of rust and scale. Blast clean to NACE near white where possible. Remove grease, oil, and other substances with suitable solvents. Coat cleaned surface before oxidation occurs.

**2. Mixing.** Mix Part A and Part B of the two-part system in the proportions recommended by the manufacturer. Mix the two parts thoroughly until a uniform color is obtained. If required, thin each part separately, with thinner recommended by the system manufacturer, to minimize loss of pot life. Furnish material having a pot life of at least 8 hours. Discard material that is not used within the pot life specified by the manufacturer.

**3. Application.** Apply material with ordinary brush or roller, according to the manufacturer's instructions, and as directed. Achieve a track free surface in 2 hours to 3 hours at 22 °C (72F). Achieve full cure in 3 days to 5 days at 22 °C (72F). Exercise care in handling pieces before they are fully cured.

**1092.4 MEASUREMENT AND PAYMENT**—Epoxy protection for structural steel is incidental to the items of work protected.

# SECTION 1100
# MANUFACTURED MATERIAL

## SECTION 1101—HIGHWAY LIGHTING

**1101.01 GENERAL REQUIREMENTS**—Design, manufacture, and test lighting material and equipment according to the latest applicable standards of IEEE, ASTM, NEMA, ANSI, and the currently adopted AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" (AASHTO Specifications).

Fabricate highway lighting structural materials according to AWS, the AASHTO Specifications, and Section 1105 (steel members only); except, applying water to the base metal is permitted for the air plasma arc cutting process. Bulletin 15 listing, shop inspection, and AWS certified welding inspectors (CWI) are required for welded aluminum pole manufacturers and for welded steel pole manufacturers. Bulletin 15, shop inspection, and Section 1105 do not apply to cast aluminum poles, cast steel poles, cast iron poles, painting of aluminum poles, or poles without welds on any areas subject to tensile stress.

Design calculations are required for all poles. Submit design calculations and fatigue analysis within 60 days of contract award, or as directed. If the Bureau of Design has previously approved identical lighting material and equipment, submission of design calculations and fatigue analysis may not be required. Provide calculations signed and sealed by a Professional Engineer registered in Pennsylvania.

Provide steel poles that are fabricated from material conforming to the current AASHTO Specifications. The Charpy V-Notch toughness test is required for load carrying tension members 13 mm (1/2 inch) and greater in thickness, including base plates and arm connection plates, as required for Zone 2 in Table S1 of the applicable AASHTO Specifications. The Charpy V-Notch toughness test is not required for high mast handhole frames. Bend testing is required for material less than 13 mm (1/2 inch) in thickness.

Provide steel poles that are either round or multisided with a minimum of eight sides.

Use radiographic test methods when inspecting complete penetration welds on steel poles with material less than 8 mm (5/16 inch) in thickness, and use radiographic or ultrasonic test methods when inspecting complete penetration welds on steel poles with material 8 mm (5/16 inch) in thickness and greater. Perform and evaluate all non-destructive testing according to cyclically loaded, non-tubular tension criteria. Use radiographic, ultrasonic, or magnetic particle test methods when inspecting other welds on steel poles.

Provide aluminum poles that are round. Provide aluminum welds and aluminum welding material conforming to ANSI/AWS D1.2, Structural Welding Code for Aluminum. Use radiographic test methods when inspecting complete-penetration welds on aluminum poles. Use radiographic or dye penetrant test methods when inspecting other welds on aluminum poles.

Provide testing and test methods according to ANSI/AWS D1.1 (Steel) D1.2 (Aluminum) and as determined by the MTD. Contact the MTD to arrange for proper pole manufacturing inspection. Inspection will include 100% of the length of each complete penetration weld and a minimum of 25% of the length of each other weld. The portion of the other welds to be tested will be selected by the Department's agency inspector. Certify lighting poles, nuts, bolts, and associated hardware as specified in Section 106.03(b)3, including Charpy V-Notch test results, bend test results, and weld inspection reports. Provide catalog cuts or shop drawings for approval, instead of certification, for all other highway lighting items. The Department may select test samples at the source of supply before shipping or at the project site after delivery.

Submit for approval, before purchase and at no expense to the Department, catalog cuts, drawings, and manufacturer's specifications for all lighting material including; lighting poles, luminaires, junction boxes, conduits, cables, and power supply components proposed for the project. Refer to the Project Office Manual for material information requirements.

Do not alter or modify any material unless authorized, in writing, by the manufacturer. Inform the Department of any alterations or modifications made outside of the manufacturer's facilities, and furnish proof of authorization from the manufacturer.

Provide poles, which are less than 21.3 m (70 feet) in height in two sections or less.

Provide poles, which are between 21.3 m and 30.5 m (70 feet and 100 feet) in height in three sections or less.

Provide poles, which are over 30.5 m (100 feet) in height in four sections or less.

Furnish minimum pole section lengths of 3.7 m (12 feet) for high-mast poles and 4.6 m (15 feet) for conventional

poles. Obtain approval to furnish shorter section lengths.

Provide all units of any one item; such as luminaires, lamps, cable, and poles; that are of similar type and from the same manufacturer unless approved as a substitute.

**1101.02 POLES AND BASES (CONVENTIONAL LIGHTING)**—Furnish Type A poles with non-breakaway bases or Type S poles with breakaway bases, as indicated, conforming to the details as shown on the Standard Drawings, and as follows:

**(a) General.**

**1. Poles.**

- Manufacture shafts of steel or aluminum, with the shaft uniformly tapered approximately 12 mm/m (0.14 inch per foot). Fabricate multipiece shafts to allow field assembly by overlapping sections.

- Design for a recommended life of 25 years and use the Alternate Method for Wind Pressures contained in Appendix C of the AASHTO Specifications. Fatigue is not a required design element.

- Provide a handhole finished without rough edges and with a reinforcing frame and cover designed to maintain the required pole strength.

- Weld a 60 mm to 80 mm (2 3/8-inch to 3-inch) O.D. vertical tenon, fabricated from the same grade metal as the shaft, at the top of poles with post top luminaire mounting, and on the same axis as the pole.

- Compute the ice load on the luminaire using a surface area equal to six times the Actual Projected Area (APA).

- Design decorative light poles (with no significant arms) for a recommended life of 25 years. Use the Alternate Method for Wind Pressures contained in Appendix C of the AASHTO Specifications. For square cross section poles only, include a fatigue design which considers Vortex Shedding and Natural Wind Gusts per Table 11-1 for Fatigue Category III as found in the AASHTO Specifications.

Furnish poles capable of sustaining loadings as follows:

- Horizontal load of 2200 N (500 pounds) applied 460 mm (18 inches) from the shaft top in any direction with no failure of any component part. The shaft's deflection from vertical is limited to 7.5% of the shaft length.

- Horizontal load of 220 N (50 pounds) applied at the luminaire attachment point and normal to the pole bracket member plane, with a vertical load of 135 N (30 pounds) on the luminaire supporting arm. Rotation of individual sections of two-section poles is not allowed. The horizontal deflection is limited to 10% of the luminaire supporting arm's horizontal length.

- Vertical load of 440 N (100 pounds) applied at the luminaire attachment point. The vertical deflection is limited to 5.5% of the pole arm's horizontal length.

- Vertical load of 1100 N (250 pounds) applied at the luminaire attachment point. Collapse or rupture of any portion of the structure is not allowed.

- Pole arm and luminaire dead load. The deflection from vertical at the top of the pole is limited to 1% of the total shaft length. The pole deflection from vertical is defined as the horizontal distance between the pole top centerline, when the pole alone is installed plumb, and the pole top centerline, after the arm and luminaire combination are installed on the previously plumb pole, measured without

additional shaft adjustment.

**2. Anchor Bases.**

- Finish clean, smooth, and of the dimensions required for adequate pole mounting and structural support.
- Provide holes for anchor bolts.
- Telescope the base over the shaft and secure in place by electric arc welding at the pole bottom and at the top of the base plate.

**3. Anchor Bolt Covers.** Furnish a cover for each anchor bolt and use M6 x 1 (1/4-inch), stainless steel, Phillips-head, or hex-head screws.

**4. Frangible or Breakaway Bases.** Furnish breakaway supports, designed according to the AASHTO Specifications.

**(b) Steel Poles.**

**1. Shaft.**

- Fabricate from material conforming to ASTM A 595 and not less than 3.04 mm (No. 11 gage), or from hot-rolled, low carbon, high-strength steel conforming to the following requirements:

  Minimum yield strength—345 MPa (50 kips per square inch)
  Minimum ultimate tensile strength—448 MPa (65 kips per square inch)
  Carbon content─0.15% min., 0.25% max.
  Maximum phosphorus content─0.04%
  Maximum sulfur content─0.05%
  Maximum silicon content─0.05%

Do not use equivalent steel types unless approved.

- Form into a continuously tapered shaft with one automatic electric arc welded, longitudinal joint per piece.
- Do not use transverse intermediate welds.
- It is permitted, after forming and welding, to use longitudinal cold rolling with sufficient pressure to tighten the weld, form a round shaft, and to increase the metal's minimum yield strength to 345 MPa (50 kips per square inch).
- Grind or bevel longitudinal weld beads and mating edges of two-piece shafts to avoid binding during section assembly.
- Provide complete-penetration longitudinal welds in the slip-joint area (1.5 times the inside diameter of the exposed end of the female section) plus 150 mm (6 inches) beyond, for the female section only.
- Provide a grounding nut for a M14 x 2 (1/2-inch x 13 UNC) threaded bolt or stud, when applicable, on the inside of the shaft, accessible from the handhole.
- Poles octagonal in shape, with flat or fluted faces, may be substituted for round steel poles. Furnish octagonal poles at least equal to round poles in thickness of metal and strength of pole, and meeting the requirements for round poles.

- Provide tapped holes for attaching anchor bolt covers.

**2. Anchor Bases.** Fabricate one-piece bases of cast steel conforming to ASTM A 27/A 27M, Grades 450-240 (Grade 65-35), or steel plate conforming to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).

**3. Finish.**

- Hot-dip galvanize the inside and outside surfaces of poles and bases as specified in Section 1105.02(s) (ASTM A 123/A 123M) after fabrication and before shipment.

- Clean the welds on poles by sandblasting or by an alternate, approved method before galvanizing.

**(c) Aluminum Poles.**

**1. Shaft.**

- Spin shafts to provide Alloy 6063-T6 according to the AASHTO Specifications.

- Provide a satin finish.

- Weld an aluminum grounding nut or lug for an M14 x 2 (1/2-inch x 13 UNC) threaded bolt or stud, when applicable, on the shaft inside, opposite the handhole.

- Furnish stainless steel hardware, unless otherwise directed.

- Provide poles with a J-Hook at the top of the shaft.

**2. Anchor Bases.** Fabricate one-piece bases of cast Aluminum Alloy SG70A-T6 (356-T6), ASTM B 26/B-26M or ASTM B 108/B108M. Provide tapped holes for attaching anchor bolt covers.

**1101.03 POLE ARMS (CONVENTIONAL LIGHTING)**—Furnish steel bracket arms and connections conforming to the details shown on the Standard Drawings, and furnish clamp connections for aluminum truss arms and poles, and as follows:

**(a) General.**

- Manufacture arms of steel or aluminum.

- Install the arm with a weather-resistant connection to the shaft, with a smooth raceway for wiring.

- Furnish arms of the same material as the pole.

- Provide ASTM A 325 connecting bolts as specified in Section 1105.02(d) for steel poles.

**(b) Bracket Type.**

- Furnish arm assemblies, consisting of an upper member and a lower member, rigidly secured by vertical struts (truss), or consisting of a cantilever-type arm (single member).

- Provide a fitting on the pole end of each type arm to allow the bracket-arm assembly to be secured to the pole.

**1. Truss Arms.**

**1.a Steel.** Fabricate arms to have a minimum diameter of 50 mm (2 inches). Finish as specified in Section 1101.02(b)3.

**1.b Aluminum.** Fabricate upper and lower members using 50 mm (2-inch) or larger diameter aluminum pipe, or using a combination of pipe and elliptical sections. Provide Alloy 6063-T6 according to the AASHTO Specifications

**2. Single-Member Arms.**

**2.a Steel.** Fabricate arms to have the same taper and a minimum diameter of 50 mm (2 inches). Finish as specified in Section 1101.02(b)3.

**2.b Aluminum.** Fabricate using 50 mm (2-inch) or larger diameter tapered aluminum tube or using tapered aluminum section, oval in shape, at the pole end and tapering to the luminaire end. Provide Alloy 6063-T6 according to AASHTO Specifications

**1101.04 ANCHOR BOLTS, NUTS, AND WASHERS (CONVENTIONAL AND HIGH MAST LIGHTING)—** Provide a preassembled high mast, anchor bolt arrangement with six bolts per pole. Mark the anchor bolt assembly for matching with the corresponding high mast, pole base plate. Use an identification mark that will be visible after imbedment in concrete.

Furnish structural steel anchor bolts, hex-head bolts, nuts, and washers for conventional and high mast lighting conforming to Section 1105.02(c)3, the following requirements, and as shown on the Standard Drawings:

**(a) Hex Head Bolts.** Provide hot–dipped galvanized bolts conforming to ASTM A 325 for anchor bolts with yield strength of 379 MPa (55 kips per square inch) and ASTM A 354, Grade BC, for anchor bolts with yield strength of 724 MPa (105 kips per square inch).

**(b) Galvanizing.** As specified in Section 1105.02(s) and as follows:

Galvanize the top 300 mm (12 inches) minimum of anchor bolts and all associated hardware according to ASTM A 153/A 153M, or another acceptable method which conforms to the thickness and adherence requirements of ASTM A 153/A 153M. Brushing of the threaded area to remove excess zinc is allowed, as specified in the American Hot-Dip Galvanizers Association's recommended procedures for galvanizing of threaded parts.

**1101.05 POLES (HIGH MAST LIGHTING)—**Furnish poles conforming to the details shown on the Standard Drawings, as specified in Section 1101.01, and the following:

**(a) General.**

- Comply with the AASHTO Specifications. Design for a recommended life of 50 years. Use the Alternate Method for Wind Pressure contained in Appendix C of the AASHTO Specifications. Consider Vortex Shedding and Natural Wind Gusts per Table 11-1 for Fatigue Category I.

- Design poles to provide a maximum deflection equal to 15% of the shaft length.

- Design based on ten luminaires per pole with each luminaire exerting a downward force equal to 334 N (75 pounds) and having an Effective Projected Area (EPA) of 0.19 $m^2$ (2.0 square feet). Include EPA and downward force for the head frame assembly being used. Compute the ice load on the luminaire using a surface area equal to six times the APA.

- Fabricate pole shafts and base plates from high-strength, low-alloy structural steel conforming to AASHTO M 270/M 270M (ASTM A 709 /A 709M) Grade 345 (Grade 50 ). Do not use equivalent steel types unless approved.

- Galvanize poles and base plates as specified in Section 1101.02(b)3.
- Grind or bevel mating edges of multi-section poles to avoid binding during section assembly.
- Do not use transverse welds.
- Provide base plates with a minimum thickness of 76 mm (3-inch) unless otherwise approved.
- Provide bottom shaft sections with an 8 mm (0.3125 inch) minimum thickness.
- Provide a complete joint penetration weld for the connection of the shaft to the base plate.
- Provide complete-penetration longitudinal welds in the slip-joint area (1.5 times the inside diameter of the exposed end of the female section) plus 150 mm (6 inches) beyond, for the female section only.
- Join each pole section by telescoping the individual sections. Overlap a minimum length of 1.5 times the inside diameter of the exposed end of the female section. Do not field weld.
- Mark corresponding pole sections for field mating and assembly.
- Mark the inner telescoping section to show the minimum required telescoping length.
- Clearly mark and identify each pole base plate for matching to the corresponding anchor bolt assembly, to ensure proper fit in the erection of each pole.
- Permanently inscribe each pole with manufacturing identification and reordering information, or show on a nameplate attached to the pole.
- Provide four-conductor copper 5.26 $mm^2$ (No. 10 AWG) minimum, 600 V, electrical cable, of the type and length required, with a watertight electrical plug and receptacle suitable for use.
- Provide a matching watertight power receptacle having sufficient cord length to be brought outside for energizing the lowered luminaire mounting ring and the electrical power drive.
- Provide a low resistance grounding lug at the top of the pole for grounding the lightning rod to the pole shaft.
- Provide stainless steel hardware; such as nuts, bolts, screws, and washers.

**(b) Head Frame Assembly.** Provide a head frame assembly with each high-mast pole, to support the luminaire ring with its required number of luminaires, and as follows:

- Mount pulleys and mechanisms on the head-frame assembly; cover with a protective non-corrosive housing.
- Make necessary cable openings as small as practical to prevent the entry of birds.
- Provide a housing that can be easily removed from the head-frame assembly for servicing of pulleys and other mechanisms.
- Provide a 610 mm (24-inch), nickel-tip copper lightning rod on each pole, extending not less than 500 mm (20 inches) above the head-frame cover and located on or near the pole centerline.
- Ground the lightning rod to a grounding lug at the pole top, using 53.4 $mm^2$ (No. 1/0 AWG) braided copper wire, adapters, and cable connectors. Provide a grounding lug furnished by the lightning rod manufacturer.

- Mount the lightning rod with brass or bronze hardware.
- Provide pulleys large enough to contain the various required cables, without exceeding the recommended bending radii.
- Fabricate pulleys of either cast steel with a nylon bushing or aluminum with a bronze bushing, both with a stainless-steel shaft Type 304, and both equipped with guards to prevent the cable from jumping off the pulley.
- Furnish a head frame that provides three-point suspension and positive centering and engagement between the mating parts of the head frame and the luminaire ring assembly.
- Hot-dip galvanize the head frame, after fabrication, as specified in Section 1105.02(s) (ASTM A 123/A 123M), or completely zinc-electroplate with an additional 0.13 mm (5-mil) minimum thickness of approved zinc-rich paint or an epoxy powder coating.

**(c) Latching.** Furnish each high mast pole assembly with either a latching device or two safety cables to secure the luminaire ring in the fully raised position after tension is removed from the winch hoist cable.

- If a latching device is furnished, the mechanism is required to release either automatically or by manual pull of a cable after the luminaire ring has been raised from the latching pins or fingers. Provide a mechanically operated indicator for each of the three luminaire ring latches to indicate positive latching at each point on the luminaire ring.
- If two safety cables are furnished, anchor the cables to the winch-mounting frame or to eyebolts embedded in the foundation. Attach the safety cables to the cable terminator securing the luminaire ring in the fully raised position removing tension from the winch hoist cable. Provide a mechanically operated indicator for each of the three cables to indicate a fully seated ring.

**(d) Luminaire Ring Assembly.**

- Equally space 50 mm (2-inch) luminaire tenons around the ring for the indicated number of luminaires.
- Hot-dip galvanize the entire luminaire ring assembly after fabrication as specified in Section 1105.02(s) (ASTM A 123/A 123M).
- Provide a weatherproof male plug wired to the terminal box, for energizing the luminaires in the servicing position.
- Provide a 30 A, four-wire type watertight plug to mate with the power receptacle.
- Provide a ring-mounted enclosure as specified in Section 1101.11(c) to house a terminal block, fuse block, and lightning arrester.
- Provide guide rollers or pads to cushion excess swing during raising and lowering operations.

**(e) Winch Assembly.** Provide a self-locking, permanently lubricated, worm gear winch assembly, enclosed within the pole mast, capable of raising and lowering the entire luminaire ring at a rate of approximately 76 mm/s (15 feet per minute) when driven by a portable winch drive. Provide a drive unit of a size and speed determined by the lifting and lowering force required, and the required raising and lowering speed, without exceeding 50% of the capacity of the worm gear assembly or the drive unit. Provide a winch that remains locked in any position to prevent the luminaire ring assembly from falling under its own gravitational force if the operator interrupts the raising or lowering operations. Provide a winch designed to ensure proper spooling of the cable upon the drum at all times.

**(f) Electrical Winch Drive.** Furnish, for each project, one portable, heavy-duty, industrial-rated, reversible, electrical winch drive as follows:

- Provide the drive with a torque limiter that causes drive slipping at a predetermined torque to prevent damage to the system.
- Provide sufficient length of cable and mating plug to directly utilize the power supply.
- Equip the drive to attach to the winch drive shaft and the pole so the drive is completely self-supporting.
- Furnish a drive that operates from a remote switch, with sufficient cable length so the operator can stand a safe distance outside the radius of the luminaire ring assembly.
- A 120 V drill motor and transformer may be provided instead of a 240 V drill motor. The maximum transformer mass (weight) allowed is 220 N (50 pounds). Provide a transformer enclosure, carrying handle, and connectors.

**(g) Hoist Cables.** Furnish hoist cables made from stainless-steel aircraft cable, conforming to Military Specification MIL-W-83420J.

- Attach the support cables to a self-leveling yoke, to which is attached the winch cable from the winch drum.
- Provide guide cables or other acceptable means to prevent cable entanglements in the pole shaft.

**(h) Miscellaneous Hardware.** Furnish miscellaneous hardware of stainless steel, ASTM A 167, Type 304.

**1101.06 LUMINAIRES (CONVENTIONAL LIGHTING)**—Furnish luminaires complete including lamps, ballasts, decals, associated hardware, and necessary wiring.

**(a) General.**

- Furnish materials incorporating the latest available ratings and design improvements.
- Provide individual photoelectric cell control as specified in Section 1101.11(b), when indicated.
- Furnish luminaire certification of UL approval, as applicable.
- Furnish a sample luminaire for review and acceptance, if directed, when data is submitted for a product that has not previously been accepted by the Department.
- Furnish luminaire photometric data and ballast data with catalog cut information.
- Install glare shields, where indicated.
- Furnish clear high pressure sodium lamps. Provide lamps with a date marking code on the base. The nominal lamp voltage for less than 150 W is 55 V, and for 150 W and greater is 100 V.
- Provide luminaires with internal prewired ballasts, regulator or auto-regulator, capable of operating within ±10% of the specified supply voltage. Furnish ballasts that provide dependable starting of the lamp at a temperature of -29 °C (-20F), with a power factor of not less than 90%, and in compliance with the latest ANSI specifications.

**(b) Arm Mount Luminaires (Cobra Head).**

**1. Housings.**

- Provide a precision cast or formed housing of aluminum, with a refractor holder and an integral 50 mm (2-inch) slipfitter, capable of adapting to the mounting tenons.

- Provide a gasketed, thermal, shock-resistant glass prismatic refractor accurately molded to give the specified light distribution pattern, held in position in the lower housing with retaining clips.

- Provide a detachable reflector of processed aluminum, with a sealed anodic coating over an electrolytically or chemically brightened surface.

- Install the reflector with a gasket between it and the refractor, designed for easy removal from the housing. Silicone rubber gaskets are acceptable for luminaires up to and including 1000 W, and ethylene propylene (EPT or EPDM) gaskets are acceptable for luminaires up to and including 400 W. For Cobra head and other luminaires where the housing provides a drip-proof protection, refractor gaskets of high density, filtering type, non-wicking dacron polyester not less than 6 mm (1/4 inch) thick are also permitted. Die cut gaskets and overlay at joints.

- Include an adjustable mogul lamp socket.

- Furnish a luminaire capable of accommodating the appropriate lamps, properly positioned relative to the optical system. Provide a slip-fitter designed to prevent linear creep or rotation of the luminaire on the tenon.

- Provide a frame size for conventional High-Pressure Sodium Luminaires as follows, or equal:

| Watts | American Electric | Cooper Lighting | General Electric | Hubbell |
|---|---|---|---|---|
| Less than 200 | 115 | OVZ | M-250 | RM 150 |
| 200, 250 & 400 | 125 | OVF | M-400R | RL 400 |

- Provide luminaires with a maximum EPA of 0.14 $m^2$ (1.5 square feet), and a maximum mass (weight) of 25 kg (55 pounds).

**(c) Post Top Mount Luminaires (Offset).** Furnish as specified in the applicable requirements of Section 1101.06(b) and as follows:

- Furnish a precision cast aluminum housing, with a refractor holder.

- Provide a gasketed, thermal, shock-resistant glass prismatic refractor accurately molded to give the specified light distribution pattern, held in position in the lower housing with retaining clips.

- Join the upper and lower housings by stainless steel hinges and provide with twin trigger latches for access to internal components.

- Install gaskets at critical points to prevent entry of moisture and contaminants.

- Provide a detachable reflector, of processed aluminum, with a sealed anodic coating over an electrolytically or chemically brightened surface.

- Permanently attach the lamp socket to the reflector, to ensure correct lamp positioning. Provide the socket with a quick disconnect for easy removal of the reflector/socket assembly.

- Provide the luminaire with a slipfitter designed to accept a 60 mm to 80 mm (2 3/8-inch to 3-inch) O.D. vertical tenon for lateral orientation.

- Provide external adjustments for horizontal luminaire leveling.

- Provide infinite angular fixture adjustment in the vertical plane for proper luminaire aiming.

**(d) Wall Mount Luminaires (Underpass).** Furnish as specified in the applicable requirements of Section 1101.06(b) and as follows.

Furnish luminaires that provide total available downward street side lumens, between one mounting height and three mounting heights transverse distance, of not less than 20% of the bare lamp lumen output.

**(e) Overhead Mount Luminaires (Underpass).** Furnish as specified in the applicable requirement of Section 1101.06(b).

**1101.07 LUMINAIRES (HIGH-MAST LIGHTING)**—Furnish open-type, cutoff luminaires complete with lamps, ballasts, associated hardware, and necessary wiring as specified in the applicable parts of Sections 1101.06(a) and (b), and as follows:

- Provide with adjustable slipfitters designed for a 50 mm (2-inch) tenon to allow a positioning adjustment of ±3 degrees about the tenon axis.

- Provide with a heavy-duty, porcelain-enclosed, lamp socket, with the brass shell impregnated to prevent thermal freezing with the lamp base.

- Provide a lamp-stabilizing clamp that is nonasbestos-lined, heat-resistant, and stainless steel.

- Equip luminaires with ballasts, as specified in Section 1101.06(a).

- Furnish 400 W, high-pressure sodium lamps with a minimum initial output rating of 50 000 lumen and a minimum rated life of 24 000 hours based on 10 hours of operation per start.

- Furnish lamps that burn in a vertical (base-up) position.

- Provide luminaires with a maximum luminous intensity angle nominally 60 to 65 degrees from nadir.

- Furnish luminaires having a projected area not exceeding 0.33 $m^2$ (3.5 square feet), an EPA not exceeding 0.19 $m^2$ (2.0 square feet), and exerting a gravitational force not more than 334 N (75 pounds).

- Provide glare shields, when indicated.

- Furnish luminaires that provide the following nominal initial luminous intensity at the angles shown:

| Vertical Angle (degrees) | Luminous Intensity (candelas) |
|---|---|
| 20 | 2850 |
| 30 | 4170 |
| 40 | 4760 |
| 50 | 7500 |
| 55 | 9550 |
| 60 | 12900 |
| 65 | 13800 |
| 70 | 9250* |
| 72 1/2 | 7350* |
| 75 | 4350* |

* These are minimum values at the respective angles. Other candelas are nominal values.

Furnish vertical luminous intensity trace data to ascertain compliance with luminous intensity distribution requirements.

**1101.08 CABLE**—Furnish cable as follows:

**(a) General.**

- Provide 600 V conductors with insulation, and jacket as applicable, conforming to ICEA S-95-658/NEMA WC-70, or provide bare conductors for ground wire.

- Provide color-coded cables. Color code by surface markings, pigmented insulation, or tape. If surface markings are used, place marks at intervals not exceeding 610 mm (24 inches), located so as not to conflict with the required NEC markings. Provide cable with surface markings, except as specified in Section 1101.01. If taping is provided, overlap the tape for a minimum of 150 mm (6 inches) on the cable, at all access locations, and for each conductor.

- Conductors for all types of cables, including ground wire, as follows:

| | Copper |
|---|---|
| Conductor | Soft Drawn<br>ASTM B 3 |
| Stranding | ASTM B 8<br>5.26 to 33.6 $mm^2$ (10-2): 7 Strand<br>42.4 to 107.2 $mm^2$ (1-4/0): 19 Strand |

**(b) Underground Cable.** Furnish with insulation and jacket, as required, conforming to the following:

**METRIC**

| | Rubber-Neoprene | XLP |
|---|---|---|
| Insulation | ****SBR Rubber**<br><br>***Ethylene Propylene<br>**(EP) Rubber**<br><br>Thickness (mm)<br>3.30 - 5.26 $mm^2$: 1.14<br>8.38 - 33.6 $mm^2$: 1.52<br>42.4 - 107.2 $mm^2$: 2.03 | **Cross-Linked**<br><br>Thickness (mm)<br>3.30 - 5.26 $mm^2$: 1.14<br>8.38 - 33.6 $mm^2$: 1.52<br>42.4 - 107.2 $mm^2$: 2.03 |
| Jacket | **Neoprene**<br>ASTM D 4247<br><br>Thickness (mm)<br>3.30 - 33.6 $mm^2$: 0.76<br>42.4 - 107.2 $mm^2$: 1.14 | None |
| Max. Normal Operating Temperature | **75 °C<br>***90 °C | Wet: 75 °C<br>Dry: 90 °C |
| Code | ****RHW**<br>*****RHW, RHH, USE** | **RHW, RHH, USE** |

**ENGLISH**

| | Rubber-Neoprene | XLP |
|---|---|---|
| Insulation | ****SBR Rubber**<br><br>***Ethylene Propylene<br>**(EP) Rubber**<br><br>Thickness (in.)<br>12-10: 3/64 or 0.045<br>8-2: 4/64 or 0.060<br>1-4/0: 5/64 or 0.080 | **Cross-Linked**<br><br>Thickness (in.)<br>12-10: 3/64 or 0.045<br>8-2: 4/64 or 0.060<br>1-4/0: 5/64 or 0.080 |
| Jacket | **Neoprene**<br>ASTM D 752<br><br>Thickness (in.)<br>12-2: 2/64 or 0.030<br>1-4/0: 3/64 or 0.045 | None |
| Max. Normal Operating Temperature | **167F<br>***194F | Wet: 167F<br>Dry: 194F |
| Code | ****RHW**<br>*****RHW, RHH, USE** | **RHW, RHH, USE** |

**(c) Aboveground Cable.** The cables specified for Underground applications may be used for above ground applications.

Furnish with PVC insulation without nylon jacket or thinner XLP-insulated, as applicable, and as follows:

**METRIC**

| | PVC (Without Jacket) | XLP |
|---|---|---|
| Insulation | Thickness (mm)<br>3.30 - 5.26 $mm^2$: 1.14<br>8.38 - 33.6 $mm^2$: 1.52<br>42.4 - 107.2 $mm^2$: 2.03 | **Cross-Linked Polyethylene**<br><br>Thickness (mm)<br>3.30 - 5.26 $mm^2$: 0.76<br>8.38 - 33.6 $mm^2$: 1.14<br>42.4 - 107.2 $mm^2$: 1.40 |
| Jacket | None | None |
| Max. Normal Operating Temperature | Wet: 75 °C<br>Dry: 90 °C | Wet: 75 °C<br>Dry: 90 °C |
| Code | THW | XHHW |

**ENGLISH**

| | PVC (Without Jacket) | XLP |
|---|---|---|
| Insulation | Thickness (in.)<br>12-10: 3/64 or 0.045<br>8-2: 4/64 or 0.060<br>1-4/0: 5/64 or 0.080 | **Cross-Linked Polyethylene**<br><br>Thickness (in.)<br>12-10: 0.030<br>8-2: 0.045<br>1-4/0: 0.055 |
| Jacket | None | None |
| Max. Normal Operating Temperature | Wet: 167F<br>Dry: 194F | Wet: 167F<br>Dry: 194F |
| Code | THW | XHHW |

**(d) Cable Duct.** When indicated, furnish cable, preinstalled in a polyethylene Schedule 40 plastic conduit conforming to Nema TC-7. Provide cable conductors and stranding, as specified for Underground Cable, with cable insulation RHW/RHH/USE, and with insulation thickness as specified above.

**(e) Application, Testing, and Shipping.**

- Utilize acceptable cable as follows:

  With luminaires 90 °C (194F)
  Other uses 75 °C (167F)

- Show the name of the manufacturer, conductor size in $mm^2$ (AWG or MCM), and cable voltage rating on the outer cable covering with the code clearly printed or molded on the sheath.

- Manufacture, inspect, and test cable, according to the latest issues of ICEA Publications.
- Submit certification of these tests identifying each cable reel with the test data supplied.
- Ship cable on reels, plainly and indelibly marked with the name of the manufacturer, gross, net and tare masses, size, type, voltage rating, and length of cable per reel.
- Ship on a reel having a minimum drum diameter not less than 14 times the nominal cable diameter.
- Seal cable ends against entrance of moisture.
- Provide a covering of heavy cardboard, burlap, or lagging to protect the cable during handling or shipping.

**1101.09 CONDUIT**—Furnish conduit and protective coating for conduit.

**(a) General.** Furnish PVC and fiberglass conduit, conduit fittings, and conduit elbows and expansion fittings from the same manufacturer. Provide expansion/deflection fittings required for structures as shown on Standard Drawing BC-721M (BC-721). Use cement labeled by or recommended by the conduit manufacturer.

If metal conduit bodies and fittings are specified and hot dipped galvanized parts are not available, apply two coats of zinc paint as specified in Section 910.3(r).

Provide manufactured sweep bends or as specified in Section 910.3(g).

**(b) Direct Burial.**

**1. Polyvinyl Chloride (PVC) Conduit.** Provide Schedule 40; 90 °C (194F), UL-listed conduit conforming to NEMA Standard TC-2 (EPC-40-PVC), with fittings conforming to NEMA Standard TC-3 (EPC-40-PVC).

**2. Fiberglass Reinforced Epoxy Conduit.** Provide UL-rated conduit conforming to NEMA Standard TC-14, Part B; and as follows:

- Filament wound
- Minimum glass content of 68%
- Minimum tensile strength of 76 MPa (11,000 pounds per square inch)
- Containing carbon black for ultra-violet protection.

**(c) Concrete Encased or Exposed.** Provide one of the following:

**1. Rigid Steel Conduit.** Hot-dipped galvanized, inside and outside; and conforming to ANSI C80.1 and Federal Specification WW-C-581E. Provide hot-dipped galvanized conduit bodies and fittings.

**2. Polyvinyl Chloride (PVC) Conduit.** As specified in Section 1101.09(b) for Direct Burial Conduit.

**3. Fiberglass Reinforced Epoxy Conduit.** As specified in Section 1101.09(b) for Direct Burial Conduit.

**(d) Conduit Sleeve – Jacked, Augered, or Bored Conduit.** Rigid steel conduit, as specified for concrete encased or exposed conduit.

**1101.10 JUNCTION BOXES AND BURIED CABLE AND CONDUIT MARKERS—**

**(a) Junction Boxes.** Furnish as shown on the Standard Drawings for the type indicated, and as follows:

- **Concrete Junction Boxes.** Provide cast-in-place boxes made from Class A cement concrete as specified in Section 704; or provide precast boxes as specified in Section 714. Provide frames as specified in Section 605. Refer to Standard Drawings RC-81M and RC-82M for details of junction boxes JB-1, 2, 11, and 12.

- **Cast iron or Welded Steel Plate Junction Boxes.** Provide boxes as specified in Section 605. Provide boxes hot-dipped galvanized as specified in Section 1105.02(s) (ASTM A 123/A 123M) after fabrication. Provide a cover with a closed cell neoprene gasket with screws to secure cover. Provide a factory installed grounding stud and hex nut in rear of the box, as applicable. Refer to Standard Drawing BC-721M for junction box JB-25 details.

**(b) Buried Cable and Conduit Markers.** Furnish cast-in-place or precast, Class A cement concrete markers as shown on the Standard Drawings. Form letters and arrows by making depressions in the plastic concrete. Refer to Standard Drawing RC-84M for marker details.

**1101.11 POWER SUPPLY**—Furnish the power supply, consisting of:

**(a) Service Poles.**

- Conforming to ANSI specifications.

- Of Western Red Cedar, Southern Yellow Pine, or equal.

- Minimum size, as listed under Class 4.

- Minimum length of 9 m (30 feet).

- Impregnate with non-leaching, waterborne preservative Chromated Copper Arsenate (CCA), Type C, conforming to AWPA-P5, preservative applied in closed cylinder by pressure process according to AWPA-C4. Provide retention of CCA dry salts of 10 kg/m$^3$ (0.60 pounds per cubic foot) (Oxide basis). Approved trade names: Chrom-Ar-Cu; Osmose K-33C; Wolman CCA, and Wolmanac CCA. Include treatment certification with each shipment.

**(b) Photoelectric Control Device.**

- Photo cell of the cadmium-sulphide type with fail-safe in the "On" position.

- Weatherproof pheonolic, cycolac, or acrylic plastic housing, not susceptible to distortion, discoloration, cracking, or crazing.

- Adaptable for pole-top or cross-arm mounting in a plug-in, locking-type receptacle, conforming to UL Specification 773.

- Rated 1,800 VA.

- Control unit, with a built-in surge protective device for protection from induced high voltage and follow-through currents, and having a turn-off time delay to prevent false turn-off, due to lightning, stray lighting, or flashing lights.

- Designed to operate at the required voltage, and to operate satisfactorily at -29 °C (-20F) ambient temperature, with performance characteristics equal to, or exceeding, EEI and NEMA standards.

A separate photoelectric cell conforming to the above requirements may be installed as an integral part of each luminaire assembly, as a substitute for the above, when indicated.

**(c) Control Cabinet (Enclosure).** As shown on the Standard Drawings and as follows:

**1. Cabinet Construction.** Conforming to one of the following:

- Code gage stainless steel, ASTM A 167, Type 304.
- Code gage aluminum sheet alloy, No. 5052-H32, having mechanical properties of not less than ASTM B 209/B 209M.

**2. Other Requirements.**

- NEMA 3R or 4.
- Having closed cell neoprene gasket, welded seams, continuous hinge with stainless steel pin, and stainless steel external hardware.
- Having a backboard for mounting apparatus.
- Having two weep holes in the bottom.
- Equipped for padlocking. Provide acceptable outdoor, tumbler-type padlocks, keyed as directed. Furnish two keys with each lock.
- Having manufacturer's nameplate.

**(d) Main Disconnect.** Two-pole, 10000 A.I.C. minimum, molded-case circuit breaker, with lugs and capacity to accommodate the specified conductors and current, and conforming to Federal Specification W-C-375b. If greater interrupting capacity is required by the local utility, the main disconnect may be a fused device.

**(e) Lightning Arrester.** Rated for an operating voltage of 650 V, rms, with a bracket for mounting on the control cabinet backboard.

**(f) Lighting Contactor.** Magnetic, 600 V, two-pole lighting contactor with coil and contacts rated as specified.

**(g) Selector Switch (for the Photoelectric Control Contactor).** Provide a 600 V, three position (automatic-off-manual), maintained-contact control station.

**(h) Distribution Circuit Breakers.**

- Minimum rating of 10000 A.I.C.
- No fuse, quick-make, quick-break type; having tumbler mechanism, full contact, and positive pressure until opening, whether operated automatically or manually.
- Stationary contacts as an integral breaker part and nonwelding contacts when operating.
- Trip free from handle so the contacts cannot be held closed against short circuit or abnormal overload.

- Mounted individually or in a panel.
- Handle position, indicating the breaker contact position.
- Size and capacity, as indicated

**(i) Circuit Breaker Panels.** Enclosure mounted panel with solid neutral; and with bus bars and solderless lugs of large enough rating and size to accommodate the required voltage, current, and conductors.

**(j) Ground Rod.** Copper-clad steel, UL listed. Provide with bronze clamp or exothermic weld for connection to grounding conductor.

**(k) Transformers (Less Than or Equal to 25 KVA).**

- Secondary windings for three-wire unbalanced circuits.
- Step-up or step-down as indicated.
- Copper or aluminum windings.
- Totally enclosed nonventilated outdoor type.
- Enclosure degreased, primed, and finished with a coat of outdoor enamel.
- Core and coil assembly encapsulated with an epoxy compound for transformers rated 25 KVA and less.
- Insulation of Class F material that does not exceed 115 °C (239F) raise above a 40 °C (104F) ambient, when tested according to ANSI and NEMA Standards.
- Terminal compartment located in the transformer bottom, with provisions for side or bottom, conduit entrance.
- Certified copy of results required for transformer temperature, performance, and sound tests, conforming to ANSI and NEMA Standards.

**(m) Guy Anchor Assembly.** Single down guy consisting of:

- A cone-type anchor having a diameter of not less than 300 mm (12 inches).
- A 20 mm (3/4-inch) thimble-eye, anchor rod.
- A 13 mm (1/2-inch), seven-strand, galvanized steel, guy wire.
- Three bolt, heavy-duty, guy clamps.
- A strain insulator.
- Strain and load plates on the pole.
- An angle thimble-eye through bolt of the required length.
- Curved washer and nuts.
- Hardware, galvanized as specified in Section 1105.02(s) (ASTM A 123/A 123M) or other acceptable method conforming to the thickness, adherence, and quality requirements of ASTM A 153/A 153M.

**1101.12 MISCELLANEOUS MATERIAL**—Furnish as follows:

**(a) Hardware** Stainless-steel or hot-dipped galvanized, as directed.

**(b) Shims.** Stainless steel, nonmagnetic, 300 Series, or acceptable aluminum.

**(c) Pulling Lubricant.** As recommended by the cable manufacturer.

**(d) Cable Tags.** Acceptable, nonconducting.

**(e) Plastic Marking Tape.** Provide one of the following or approved equal:

- "Allen Marking Tape" (Allen Systems Inc.)
- "Brady Identoline Tape" (W.H. Brady Co.)
- "Terra Tape" (Reef Industries Inc.)

**(f) Ground Rod.** As specified in Section 1101.11(j).

# SECTION 1102—SIGN LIGHTING

**1102.01 GENERAL REQUIREMENTS**—Section 1101.01

**1102.02 LUMINAIRES—**

**(a) Light Fixture.** Furnish a mercury vapor light fixture having:

- An aluminum mounting bracket, when specified.
- Positive door closure by use of stainless steel latches and hinges.
- Cast aluminum housing and door assembly.
- A refractor and door assembly with nonpermanent-set gasket material.
- Thermal and shock resistant borosilicate glass refractor.
- Weep holes in the lowest area of the luminaire housing bottom when mounted.
- Polished aluminum reflector.
- Conduit entries in the luminaire assembly.
- Constant-wattage ballast, either integral or remote mounted.

Furnish luminaires of one of the following types, or equal:

- Holophane PANL XXX MV MT N D G with mounting bracket #4 BOLT.
- General Electric V2FSXXCOC1SSN4GR with photometric 35-178374 and mounting plate MP-V2FS.
- Crouse-Hinds Type SLS with remote ballast or Type ISL with integral ballast. Mount Type SLS luminaire on a 35 mm (1 1/4-inch) diameter conduit with locking set screw. Mount Type ISL luminaire with appropriate mounting plate to twin angles. Remove drain screw in bottom of reflector.

**(b) Mercury Vapor Lamps.** Furnish 175 W or 250 W deluxe white lamps, as indicated, with a minimum rated life of 24 000 hours.

**(c) Ballasts.** Furnish 120/240 V, 60 Hz ballasts, as follows:

- Weatherproof, UL approved, constant wattage type; to operate a mercury vapor lamp.
- With a power factor of not less than 90%, providing lamp starting down to -29 C (-20F) ambient temperature.
- With starting line current not to exceed the operating current.
- With lamp wattage change not to exceed ±5% with ±10% input voltage variation.

**(d) Fittings.** Furnish:

- Washers to level and adjust the luminaires on the supports, and made of the same material as the supports.
- Fittings at the entry into the luminaires made of a standard, factory-made, watertight design.

**1102.03 CIRCUIT BREAKERS, PANELS, AND ENCLOSURES**—Furnish the following:

**(a) Circuit Breakers.** Section 1101.11(h)

**(b) Circuit Breaker Panels.** Section 1101.11(i)

**(c) Enclosures.** Section 1101.11(c) and as follows:
Provide enclosures with dimensions that provide code clearance and wiring space for the specified control apparatus.

**1102.04 CONTROLS**—Furnish the following controls:

**(a) Photoelectric Control Device.** Section 1101.11(b)

**(b) Control Contactor.** Magnetic control contactor, 600 V, two-pole, 60 A, with a 120 V or 240 V operating coil.

**(c) Selector Switch.** Section 1101.11(g)

**1102.05 LIGHTNING ARRESTER**—Section 1101.11(e)

**1102.06 JUNCTION BOXES**—Section 1101.10:

**1102.07 CABLE**—Section 1101.08 and as follows:
Provide Type TC, Tray Cable, with XHHW insulation and a PVC jacket, for cable from the sign enclosure to the luminaire.

**1102.08 CONDUIT**—Section 1101.09

**1102.09 MISCELLANEOUS MATERIAL**—Section 1101.12 and as follows:

**(a) Service Poles.** Section 1101.11(a)

**(b) Ground Rod.** Section 1101.11(j)

**(c) Guy Anchor Assembly.** Section 1101.11(m)

**(d) Fittings.** Provide standard, factory-made, watertight fittings at enclosures, junction boxes, conduits, and service heads.

# SECTION 1103—TRAFFIC SIGNING AND MARKING

**1103.01 GENERAL REQUIREMENTS—**Certify material, as specified in Section 106.03(b)3.

**1103.02 EXTRUDED ALUMINUM CHANNEL SIGNS (FOR POST MOUNTED SIGNS, TYPES A AND E AND STRUCTURE MOUNTED)—**

**(a) Extruded Aluminum Channels.** As shown on the Standard Drawings.

Use channels conforming to ASTM B 221/B 221M, Alloy 6063-T6, from a manufacturer listed in Bulletin 15.

Use continuous-channel sections equal to the sign width. The channel section is nominal. The Contractor may use an alternate extruded channel section of equal or greater section moduli with dimensions suitable to utilize the mounting hardware with written permission.

**(b) Coating Treatment.** Use a chemical conversion coating, such as Alodine No. 1200, Alodine No. 1200S, or Bonderite No. 781.

Apply the coating to the channel surfaces to ensure a good bond between the reflective sheeting material and the surface. Coat according to Military Specification, MIL-C-5541E, "Chemical Conversion Coatings on Aluminum and Aluminum Alloys." Do not handle with bare hands between the chemical conversion coating process and the application of the reflective sheeting. Handle by special devices or by hand wearing clean PVC gloves.

**(c) Reflective Sheeting.** Use precolored Type III or Type IV sheeting, conforming to the Department's specification for Retroreflective Sheeting Materials and Process Inks for Traffic Control, from a manufacturer listed in Bulletin 15.

Apply the sheeting to the face and a 10 mm (3/8-inch) width along both edges of the channel sections, using a procedure specified by the sheeting material manufacturer. Apply free of bubbles or wrinkles greater than 75 mm (3 inches) in length and with total sheeting shrinkage of not more than 3.2 mm (1/8 inch). A maximum of one splice may be made in the sheeting for any channel section. Make the splice perpendicular to the longitudinal centerline of the channel, with the edges of adjacent pieces butted together throughout the entire seam length, without any overlap or separation. If covered sections are stacked before sign fabrication, then use microfoam between sign faces and store sections in a vertical position.

**(d) Legend and Border.** Use direct-applied cutout Type IX reflective sheeting material for letters, numerals, accessories, borders, and symbols.

**(e) Sign Fabrication.** Apply the reflective sheeting, then firmly bolt channels together with the webs in the same plane, to form a smooth and uniform surface. Adjust channel ends for correct position so the edges are free from projections.

Securely fasten assembled sign panels to a rigid framework, before application of legend and before shipment. Lay out the legend and border on the sign face as indicated on the sign fabrication drawings.

Apply cutout Type IX legend and border to sign face according to manufacturer's instructions.

Fabricate signs in a single unit. If necessary, ship large signs sectionalized in panels. When shipping sectionalized signs, slit any legend and border, which overlaps the panels.

**(f) Sign Identification.** Fabricate the plaques of aluminum, plastic, or fiberglass of sufficient thickness to provide the necessary stiffness and to resist vandalism, or stencil directly on the sign panel with weather-resistant paint. Indicate sign number and the month and year of erection in 25 mm (1-inch) high characters of a contrasting color to the background, and affix to the rear of the sign in the lower righthand corner when viewed from the back. If rivets are used to attach plaques, use 3.2 mm (1/8-inch) aluminum rivets inserted from the sign face.

**1103.03 FLAT SHEET ALUMINUM SIGNS WITH STIFFENERS (FOR POST MOUNTED SIGNS, TYPES A, D, AND E; AND STRUCTURE MOUNTED SIGNS)—**

**(a) Flat Sheet Aluminum.** Use aluminum as specified in Section 1103.04(a) with a minimum thickness of 2.03 mm (0.080 inch).

Fabricate panels from a single aluminum sheet or from a number of pieces, making every effort to minimize the total length of joints. Locate joints so the legend does not straddle two or more aluminum sheets, whenever possible. Use sheets with a minimum width of 1200 mm (48 inches), wherever possible. Use continuous sheets for the full width of signs less than 3.6 m (12 feet) wide or for the full height of signs less than 3.6 m (12 feet) high. Use sheets free of buckles, warps, or dents. Remove burrs.

**(b) Coating Treatment and Reflective Sheeting.** Sections 1103.02(b) and (c), except as follows:

Apply the sheeting only to the face of the sign. A maximum of one splice in the reflective sheeting will be allowed on an aluminum sheet.

**(c) Legend and Border.** Section 1103.02(d)

**(d) Extruded Aluminum Stiffeners, and Splice Bars.** As shown on the Standard Drawings and as follows:

Manufacture channels from aluminum, conforming to ASTM B 209/B 209M, Alloy 6061-T6.

Use large stiffener sections in 4.9 m (16-foot) lengths and medium stiffener sections in 3.6 m (12-foot) lengths. An alternate cross section of equal or greater section modulus than that indicated may be used with written permission.

**(e) Sign Fabrication.** Stiffener sections may end at a maximum of 75 mm (3 inches) from each sign edge. If the sign is more than 150 mm (6 inches) wider than the length of a full-length stiffener section, then splice two sections together, using 4.8 mm (3/16-inch) rivets, as shown on the Standard Drawings, to form a longer composite section. Position the splice so it is not on or within 380 mm (15 inches) of a sign post or within the center half of the span between sign posts. Stagger splices on adjacent sign stiffeners as much as possible. The aluminum sheeting may extend above the top stiffener or below the bottom stiffener for a maximum distance equal to one-third of the spacing between the stiffeners. If using an exit panel, use a stiffener on both the primary sign top and on the exit panel bottom.

Use 4.8 mm (3/16-inch) aluminum rivets at a maximum spacing of 150 mm (6 inches) and end rivets within 25 mm (1 inch) of the end of the stiffener. Hold the aluminum sheet firmly against the stiffener section while holes are drilled and rivets are expanded.

If the aluminum sheets are placed with the long dimension vertical or if a single large section stiffener or a single flanged medium section stiffener is used to join two panels together, then it may be necessary to have the flat sheet aluminum clamped to the stiffener section while the holes are drilled. Then, disassemble the sign for shipping. If disassembled, then remove burrs around the drilled holes to facilitate handling and to ensure a tight connection.

If exit panels cannot be supported by two sign posts, brace the panel with one or more auxiliary supports. Bolt the supports to a minimum of three stiffeners on the primary sign by use of clips.

If a single stiffener section is not used to join two adjacent panels together use butting plates, as shown on the Standard Drawings. Place butting plates at the left and right edges of the sign and at intervals not greater than 900 mm (36 inches) throughout the length of horizontal joints between the posts. Use either twist-in bolts or standard-connection bolts and plastic inserts to fasten the butting plates.

For joints between aluminum sheets, without a stiffener on the joint, fasten lightweight aluminum sheets with 3.2 mm (1/8-inch) aluminum rivets to the sign back.

Use twist-in toggle and buckle straps, or post clips, on stiffener sections at each post.

Lay out the legend and border on the sign face according to the sign fabrication drawings.

Apply cutout Type III or Type IV legend and border to sign face according to manufacturer's instructions.

Fabricate signs in a single unit. If necessary, ship large signs sectionalized in panels Slit any legend and border, which overlaps the panel, when shipping sectionalized signs.

**(f) Sign Identification.** Section 1103.02(f)

**1103.04 FLAT SHEET SIGNS (FOR POST MOUNTED SIGNS, TYPES B, C, AND F; AND DISTANCE MARKER(S)—**

**(a) Blanks.** Use aluminum blanks. For signs furnished under Section 901, use plywood, aluminum, acryonitrite butadiene styrene (ABS), aluminum/plastic laminate, corrugated polypropylene, or polyethylene blanks.

Physical and chemical properties of plywood and aluminum blanks are to conform to Publication 306M.

**(b) Coating Treatment.** Prepare sign faces with appropriate coating conforming to Publication 306M.

**(c) Reflective Sheeting.** Use sheeting from a manufacturer listed in Bulletin 15.

**1. General.** Apply the sheeting to the sign face using a procedure according to the sheeting manufacturer, free of bubbles or wrinkles greater than 75 mm (3 inches) in length, and with total sheeting shrinkage of not more than 3.2 mm (1/8 inch).

On signs larger than 1200 mm (48 inches) on the shorter side, sheeting may be spliced with the edges of adjacent pieces butted together throughout the entire seam length without any overlap or separation.

Use Type III or Type IV sheeting for all signs.

**(d) Ink.** As recommended by the manufacturer of the reflective sheeting.

**(e) Electronic Cuttable (EC) Film.** Use film from a sheeting manufacturer listed in Bulletin 15. Apply the sheeting to the sign face using a procedure according to the sheeting manufacturer, free of bubbles or wrinkles greater than 25 mm (1 inch) in length.

**(f) Legend and Border.** Apply legend and border of the color, size, and dimensions shown in Publication 212, Publication 213, and the MUTCD or as indicated. Use silk screens with a mesh of 12XX or finer for reverse screening. Use stencils with sharp clear-cut edges, uniform curvature, and straight lines. Silk screen in a manner resulting in uniform color and tone, with sharply-defined edges and without blemishes on the sign background. Air dry or bake signs after silk screening to achieve a smooth hard finish. Blisters appearing during the drying process will be cause for rejection. If direct-applied legend is indicated for any directional or destination sign, use Type III or Type IV reflective sheeting. Slip-sheet and pack signs to ensure delivery in an undamaged condition.

**1103.05 DELINEATION DEVICES**—Not used.

**1103.07 STEEL S OR W BEAM POSTS AND BREAKAWAY SYSTEM (FOR POST MOUNTED SIGNS, TYPE A)—**

**(a) Steel S or W Beam Posts.** As shown on the Standard Drawings.

**(b) Breakaway System.** As shown on the Standard Drawings and as follows:

**1. Couplings.** Alloy steel AMS 6378D with:

- Minimum tensile yield stress of 896 MPa (130,000 psi).
- Ultimate tensile strength of 1034 MPa (150,000 psi).
- Minimum Rockwell C hardness of 32.
- Capable of withstanding a tensile breaking load of 182.4 kN (41,000 pounds).

**2. Hinge Plates.** Alloy steel AISI 4130, 4340, or an equivalent material with a minimum tensile yield stress of 482 MPa (70,000 pounds per square inch), an ultimate tensile stress range of 620 MPa (90,000 pounds per square inch) to 745 MPa (108,000 pounds per square inch), and a tensile breaking load, in kilonewtons (pounds), as follows:

| | |
|---|---|
| Model SBHB1B | 51 min. (11,450 min.) |
| Model SBHB2B | 73 min. (16,400 min.) |

**3. Brackets.** Aluminum alloy ASTM B 221/B 221M, Alloy 6061-T6 or equal, with a load-concentrating boss of stainless steel, ASTM A 582/A 582M, Type 416, or equal.

**4. Bolts, Nuts, and Washers.**

**4.a Hinge Plates.** AISI 4130 Steel. Galvanized as specified in Section 1105.02(s), ASTM A 153.

**4.b Brackets.** ASTM B 209; Alloy 6061-T6.

**5. Anchor.** Type 304 stainless steel ferrule with 1053 steel rod and coil.

**6. Coupling Bolts.** AMS 6378D, galvanized as specified in Section 1105.02(s), ASTM A 153/A 153M.

**(c) Fabrication.** Cut, drill or punch holes in parts or members, before galvanizing. Furnish a statement, before the beginning of galvanizing, showing the carbon content of the steel to be galvanized. Hot-dip galvanize posts and hardware after fabrication, as specified in Section 1105.02(s). Bolts, nuts, and washers to be galvanized according to ASTM B 695 and B 696 (AASHTO M 298 and M 299) and conforming to the coating thickness, adherence, and quality requirements of ASTM A 153/A 153M (AASHTO M 232).

## 1103.08 BREAKAWAY STEEL POSTS (FOR POST MOUNTED SIGNS, TYPE B AND DISTANCE MARKERS)—

**(a) Steel Channel Bar Posts.** As shown on the Standard Drawings and as follows:

Roll posts from standard carbon steel rails, ASTM A 499, with a minimum tensile strength of 620 MPa (90,000 pounds per square inch) and a minimum yield strength of 415 MPa (60,000 pounds per square inch) or new billet steel equivalent with a minimum tensile strength of 620 MPa (90,000 pounds per square inch) and a minimum yield strength of 415 MPa (60,000 pounds per square inch). Cast heat analysis of new billet as follows:

| Element | Composition (%) |
|---|---|
| Carbon | 0.67 to 0.82 |
| Manganese | 0.70 to 1.10 |
| Phosphorus, max. | 0.04 |
| Sulphur, max. | 0.05 |
| Silicon | 0.10 to 0.25 |

Roll bars to the required shape, dimensions, and mass (weight).

Drill or punch holes for mounting. Additional holes on 25.4 mm (1-inch) centers available for punching are allowed. After fabrication, paint green according to ASTM G 154 using Federal Color No. 595.14062; electrostatically coat with a green polyester coating as specified in Section 1103.08(c); or hot-dip galvanize as specified in Section 1105.02(s) (ASTM A 123/A 123M).

**(b) Steel Square Posts.** As shown on the Standard Drawings and as follows:

**1. Material.** Roll formed and conforming to one of the following:

- Cold rolled steel in 3.4 mm (10 gage (0.135-inch)) or 2.7 mm (12 gage (0.105-inch)) with a minimum yield strength of 230 MPa (33,000 pounds per square inch) and a minimum tensile strength of 310 MPa (45,000 pounds per square inch), conforming to the chemical and mechanical requirements of ASTM A 653/A 653M and ASTM A 924/A 924M, Grade 230 (Grade A).

- Hot rolled carbon sheet steel in 2.7 mm (12 gage (0.105 inch)) or 1.9 mm (14 gage (0.083-inch)) with a minimum yield strength of 415 MPa (60,000 pounds per square inch) and a minimum tensile strength of 515 MPa (75,000 pounds per square inch), conforming to the chemical requirements of ASTM A 1011/A 1011M, Grade 55.

- Cold rolled steel in 1.9 mm (14 gage (0.075-inch)) with a minimum yield strength of 415 MPa (60,000 pounds per square inch) and a minimum tensile strength of 480 MPa (70,000 pounds per square inch), conforming to the chemical requirements of ASTM A 1008/A 1008M.

**2. Fabrication.**

- Corner weld and scarf as necessary to allow sections to telescope within each other.

- Space 11.1 mm (7/16-inch) diameter cut holes or knockout holes on 25.4 mm (1-inch) centers, on the centerline of all four sides, in true alignment, and opposite to each other.

**3. Protective Coating.** Apply after fabrication using one of the following methods:

**3.a Method 1.** Galvanize or coat the inside and outside as specified in Section 1105.02(s) (AASHTO M 111). Either of two alternate coating systems may be used as follows:

- **Outside.** Apply a hot-dipped coating of zinc, according to ASTM B 6, at a minimum rate of 0.305 kg/m$^2$ ± 0.030 kg/m$^2$ (1.0 ounce per square foot ± 0.1 ounce per square foot) of actual surface area; a chromate conversion coating at a rate 46.5 mg/m$^2$ ± 23.25 mg/m$^2$ (30 micrograms per square inch ± 15 micrograms per square inch) of actual surface area; and a thermoplastic, electrostatically applied acrylic or polymer coating, 0.013 mm ± 0.005 mm (0.5 mil ± 0.2 mil) in thickness, and

- **Inside.** Apply a zinc based coating, 0.013 ± 0.005 mm (0.5 ± 0.2 mil) in thickness, at a rate of 0.092 kg/m$^2$ ± 0.0153 kg/m$^2$ (0.3 ounce per square foot ± 0.05 ounce per square foot) with a minimum of 80% zinc powder by mass (weight).

**3.b Method 2.** Apply a triple coating of zinc, conforming to AASHTO M 120, having a mass (weight) of 0.183 kg/m$^2$ ± 0.046 kg/m$^2$ (0.60 ounce per square foot ± 0.15 ounce per square foot), to the outside of posts after fabrication. Apply a chromate conversion coating of 23.25 mg/m$^2$ ± 7.75 mg/m$^2$ (15 micrograms per square inch ± 5 micrograms per square inch) and a clear organic exterior coating of 0.005 mm ± 0.003 mm (0.2 mil ± 0.1 mil) following the zinc application. Provide a double, in-line application of a full zinc-based organic coating of 0.030 mm ± 0.015 mm (1.2 mils ± 0.6 mils) for the inside surface, tested according to ASTM B 117.

**3.c Method 3.** Galvanize inside and outside according to ASTM A 653/A 653M and ASTM A 924/A 924M, coating designation Z275 (G90), by hot-dip method before fabrication. Provide zinc-coating to corner welds after scarifying operations.

**(c) Polyester Post Coating.**

**1. Powder Composition.** As follows, or of sufficiently similar composition to meet the specified testing requirements:

- Polyester Resin (molecular weight equivalent 2,000-5,000) 40%-75%
- Blocked-Isocyanate Curing Agent (molecular weight equivalent 1,000-3,000) 10%-25%
- Flow Control Agent (acrylo-terpolymers) 0.1%-2.0%
- Exterior-Durable Grade Pigment and Extender 25%-50%
- Organic Volatile Content 3% Max.

**2. Pretreatment.** Blast clean steel posts to near white with blast profile not greater than 0.051 mm (2 mils). Apply coating immediately after cleaning, as an electrostatically charged dry powder sprayed onto the grounded post, using an electrostatic spray gun.

**3. Color.** Green, unless otherwise specified.

**4. Physical Tests.** Test coating as follows:

- **Impact Test.** According to ASTM D 2794, showing no cracks or breaks when an impact of 11.3 N·m (100 inch-pounds) is applied.
- **Salt Spray.** No rust, blisters, or undercutting of uncoated or scribed areas apparent, when tested for 500 hours, according to ASTM B 117.
- **Film Thickness.** Thickness measured on a flat surface of the post, according to ASTM D 1186, 0.051 mm (0.002 inch) minimum.
- **Weatherometer.** No more than 15% gloss loss, when tested for 1,000 hours in a carbon arc weatherometer, according to ASTM G 152, Type EH.
- **Humidity.** No blistering of the coating nor gloss loss greater than 5%, when tested according to ASTM D 2247.

## 1103.09 TREATED WOOD AND COMPOSITE POSTS (FOR POST MOUNTED SIGNS, TYPES C AND E)—

**(a) Treated Wood Posts (for Post Mounted Signs, Types C and E).**

**1. Posts.** S4S No. 1 Dense or No. 1 Dense SR Southern Yellow Pine or No. 1 Douglas Fir-Larch, seasoned to a maximum of 19% moisture.

Grade and grade mark each post, before treatment, with an official grade stamp or inspection agency mark, certified by the Board of Review, American Lumber Standards Committee. Cut and drill before preservative treatment.

**2. Treatment.** Treat with Ammoniacal Copper Arsenite (ACA) or Chromated Copper Arsenate (CCA) Type A, B, or C meeting AWPA Standard P5. Use a minimum preservative retention of 6.4 kg/m$^3$ (0.40 pound per cubic foot) by assay (oxide basis). Treat and quality mark according to AWPA C2. Inspect according to AWPA Standards M1 and M2.

Include a treatment certificate with each shipment.

**(b) Composite Posts (for Post Mounted Signs, Type E).**

**1. Posts.** Unsaturated polyester resin reinforced with E-glass and lightweight aggregate concrete not greater than 1762 kg/m$^3$ (110 pounds per cubic foot) to form a rigid structural support member. Tensile modulus of tube to be not less than 1.7 x 10$^4$ MPa (2,500 kips per square inch). Posts to be equal to or greater in strength to Schedule 40 steel of the same diameter (ASTM A 53/A 53M).

**2. Weathering.** Post shall have less than 10% loss of strength after 3,600 hours of accelerated weathering exposure to moisture and lamps required in ASTM G 152, G 155 and G 154.

**3. Color.** Specified post color will be permanent throughout the FRP tube with not less than 38 µm (1.5 mil) dry film thickness. After 3,600 hours exposure according to ASTM G 152, G 155, and G 154, posts will exhibit 90% adhesion, ASTM D 4541 and a maximum color change of 25, Delta -E.

**1103.10 DELINEATOR POSTS**—Not used.

**1103.11 MISCELLANEOUS MATERIALS—**

**(a) Bolts and Nuts for Extruded Panel Sign Post-Clips.** Galvanized steel as specified in Section 1105.02(s); ASTM A 307 or A 325/A 325M.

**(b) Washers.**

**1. Aluminum.** Conforming to ASTM B 209/B 209M, Alclad 2024-T4

**2. Nylon.** 3.2 mm (1/8 inch) thick by 25 mm (1-inch) minimum outside diameter. Maximum allowable applied torque 54 N·m (480 inch-pounds).

**(c) Lock-Nuts and Lock-Washers for Extruded Panel Sign Post-Clips.** Galvanized as specified in Section 1105.02(s); ASTM A 307 or A 325/A 325M.

**(d) Post-Clips.** For extruded panel signs, aluminum, conforming to ASTM B 108, Alloy 356-T6. For flat sheet aluminum signs with stiffeners, stainless steel, Type 304, 1.9 mm (14 gage).

**(e) Auxiliary Supports for Exit Panels.** Aluminum conforming to ASTM B 211/B 211M, Alloy 6061-T6. 76 mm x 76 mm x 4.8 mm (3 inches by 3 inches by 3/16-inch) angle, 2 m (6 1/2 feet) long or long enough to attach to three stiffeners on the main sign.

**(f) Lag Screws.** M8 x 1.25 (5/16-inch) round head, galvanized steel as specified in Section 1105.02(s); ASTM A 307.

**(g) Rivets.** Aluminum, self-plugging or hollow-core, as follows:

- 4.8 mm (3/16-inch) for mounting reflective units and distance plaques—Alloy 5056 with 7178 mandrels.
- 4.8 mm (3/16-inch) for mounting flat aluminum sheets to stiffeners sections— Alloy 5056 with carbon steel mandrels.

Rivet size specified is the minimum shank diameter. Use rivets with sufficient grip range to attach to background sign material, stiffeners, or posts. Use a 5.40 mm (No. 10) drill for 5 mm (3/16-inch) rivets for attachment of stiffeners and splice bars.

**(h) Bolts, Nuts, and Washers for Flat Sheet Aluminum Signs with Stiffeners.** Stainless steel, Type 304 bolts. Use M8 x 1.25 x 25 (5/16-inch by 1 inch long) for butting plates and M8 x 1.25 x 50 (5/16-inch by 2 inches long) for post-clips. Use standard connection bolts or twist-in bolts.

**(i) Twist-in Toggle and Buckle Straps.** Stainless steel, Type 201, and 19 mm (0.75 inch) wide and 0.76 mm (0.03 inch) thick, with rounded edges. Spot welded, twist-in type toggle on end of strap. Spot welded, antirotational buckle on other end of strap. Toggles and buckles shall be stainless steel, Type 304, and 1.6 mm (1/16 inch) thick.

**(j) Butting Plates.** Fabricate from stainless steel, Type 304.

**(k) Anchors.** Section 1105.02(c)2. From a manufacturer listed in Bulletin 15.

**(m) Anti-Theft Sign Hardware.**

**1. System A.**

- **Bolts.** Section 1105.02(c)1 and as follows:
  Provide M8 x 1.25 x 65 (5/16 inch by 2 1/2-inch) steel carriage bolts with minimum 17.5 mm (11/16-inch) diameter round head, square neck, and threads to within 25 mm (1 inch) of head.
  Furnish bolts having a mechanically deposited cadmium coating, ASTM B 696, or zinc, Type I coating as specified in Section 1105.02(s).

- **Nuts.** Square, pyramidal-shaped nuts with all four sides sloping at an angle of 41 degrees; M8 x 1.25 (5/16-18 UNC threads); C-1010 cold-rolled steel, case hardened to Rockwell hardness of 55 to 60.
  Furnish nuts having a 0.05 mm to 0.13 mm (0.002 inch to 0.005 inch) thick, mechanically deposited, zinc, Type II yellow chromate coating as specified in Section 1105.02(s) (ASTM B 695), tested according to ASTM B 201.

**2. System B.**

- **Bolts.** Section 1103.11(o) and as follows:
  Provide M8 x 1.25 x 65 (5/16-inch by 2 1/2-inch) and M8 x 1.25 x 80 (5/16-inch by 3-inch) bolts with minimum 14.3 mm (9/16-inch) diameter one-way heads and threads to within 25 mm (1 inch) of head.

- **Nuts.** Section 1103.11(p) and as follows:
  Provide nuts, Alloy 2011-T3, double-chamfered hexagon with self-locking conical shape 14.3 mm (9/16-inch) - 9.5 mm (3/8-inch) by 5 mm (3/16-inch) unit under the nut with M8 x 1.25 (5/16-18 UNC) threads. Hexagon portion should break away from self-locking unit with 4.5 N·m (5/16-18 UNC) to 9 N·m (40 inch-pounds to 80 inch-pounds) of torque.

- **Washers.** Nylon 3.2 mm (1/8 inch) thick by 25 mm (1-inch) minimum outside diameter with 54 N·m (480 inch-pounds) maximum allowable applied torque.

**(n) Banding.** Stainless steel, Type 201, 19 mm (0.750 inch) wide by 0.76 mm (0.030 inch) thick, with rounded edges for handling ease and safety. Buckles and other necessary hardware shall be of stainless steel, Type 304.

**(o) Aluminum Bolts.** ASTM B 211/B 211M. Alloy 2024-T4, thread fit, ANSI Class 6g, and threads shall be within two threads of the head or a minimum of 45 mm (1 3/4 inches).

**(p) Aluminum Nuts.** ASTM B 211/B 211M. Alloy 2024-T6, thread fit, ANSI Class 6H (ANSI Class 2B, 18 UNC threads).

**1103.12 SIGN AND DISTANCE MARKER SUPPORTS—**

**(a) General.** Hot-dip galvanize steel, except stainless steel, after fabrication, as specified in Section 1105.02(s). Drill or punch holes and cut before galvanizing.

**(b) Brackets for Post Mounted Signs, Types C, D, and F.** ASTM A 283.

**(c) Bars for Post Mounted Signs, Types C, D, and E.** AASHTO M 270/M 270M (ASTM A 709/A 709M) Grade 250 (Grade 36).

**(d) Shims for Post Mounted Sign, Types C and E.** AASHTO M 270/M 270M (ASTM A 709/A 709M) Grade 250 (Grade 36).

**(e) Steel Pipe Supports for Post Mounted Signs, Types D and E.** ASTM A 53/A 53M.

**(f) Shapes and Plates for Post Mounted Signs, Type D.** AASHTO M 270/M 270M (ASTM A 709/A 709M) Grade 250 (Grade 36).

**(g) Angles (Aluminum) for Post Mounted Signs, Type E, and Structure Mounted Signs.** ASTM B 308/B 308M, Alloy 6061-T6.

**(h) Shim Bars and Plates for Post Mounted Signs, Type E.** AASHTO M 270/M 270M (ASTM A 709/A 709M) Grade 250 (Grade 36).

**(i) Brackets, Bars, Clamps, Strips, and Gussett Plates (for Erecting Distance Markers on Bridge Railing).** Stainless Steel, ASTM A 167.

**1103.13 DELINEATOR BRACKETS**—Not used.

**1103.14 REFLECTIVE GLASS BEADS—**

**(a) General.** Furnish reflective glass beads conforming to AASHTO M 247, except as follows:

**1. Gradation.** Satisfies the following gradation for type indicated:

| Sieve Size | Percent Beads Passing | | | |
|---|---|---|---|---|
| | Type A | Type B | Type C | Type D |
| 2.0 mm (10) | - | 100 | - | - |
| 1.7 mm (12) | - | 95 to 100 | 100 | - |
| 1.4 mm (14) | - | 80 to 95 | 95 to 100 | - |
| 1.18 mm (16) | 100 | 10 to 40 | 80 to 95 | 100 |
| 1.0 mm (18) | - | 0 to 5 | 10 to 40 | - |
| 850 µm (20) | - | 0 to 2 | 0 to 5 | 95 to 100 |
| 710 µm (25) | - | - | 0 to 2 | 65 to 90 |
| 600 µm (30) | 75 to 95 | - | - | - |
| 500 µm (35) | - | - | - | 10 to 45 |
| 300 µm (50) | 15 to 35 | - | - | 0 to 10 |
| 150 µm (100) | 0 to 2 | - | - | 0 to 5 |

**2. Rounds.** Provide glass beads with a minimum of 75% true spheres overall, a minimum of 70 % true spheres per sieve, and not more than 3% angulars overall.

**3. Coating.** Supply Types A, B, and D glass beads with coatings to enhance moisture resistance, embedment, and adherence with the binder. Supply Type C with coatings to enhance embedment and adherence.

# SECTION 1104—TRAFFIC SIGNALS

**1104.01 GENERAL REQUIREMENTS**—Comply with the requirements of associations, societies, codes, and regulations, as applicable.

Fabricate traffic signal structural material according to Section 1105 (steel members only), AWS, and the AASHTO Specifications; except, applying water to the base metal during plasma arc cutting is permitted. Bulletin 15 listing and shop inspection is required. Fabricators provide an AWS certified welding inspector (CWI) for welded aluminum pole products and for welded steel pole products as specified in Section 1105.01(g)3. Bulletin 15, shop inspection, and Section 1105 do not apply to painting of aluminum poles and for the following non-welded items: cast aluminum poles, cast steel poles, and cast iron poles.

Certify as specified in Section 106.03(b)3.

Permanently mark the following materials with the Manufacturer's Name, Serial Number, and Model or Part Number.

- Controller Units
- Conflict Monitors
- Flashers
- Relays
- Solid-State Load Switches
- Time Clocks
- Time-Based Coordinators
- Coordination Units
- Synchronizers
- Detector Amplifiers
- Detector Power Supplies
- Detector Sensors
- Interfaces
- Modems

Provide switches, controls, and indicators that are operable without the use of tools. Clearly and permanently identify the switches, controls, and indicators.

Furnish three copies of warranties, guarantees, instruction manuals, wiring diagrams, and parts' lists with each different type material. Also, provide in the controller assembly cabinet one instruction manual for each controller unit, time clock, and coordination unit.

Upon completion of a controller assembly, conduct a physical and functional shop test of the assembly's continuous, satisfactory operation, for not less than 5 days. Provide 300 W loads for signal circuit and simulated inputs for detectors, and interconnection. Certify that the equipment operates as indicated. Demonstrate and provide written documentation that the conflict monitor or malfunction management unit will cause transfer of the signals to flashing operation upon sensing all possible conflicting signal indications.

Label the load switch sockets and cable connectors for detector amplifiers, in the controller assembly, according to function.

All equipment which requires a separate device to set, adjust, or read the timing intervals, furnish plans or programs with one of these devices for each ten units or fraction thereof.

## 1104.02 TRAFFIC SIGNAL SUPPORTS—

### (a) General.

**1. Design and Acceptance.** Design according to the Department's "Criteria for the Design of Traffic-Related Structures." Submit shop drawings according to the Criteria, including calculations for all special structures, for review and acceptance.

**2. Supports.** Fabricate shafts and arms in any of the following shapes and styles:

**Round Tapered.**

- One longitudinal seam, continuously welded, and ground or rolled flush.
- Transverse butt welds are not acceptable.
- Uniform wall thickness.
- Uniform taper, 11.7 mm (0.14 inch) maximum and 5.8 mm (0.07 inch) minimum per meter (foot) of length.

**Round Stepped.**

- Round pipe sections, each with not more than one longitudinal seam continuously welded and ground or rolled flush. Join sections by a hot-swaged shrink fit continuously seal-welded to prevent entrance of water.
- Uniform wall thickness for each section.
- Maximum change in diameter between stepped sections not to exceed 54 mm (2 1/8 inches).

**Multi-Sided Tapered.**

- Maximum of two longitudinal seams, continuously welded, and ground or rolled to a maximum bead height of 3.2 mm (1/8 inch).
- Transverse butt welds are not acceptable.
- Uniform wall thickness.
- Uniform taper, 11.7 mm (0.14 inch) maximum and 5.8 mm (0.07 inch) minimum per meter (foot) of length.
- Minimum of eight sides.

**Round Untapered.**

- Maximum of one longitudinal seam, continuously welded, and ground or rolled flush.
- Uniform wall thickness and diameter.

- Transverse butt welds are not acceptable.

**3. Support Markings.** Stamp the Department approval number on the edge of the base plate of the shaft and the flange plate of the arm. Use letters of 12.7 mm (1/2-inch) minimum height and deep enough to provide clear readability after galvanizing.

**4. Cable Support.** Weld a cable support to the inside top of the shaft.

**5. Grounding.** Weld a UL-Listed grounding lug, capable of accommodating a 13.3 $mm^2$ (No. 6 AWG) stranded copper cable, to the inside of the shaft adjacent to the handhole.

**6. Handholes.** Provide a handhole in the shaft of the poles, as shown on the Standard Drawings. Reinforce the area to develop the minimum guaranteed yield strength of the shaft. Furnish a cover and keeper chain.

**7. Wire Inlets.** Provide a wire inlet at each signal head or at each electrically operated sign location. Weatherproof each inlet with an insulated grommet.

Provide a deburred hole, 63.5 mm (2 1/2-inch) minimum diameter, in the flange plate and shaft, that serves as a wire entrance into the arm from inside the shaft.

**8. Anchor Bases.**

- Fabricate the base clean, smooth, and of the dimensions necessary for adequate pole mounting and structural support.
- Provide holes for anchor bolts.
- Fabricate the base to telescope over the shaft and be secured in place by welding.

**9. Galvanizing.** Section 1105.02(s) and as follows:

Galvanize steel shafts and arms, including those manufactured of high strength and corrosion resistant steels, according to ASTM A 123 (AASHTO M 111). Galvanize accessories and hardware according to ASTM A 153 (AASHTO M 232).

**(b) Overhead Supports.** As shown on the Standard Drawings and as follows:

- Shaft and Arms—ASTM A 53/A 53M, A 252, A 595, or A 1008
- Luminaire Mounting Arms—Section 1101.03
- Anchor Bases—One piece steel, AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).
- Flange Plates, Gusset Plates, and Side Plates—AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).
- Flange Plate Assembly Bolts—ASTM A 325
- Shaft and Arm Caps—Galvanized steel (C-coat) cast iron or cast aluminum.

**(c) Pedestal Supports.** As shown on the Standard Drawings and as follows:

**1. Aluminum.**

- Support—One length, 114 mm (4 1/2-inch) minimum outside diameter aluminum pipe, Schedule 40, ASTM B 210/B 210M, or B 221/B 221M, Alloy 6063-T6.

- Bases—Cast aluminum, ASTM B 26/B 26M, or B 108, Alloy 356-T6; aluminum plate, ASTM B 209/B 209M, Alloy 6061-T6.

- Pole Tops—Aluminum

**2. Steel.**

- Support—One length, 114 mm (4 1/2-inch) minimum outside diameter steel pipe, Schedule 40, ASTM A 53/A 53M, Type F.

- Base—Steel casting, ASTM A 27/A 27M, Grade 450-240 (Grade 65-35); gray iron casting, ASTM A 126, Class B (Class 26); steel plate, AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).

**(d) Anchor Bolts.** As shown on the Standard Drawings and as follows:

- Anchor Bolts—ASTM A 449.

- Hex Nuts—ASTM A 563M/A 563 (AASHTO M 291)

- Washers—ASTM A 436 (AASHTO M 293)

Galvanize the top 200 mm (8 inches) of bolts and all associated hardware as specified in Section 1105.02(s) (ASTM A 153/A 153M), or by another acceptable method conforming to the coating thickness, adherence, and quality requirements of ASTM A 153/A 153M. Furnish template prints for setting anchor bolts with each support.

**(e) Span Wire.** ASTM A 475, Class A, Siemens-Martin, or ASTM B 416.

**(f) Tether Wire.** ASTM A 475, Class A, Siemens-Martin, or ASTM B 416.

**(g) Lashing.** As shown on the Standard Drawings for attaching cable to span wire.

## 1104.03 CONTROLLER ASSEMBLY—

**(a) Controller Unit.**

**1. Electromechanical Pretimed.**

**1.a NEMA Standards.** NEMA TS l, Section 2 - Environmental Standards and Test Procedures, except temperature.

**1.b Operational Requirements.**

**1.b.1 Dial.**

- Temperature Range— -34 °C to 74 °C (-29F to 165F) minimum.

- Type—Plug in.

- Cycle Duration—30 seconds to 120 seconds, in 5-second increments, up to 90 seconds, and 10-second maximum increments, above 90 seconds.

- Cycle Gears—For each controller unit, provide a set of timing gears to obtain cycle lengths from 60 seconds to 100 seconds in 10-second increments. If other cycle lengths are specified, provide additional timing gears as required.

- Dial Divisions—100 positions.

- Keys—Self locking; minimum of 11 advance, one release, and three offset.

- Motor—One per dial; 6 W, synchronous, self-start.

- Splits—One per dial, minimum.

- Settable Offsets—Three per dial, adaptable to dial control.

**1.b.2 Camshaft.**

- Temperature Range— -34 °C to 74 °C (29F to 165F) minimum.

- Signal Circuits—10 A at 120 V rating; fine silver contacts, rated for a minimum of 1 000 000 operations, functioning at two times per minute; 12 minimum circuits; wire for 19 circuits, including terminal blocks.

- Intervals—12 minimum.

- Actuation Period—200 milliseconds at 30 W.

**1.b.3 Chassis.**

- Expansible—To three dials.

- Material—Corrosion resistant

- Connector—MS or Jones Type.

- Dust Cover—With dials visible.

- Grounding—With ac ground isolated from chassis ground.

**1.c Interconnect—7-Wire System.**

- Offsets—1, 2, and 3.

- Cycles—Call Dial 2; Call Dial 3.

- Flashing—Remote flashing.

- Voltage—95 V to 135 V (ac), 57 Hz to 63 Hz.

- Input—Positive true.

- Fuse—Ampacity, per manufacturer's recommendations.

- Isolation—Remote common from local ground.

**2. Solid-State Pretimed.**

**2.a NEMA Standards.**

- TS 1, Section 2, Environmental Standards and Test Procedures.
- LI-1, Type FR-4, Circuit Boards.

**2.b Operational Requirements.**

- Cycles—Three minimum.
- Splits—One per cycle minimum.
- Settable Offsets—Three per cycle.
- Cycle Duration—30 seconds to 120 seconds, in 1-second increments.
- Signal Circuits—12 minimum, wired for 18, including terminal blocks.

**2.c Interconnect.**

- Offsets—1, 2, and 3.
- Cycle—Call Cycle 2; Call Cycle 3.
- Flashing—Remote flashing.
- Voltage—95 V to 135 V (ac), 57 Hz to 63 Hz.
- Input—Positive true.
- Fuse—Ampacity per manufacturer's recommendations.
- Isolation—Remote common from local ground.

**3. Solid-State Actuated.**

**3.a NEMA Standards.**

- TS 1, Section 2, Environmental Standards and Test Procedures.
- TS 1, Section 13, Interface Standards.
- TS 1, Section 14, Solid-State Traffic Signal Controller Units.

**4. Solid-State Actuated with Volume Density.** Section 1104.03(a)3 and with the following operational requirements:

**Functions.**

- Variable Initial Timing—Maximum variable initial timing programmable from 0 to 60 seconds.
- Gap Reduction Timings—As indicated.

**5. Solid-State Flasher.**

- Flasher—Section 1104.03(c)2
- Circuit Breaker—Section 1104.03(g)1
- Surge Protector—Section 1104.03(g)2
- Cabinet—Section 1104.03(j), except auxiliary door for police panel, filter, and fan are not required.

**(b) Conflict Monitor.**

**1. Electromechanical Controller Units.** Capable of detecting the presence of conflicting green signal indications and then causing the transfer of the signal to flashing operation. Signals are to remain flashing until manually reset. Do not reset by interruption of power to the unit.

**2. Solid-State Controller Units.** NEMA Standards TS 1, Section 6, Conflict Monitors. A minimum of one input channel for each load switch socket as specified in Section 1104.03(j).

**(c) Flasher.**

**1. Electromechanical Controller Units.**

- Contacts—20 A, Fine Silver or Silver Alloy, rated for 1 000 000 operations.
- Motor—5 W, Non-synchronous, self starting.
- Flashing rate—54 flashes per minute to 64 flashes per minute, 50% duty cycle.
- Connector—Jack mounted.

**2. Solid-State Controller Unit.** NEMA Standard TS l, Section 8, Solid-State Flashers.

**(d) Relays.**

**1. Light Duty Relay.** Mounted in a clear, plastic cover, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Logic, Preemption or Interconnection.
- Voltage—115 V (ac) or 24 V (dc).
- Switch Type—TPDT or DPDT.
- Contact Rating—2 A.
- Contact Material—Fine Silver or Silver Alloy.

**2. Heavy Duty Relay.** Mounted in a clear, plastic cover, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Continuous Duty-Transfer of signal indications from normal operation to flashing and the reverse.

- Voltage—95V to 135 V (ac), 57Hz to 63 Hz.
- Switch Type—DPDT.
- Contact Reading—20 A.
- Contact Material—Fine Silver or Silver Alloy.
- Standard Socket—8 Pin, Jones Type.

**3. Mercury Displacement Relay.** With a hermetically-sealed, mercury retainer, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Power on/off.
- Coil Rating—95V to 135 V (ac), 57Hz to 63 Hz.
- Nominal Coil Current—65 mA.
- Operating Time—50 milliseconds.
- Release Time—80 milliseconds.
- Temperature Range— -34 °C to 74 °C (-29F to 165F).
- Dialectric Strength—2500 V (rms).
- Insulation—Class B, 130 °C (266F).
- Contact Rating—30 A min., SPST normally open.

**4. Dial Transfer (Latching Relay).** Mounted in a clear plastic cover, permanently marked to indicate coil voltage rating, and as follows:

- Usage—Dial Transfer.
- Voltage—95-135 V (ac), 57 to 63 Hz, 9 W.
- Switch Type—TPDT Electric Latching (two external poles), DPDT Mechanical Latching.
- Contact Rating—1 A.
- Contact Material—Fine Silver or Silver Alloy.
- Standard Socket—Plug, interchangeable with furnished base.

**(e) Load Switches.** According to NEMA TS 1, Section 5, Solid-State Load Switches. Provide LED indicators to display operation. Isolate signal load from load switch input using optic couplers. Furnish a minimum of one load switch for each of the following active controller unit functions:

- Vehicle Phase.
- Overlapping Vehicle Phase.

- Subordinate Pedestrian Phase.

**(f) Cable Terminal/Harness Assembly.** For wiring the cabinet, including connections to the electrical load center, police panel switches, signal load switches, signal cable terminals, controller unit, conflict monitor, detectors, and relays, and as follows:

- Connectors—Non-interchangeable between controller units, load switches, and flashers.
- Wiring—Arrange and lace or enclose in a raceway or in plastic tubing.
- Terminal Blocks—Barrier-type, with marker strips and nickel-plated brass screws, 8-32 x 7.94 mm (5/16-inch) minimum for detector leads, 10-32 x 7.94 mm (5/16-inch) minimum for signal leads, rated for 20 A at 1000 V (rms).

**(g) Electrical Load Center.**

**1. Breakers and Receptacles.**

- Circuit Breakers—15 A minimum, flashing circuit and duplex receptacle. 15 A minimum, traffic control equipment.
- Duplex Receptacle—NEC-Type, Ground Fault Interruptor, with test buttons.

**2. Power Line Surge Protectors.** UL-Listed, rated for a maximum permissible line to ground voltage of 175 V (rms).

**3. Radio Frequency Interference (RFI).** UL-Listed, RFI filter, according to NEMA standard testing procedures, and as follows:

- Line Voltage—95 V to 135 V (ac).
- Line Frequency—57 Hz to 63 Hz.
- Line Current—125% of the total connected load, 30 A minimum.
- Operating Temperature— -34 °C to 74 °C (-29F to 165F).
- Insulation Resistance—6,000 megaohms.
- Line to Ground Rating—1500 V (ac), one minute.
- Line to Line Rating—1450 V (dc), one minute.
- Humidity Range—5 % to 95 %, relative.
- Maximum Filter Limit—150 kHz.
- Overload—360 A, for 8 minutes.

**(h) Preemption Equipment.** A preemptor that provides the indicated clearance and operational intervals and as follows:

- Solid-state components with solid-state controller unit.
- Electrical-mechanical or solid-state components, with electrical-mechanical controller unit.

- An integral, but dedicated module of the controller unit or a shelf-mounted chassis connected to the controller unit with a MS connector.
- A timing control able to be set for each preemption interval.
- An indicator light for each preemption interval.
- Momentary contact switch in the actuation circuit for testing the preemptor.
- Operates only when actuated by the preemption circuit or by the test switch.
- Delay timers, adjustable from 0 seconds to 60 seconds minimum, with manually operated emergency vehicle preemptors.

**(i) Police Panel.** Furnish with the following switches:

- Auto—Flash
- Lights (ON—OFF)
- Auto—Manual

**(j) Cabinet.** Furnish a weatherproof controller cabinet, large enough to suitably house the traffic signal controller unit and auxiliary equipment, and conforming to the following requirements:

**1. Enclosure.**

- Material—Sheet or cast aluminum.
- Wall Thickness—3 mm (1/8 inch) minimum, reinforced where required.
- Minimum Size—As shown on the Standard Drawings and as follows:
  Position equipment in the cabinet to provide access to all terminal strips and equipment from the front without removing other equipment. Provide an unobstructed view of all equipment having visual indicators. Place all equipment in an upright position and not on top of other equipment.
- Hardware—Vandal and corrosion resistant.
- Finish—Natural with external welds free of irregularities and a maximum bead height of 3.2 mm (1/8 inch).
- Gaskets—Neoprene, attached with an oil resistant adhesive.
- Mountings—As indicated, pole or foundation.
- Locks—Brass, tumbler type for main door and standard police lock for auxiliary door; two keys for each lock.
- Door—Hinged on right side, door stop at 90 degrees and 180 degrees, ± 10 degrees, for all doors over 460 mm (18 inches) wide, auxiliary door for access to police panel, pocket for prints.
- Latching Mechanism—One point-through mechanism for doors less than 555 mm (22 inches) in width; three point-through mechanism for doors 555 mm (22 inches) or wider.

- Interior—Shelf-mounted equipment, unless rack or panel-mounted.

- Test Pushbutton Panel—One pushbutton to each input for simulated detector operation of vehicles and pedestrians with type and phase permanently labeled on panel. Mount panel on inside of door.

Back panels, wiring and terminals for maximum phase capability of solid-state controller unit, load switch sockets as required and as follows:

| Controller Unit | Load Switch Sockets | |
|---|---|---|
| | Minimum Number | Maximum Number |
| Pretimed | 6 | As required |
| 2 Phase Actuated | 4 | As required |
| 2-4 Phase Actuated | 8* | 12 |
| 2-8 Phase Actuated | 12* | 20 |

* Provide a minimum of two unused sockets per unit.

**2. Environmental Controls.**

**2.a General.**

- Ventilation—Weatherproof vents of sufficient area in the lower part of the door or cabinet.

- Filter—Cover vents with a disposable filter securely held in place.

**2.b Solid-State Equipment.**

- Fan—Capacity; 47 L/s (100 cfm) minimum.

- Fan Thermostat—Line-voltage type, adjustable from 33 °C to 65 °C (91F to 149F), with 6 °C (43F) turn off below on position.

**(k) Time Clock, Solid-State.** Enclosed in an electrical-shockproof housing, conforming to the following requirements.

- Input Voltage—95 V to 135 V (ac), 57 Hz to 63 Hz.

- Output Voltage—95 V to 135 V (ac), 57Hz to 63 Hz.

- Output Current—5 A.

- Output Circuits—As required.

- Output Setting Limit—10 minutes.

- Skip-Feature—7 day.

- Carryover—24 hours minimum.

- Clock Setting Limit—1 second.

- Time Sets—One on-off/day/circuit.

- Temperature— -34 °C to 74 °C (-29F to 165F).

- Transient Immunity—Varistor.
- Humidity—5% to 95% relative.
- Daylight Savings Time—Automatic transfer.

**1104.04 SYSTEMS—**

**(a) Time-Based Coordinator Unit.**

**1. Type.** As required to interface with controller unit having ac or dc input/output. If being placed in an existing traffic signal system, make compatible with the existing time-based coordinators in that system.

**2. NEMA Standards.**

- TS 1-2.1.1, Operating Voltage, Frequency, and Power Interrupt.
- TS 1-2.1.2, Voltage.
- TS 1-2.1.3, Frequency Range.
- TS 1-2.1.5, Temperature and Humidity.
- TS 1-2.1.6, Transients, Power Service.
- TS 1-2.1.12, Vibration.
- TS 1-2.1.13, Shock.
- TS 1-13.2, Electrical Limits of Input/Output.

**3. Provisions for Timing Plans.**

- Storage Capability—Nine, settable, timing programs; (minimum) one dedicated free-operation program; and three control programs.
- Settable Program Positions (minimum)—One Offset; One Cycle; One Split
- On/Off Output Switch—One per control program.
- Program Assertion—Turn-off previous settable or free programs at the assertion of any of the settable or free, operational programs.

**4. Cycle.**

- Number—Three, minimum.
- Duration—Settable range of at least 30 seconds to 180 seconds.
- Increments—5 second maximum.

**5. Clock/Calendar.**

- Resolution—1 second.
- Selectable Programs—Day of week/hour/minute/second
- Number of Changes—50 minimum per day.
- Daylight Savings Time—Automatic transfer.
- Accuracy—±0.005 (50 ppm)% of clock calendar time, with respect to real time.

**6. Display.** A type having a 6 mm (1/4-inch) minimum digital readout and capable of displaying the following: day of week, hour, minute, second, program in effect, and setting stored or entered for storage.

**7. Battery Backup.**

- Memory Functions—Clock/calendar program settings.
- Memory Retention—48 hours, minimum.
- Charger—Automatic trickle type, complete recharge in 24 hours.
- Rated Life—Minimum of 5 years.
- Indicators—Battery failure.

**8. Inputs.**

- Power Requirements—95 V to 135 V (ac), 57 Hz to 63 Hz.
- Minimum Number and Type—Eight green-signal inputs at 24 V (dc), negative true.
- Keyboard—Front panel mount.
- Transfer Function—Input program from other unit.

**9. Outputs.**

- Minimum Number—As required to provide the time controlled functions indicated. Eight minimum.
- Settable Outputs—Offset 1; Offset 2; Offset 3; Call Cycle 2; Call Cycle 3.
- Special Control Functions (As indicated)—Sign Control; Remote Flashing.
- Transfer Function—Output program for input to other units.

**10. Program Transition.** Pretimed Controller Units

- Dwell in coordinated phase walk.
- Dwell not to exceed 25% of operating cycle.

- Dwell in called-cycle when cycle transfer occurs due to program change.
- Program transfer, not to exceed four cycles.

**(b) Master Controller Assembly.**

**1. Master Controller Unit.**

**1.a Electromechanical Pretimed.** Capable of functioning as an intersection controller or as a master controller to supervise other intersection controllers and as follows:

- Number of Cycles—Three.
- Offset Functions—Designed for master operation.
- Manual Dial Selection Switch—System.
- Five Dial Time Switch
  Switch 1 and 2 Off—Offset 1
  Switch 2 On—Offset 2
  Switch 1 On—Offset 3
  Switch 1 and 2 On—Offset 3
  Switch 3 On—Flashing, overrides all other switch positions.
  Switch 4 On—Cycle 2
  Switch 5 On—Cycle 3
  Switch 4 and 5 On—Cycle 1
- Output Circuits—Rated for 10 A at 95 V to 135 V(ac).

**1.b Solid-State, Pretimed.** Capable of functioning as an intersection controller or as a master controller to supervise other intersection controllers and as follows:

- Output Circuits—Ground true.
- Time Switch—Section 1104.04(b)1.a for functions.
- Manual Pushbutton—For sync function with master removed.

**2. Conflict Monitor.** Section 1104.03(b)

**3. Flasher.** Section 1104.03(c)

**4. Relays.** Section 1104.03(d)

**5. Load Switches.** Section 1104.03(e)

**6. Cable Terminal/Harness Assembly.** Section 1104.03(f)

**7. Electrical Load Center.** Section 1104.03(g)

**8. Police Panel.** Section 1104.03(i)

**9. Cabinet.** Section 1104.03(j)

**(c) Coordination Unit.**

**1. Electromechanical.** Capable of coordinating up to an eight-phase, dual-ring, solid-state, actuated controller unit and as follows:

**1.a Dial.**

- Cycle Length—As indicated, in 5-second increments up to 90 seconds and 10-second maximum increments above 90 seconds.
- Switch—Function by snap-in-place dial keys.
- Transfer—At a point in the cycle common to all three splits.
- Force-Off—Provide means to ensure force off for each ring, terminating the intended phase.
- Spare Cycle Gears—For each coordination unit, provide a set of timing gears to obtain cycle lengths from 60 seconds to 100 seconds in 10-second increments. If other cycle lengths are specified, provide additional timing gears as required.

**1.b Interface.** NEMA TS 1, Section 13.

**1.c System Interconnection.**

- Type—Standard seven-wire positive subsystem.
- Function Requirements—95 V to 135 V (ac), 57 Hz to 63 Hz with isolated remote-common.

**1.d Grounding.**

- Chassis Safety Ground—Connect exposed metal surfaces.
- Internal Connections—None between chassis safety ground, remote-common, ac ground, and logic-ground.

**1.e Environment.** NEMA TS 1, Section 2.

**2. Solid-State.** Capable of coordination up to an eight-phase, dual-ring, solid-state, actuated controller unit and as follows:

**2.a Cycle.**

- Length—As indicated, in 1-second increments.
- Force-Off—Ensure the force-off command is directed to correct phase.
- Cycle and Split Transfer—At 0% point in local cycle.
- Offset Transfer—With pedestrian control, transfer in “green/walk” interval. With nonpedestrian control, transfer in “green.” Transfer to occur in a maximum of three cycles with no more than 17% change in any one cycle.

**2.b Interface.** NEMA TS 1, Section 13.

**2.c System Interconnection.**

- Type—Standard, seven-wire, positive subsystem.
- Function Requirements—95 V to 135 V (ac), 57 Hz to 63 Hz with isolated ground.

**2.d Environment.** NEMA TS 1, Section 2

**(d) Electromechanical Synchrolizer Unit.** A one-dial unit, capable of coordinating up to an eight-phase, dual-ring, solid-state, actuated controller unit and as follows:

- Number of Background—One cycles.
- Motor—Synchronous, self-starting.
- Power Requirements—95 V to 135 V (ac), 57 Hz to 63 Hz.
- Power Consumption—6 W maximum, fused.
- Case—Shockproof, use chassis safety ground, connected to case.
- Electric Connection—None between logicground, ac-ground, remote-common, and chassis safety-ground inside the synchrolizer.
- Hold Circuit—Connected to logic-ground on one side of switch.
- Disconnect Plug—Compatible to control equipment, with external connector and harness.

**1104.05 ELECTRICAL DISTRIBUTION—**

**(a) Conduit.**

**1. Rigid Steel Conduit.** Section 1101.09, except may be used for direct burial, and UL-6 Listing for rigid metallic conduit, galvanized inside and outside.

**2. Rigid Polyvinyl Chloride Conduit.** Section 1101.09 with UL-651 Listing for rigid nonmetallic conduit, and UL 514 Listing for fittings.

**3. Cable Pulling Lubricant.** Section 1101.12(c)

**4. Conduit Sealant.** An acceptable duct seal.

**(b) Wire and Cable.**

**1. Signal Cable.** 2.08 $mm^2$ (14 AWG) minimum, stranded conductors; conforming to IMSA Specification 19-1 or 20-1.

**2. Service Wire.** 8.37 $mm^2$ (8 AWG) minimum wire, Type USE conforming to UL-854 Listing and ASTM B 3 and B 8 for soft, annealed copper.

**3. Ground Wire.** Bare or insulated (green) copper wire, 8.37 $mm^2$ (8 AWG), conforming to ASTM B 3.

**4. Cable Tags.** Section 1101.12(d)

5. **Cable Ties.** An acceptable type.

(c) **Junction Box.** Furnish the type indicated and as follows:

- Precast Junction Box—Section 714
- Steel or Cast-Iron Junction Box—steel or cast iron conforming to the requirements for cast-iron junction box, Section 1101.10.
- Reinforced Plastic Mortar Junction Box—Reinforced plastic mortar box with a nonskid cover, providing a watertight connection to the housing when installed.

(d) **Electrical Service.**

1. **Service Pole.** Section 1101.11(a)

2. **Service Head.** UL-Listed weatherproof service head, for applicable conduit type.

3. **Meter Socket.** As specified by the utility company.

4. **Service Disconnect.**

**4.a Enclosure.** Galvanized steel, aluminum, or stainless steel, with a hinged door having provisions for a padlock and no external handles or switches; conforming to the NEMA Standard for Type 3R, Type 3S, or Type 4. Provide a brass padlock for outdoor use, with two keys. All padlocks shall be keyed alike.

**4.b Main Disconnect.** Provide a means for disconnecting the service conforming to NEC.

**4.c Fuses.** UL-Listed Type K-1, 30 A minimum.

**4.d Fuse Block.** UL-Listed for K-1 fuses.

**4.e Power Line Surge Protector.** Section 1104.03(g)2

(e) **Wire Connectors.**

1. **Wire Nuts.** Insulated, UL-Listed, with spring insert for applicable wire size and rating of wire insulation.

2. **Waterproof Resin Sealer.** Insulated, UL-Listed for wire nuts.

3. **Terminal Blocks.** UL-Listed with twelve-sets minimum to two terminals each, screw-type, rated at a minimum of 600 V, and suitable for the applicable wire size. Connect each set of terminals by means of a removable link. Separate each set of terminals by a molded barrier. Provide a marker strip for terminal identification.

4. **Insulated Locking Spade Terminals.** An acceptable type.

(f) **Grounding Bushings and Lugs.**

1. **Bushings.** UL-Listed for applicable conduit type and size.

2. **Lugs.** UL-Listed for applicable materials.

(g) **Ground Rods With Clamp.** Section 1101.11(j)

**1104.06 SIGNAL HEADS—**

**(a) Vehicular Signal Heads.** Conforming to the ITE Standard for "Adjustable Face Vehicular Traffic Control Signal Heads," the regulations, and as follows:

**1. Housings.**

- Plastic—Opaque polycarbonate resin molding, conforming to ASTM D 3935. Federal yellow in color, except the inside of the visor, which will have a non-reflective black finish.

- Aluminum—Finish exterior of aluminum housings as follows:

Clean and coat surfaces of the signal housing, door, and visor, with an infrared, oven-baked, iron-oxide backing primer, conforming to Federal Specification TT-P-1757B and Federal Specification SSPC-Paint 25.

Coat finished surfaces, except the inside of the visor, with infrared, ovenbaked, highway yellow exterior enamel, conforming to , according to Federal Standard No. 595B. Finish the inside of the visor with phathalic anhydride, black, synthetic baking enamel, with zero gloss reflectance and conforming to the performance requirements of MIL-E-5557 Enamel Heating Resisting Glyceryl Phathalate, Type 4, Instrument Black.

**2. Reflectors.** Polycarbonate or aluminum. When the reflector is attached to the door, provide a means by which opening the door disables the indication.

**3. Lamps.** Furnish incandescent lamps conforming to ITE Standard for Traffic Signal Lamps and as follows:

| | **Lens Diameter** | |
|---|---|---|
| | **200 mm (8-inch)** | **300 mm (12-inch)** |
| Rated Voltage | 120 | 120 |
| Rated Life-Hours | 6000 | 6000 |
| Rated Initial Lumens | 595 | 1750 |
| Light Center Length, mm (inches) | 62 (2 7/16) | 76 (3) |

**4. Miscellaneous.** Furnish cut-away visors unless otherwise indicated. Furnish louvers and backplates as indicated, with a non-reflective black finish.

**(b) Optically Programmed Signal Heads.** Conforming to the regulations and as follows:

**1. Optical.** Incorporate an optical system that limits the visibility zone internally and optically, without the use of hoods or louvers. The projected signal may be visible or selectively veiled anywhere within 15 degrees of the optical axis.

**2. Sections.** Provide an integral means for the incremental tilting of each section, from 0 degrees to 10 degrees above and below the horizontal. Unless directed otherwise, assemble vertically-mounted signals with a 4-degree tilt below the horizontal. Provide couplers, serrated locking rings, flanges, gaskets, and other hardware necessary to mate optically programmed signal sections together or to mate with nonoptically programmed sections, all in a secure and weathertight manner. Shop-join the sections. Use corrosion resistant internal hardware.

**3. Painting.** Section 1104.06(a)1

**4. Electrical.** Use copper, brass, nickel-plated brass, or phosphor-bronze, electrical-conducting hardware. Furnish lamps that provide luminous intensity of 950 cd (950 beam candlepower), conforming to the traffic signal manufacturer's specification, rated at a minimum of 6000 hours. Color code the internal wiring. Provide a breaker that disables the indication when the lamp door is opened.

Provide an integral means within each signal face for regulating its luminous intensity between limits, in proportion to the individual background illumination, but not less than 97% of uncontrolled intensity at 10 764 lx (1,000 footcandles); and reduce to 15% ± 2% of maximum intensity at less than 10 lx (1 footcandle), proportionally and instantaneously.

**5. Miscellaneous.** Furnish cut-away visors. Furnish optical programming material and instructions. Within each section, affix a permanent, conspicuous warning label, advising of possible eye damage and fire hazard from the sun.

**(c) Pedestrian Signal Heads—Incandescent.** Conforming to the ITE Standard for "Adjustable Face Pedestrian Signal Heads," the regulations, and as follows:

**1. Housings.** Section 1104.06(a)1

**2. Reflectors.** Section 1104.06(a)2

**3. Lamps.** Furnish incandescent lamps conforming to ITE Standard for Traffic Signal Lamps and as follows:

| | **Type A** | **Type B** |
|---|---|---|
| Rated Voltage | 120 | 120 |
| Rated Life-Hours | 6000 | 6000 |
| Rated Initial Lumens | 595 | 1260 |
| Light Center Length, mm (inches) | 62 (2 7/16) | 62 (2 7/16) |

**4. Miscellaneous.** Furnish cut-away visors, unless otherwise indicated.

**(d) Pedestrian Signal Head-Fiber Optic, Halogen, or Neon.** Conforming to ITE Technical Report 5, the regulations, and as follows:

**1. Housing.** A weatherproof die-cast aluminum, rectangular housing, complete with a hinged door, door frame with gasket, visor, glass fiber optic module, color filters, light-source lenses, transformers, and face plates with the indicated legends.

**2. Electrical.** Maximum operating power consumption per message not to exceed the following:

- Neon 100 W
- Fiber optic 50 W
- Halogen 90 W

Where the reflector is attached to the door, provide a means by which opening the door of a signal disables the indications.

**3. Optical.** Use filters to correct colors. "WALK" legend to be lunar white and "DON'T WALK" legend to be Portland orange. Under any ambient light conditions, phantom words are not to be visible when the signal is not energized.

**(e) Lane-Use Traffic Control Signal Heads.** Conforming to the ITE Standard for Lane-Use Traffic Control Signal Heads, the regulations, and as follows:

**1. Housings.** For plastic, use Federal yellow opaque, polycarbonate-resin moldings, conforming to ASTM D 3935.

**2. Lamps.** For incandescent, provide lamps with 1750 rated initial lumens, with a 76 mm (3-inch) light center length, and rated at a minimum of 6000 hours of average life.

**(f) Mounting Assembly and Hardware.** Furnish signal mounting assemblies and hardware of a type and design that adequately supports the loading indicated.

## 1104.07 DETECTORS—

**(a) General.**

**1. Sealant.** Furnish a nonshrinking and nonshrinking, flexible sealant for the encapsulation of loop or magnetometer sensor and as follows:

- Number of Components—One or two
- Application Temperature—0 °C to 38 °C (32F to 100F)
- Tack Free—1 hour maximum
- Maximum Curing Time—30 hours
- Permanent Flexibility—to -29 °C (-20F)
- Chemically Resistant To:
  De-Icing Chemicals
  Gasoline
  Calcium Chloride (5%)
  Motor Oils
  Hydraulic Brake Fluid

**2. Detector Lead In Cable.** 2.08 $mm^2$ (14 AWG) minimum conforming to IMSA Specification 50-2.

**3. Card Rack Assembly.**

**3.a Power Supply.** Furnish a switching-type power supply and as follows:

- Input Voltage—95 V to 135 V (ac), 57Hz to 63 Hz
- Output Voltage—24 V ± 0.3 V (dc)
- Minimum Output Voltage—22.8 V (dc)
- Efficiency—70% minimum
- Full Load Current—3 A minimum
- Line Regulation—0.1% over entire input range
- Load Regulation—0.2% from no load to full load
- Ripple Noise—40 mV (p-p) typical, 75 mV (p-p) at full load
- Environmental—NEMA TS 1, Part 2

Provide a front panel incorporating a pilot lamp, test points for monitoring output voltage, and a circuit breaker or fuse. Ground all exterior metal surfaces to the chassis safety ground.

**3.b Card Rack.** A standard EIA, 483 mm (19-inch) rack for mounting the detector amplifier units, as follows:

- Aluminum front rails, drilled and tapped (10-32), with EIA spacing.
- Aluminum chassis supporting angles, 254 mm (10 inches) deep and 76 mm (3 inches) wide, for mounting on the sides of the controller cabinet.
- Aluminum connector panels, with connector mounting holes, tapped (4-40) on 5 mm (0.200-inch) centers, then mounted to form a cage 483 mm (19 inches) wide, 134 mm (5 1/4 inches) high, and 165 mm (6 1/2 inches) deep.
- Nonmetallic guides and Cinch-Jones No. 50-44A-30M rear connectors, mounted at 30.5 mm (1.200-inch) spacings.

**4. Re-Enterable Splice Kit.** Reusable molded body, internal and external hardware, clear polyurethane compound. Provide an appropriate size to accommodate in-line, wye, "x," butt, and dead-end splicing of cables rated at 1000 V or less, with outside diameters from 6.35 mm (0.25 inch) through 63.5 mm (2.50 inches). Supply with the following components:

- Two-part transparent mold body of PVC construction, with tongue-and-groove seams and built-in spacer web.
- Two flexible end caps, each with double-stepped cable entry ports to accommodate the many possible splicing configurations.
- Snap-in caps to cap off the fill ports, after compound pouring.
- Strain bars with insulator sleeves.
- Four shield connectors to provide shield continuity, with strain bars for shielded cables.
- Stainless steel base clamps to secure splice body, end caps, and strain bars.
- Re-enterable electrical insulation and sealing compound, capable of continuous operation at 90 °C (194F), with an emergency overload temperature rating at 130 °C (266F), a viscosity of approximately 1.1 Pa•s (1,100 centipoise) at 26 °C (79F), a gel time of approximately 20 minutes at 23 °C (73F), and zero growth fungus resistance, according to ASTM G 21.
- An instruction booklet, showing proper installation and re-entry techniques.

**(b) Loop Detector.**

**1. Loop Sensor.** 2.08 $mm^2$ (14 AWG) minimum, conforming to IMSA Specification 51-5.

**2. Loop Amplifier, Shelf-Mounted.** Self-tuning, loop amplifier, shelf-mounted, enclosed in a shock-proof housing with relay output and one or two channels as indicated, conforming to NEMA TS 1, Section 7.

**3. Loop Amplifier with Timers, Shelf-Mounted.** Self-tuning, loop amplifier, shelf-mounted enclosed in a shock-proof housing with relay output and one or two channels as indicated, conforming to NEMA TS 1, Section 11.

**4. Loop Amplifier, Rack-Mounted.** Self-tuning, loop amplifier, mounted on an edge-connected, printed circuit board with an electrically isolated solid-state output and two or four channels as indicated, conforming to NEMA TS 1, Section 7.

**5. Loop Amplifier with Timers, Rack-Mounted.** Self-tuning, loop amplifier, mounted on an edge-connected, printed circuit board with an electrically isolated solid-state output and two or four channels as indicated, conforming to NEMA TS 1, Section 11.

**(c) Magnetometer Detector.**

**1. Magnetometer Sensor.** As indicated and as follows:

- Physical Size—Cylindrical housing, nonferrous, moisture-proof, suitable for direct burial in roadway pavement, with no damage due to subsurface stresses, and with a lead-in cable of proper length for hookup.

- Operational—No moving parts and compatible with the magnetometer detector amplifiers furnished.

**2. Magnetometer Amplifier, Shelf-Mounted.** Enclosed in a shock-proof housing and as follows:

- Operation—Solid-state design with two independent detection channels in each unit, designed so the sensing element of one channel has no effect on the other.

- Bimodal—Pulse mode—Provides an output closure of 125 ms ± 25 ms duration for each vehicle entering the detection area.

  Bimodal—Presence mode—Continually indicates the presence of a vehicle, until the vehicle leaves the area of detection, at which time the indication is to cease within 100 ms.

- Sensing Elements—One to six magnetometer sensors per channel capability at a distance of up to 915 m (3,000 feet) between sensor and amplifier.

- Indicators and Switches—Provide on front panel: an LED indicator, sensitive to vehicle detection; fused or circuit breaker overcurrent protection; mode switch, calibration controls; and switch or switch position per channel for disabling the output of a channel and placing a call on a channel.

- Output—Optically isolated Darlington—An opto-isolated, NPN open collector capable of sinking 50 mA at 30 V (dc).

- Connector—MS-3106A20-29P, 17-pin connector with the following pin assignments:

| | | **Channel 1** | | **Channel 2** |
|---|---|---|---|---|
| | White | D | | T |
| | Black | E | | N |
| Probe Sets | Red | P | | J |
| | Green | R | | S |
| | Common (-) | B | | K |
| Output | Detect (+) | G | | M |
| | Neutral | | A | |
| ac Power | High | | C | |
| | Chassis Ground | | H | |

- Power Requirements—Maximum 11 V·A at 105 V to 125 V (ac), 57 Hz to 63 Hz without originating, nor being susceptible to, electrical transients in excess of the NEMA, TS 1, Section 2.

- Environment—NEMA TS 1, Section 2.

**3. Magnetometer Amplifier, Rack-Mounted.** Mounted on an edge connected, printed circuit board for rack-mounting and as follows:

- Physical—Provide a hand pull to facilitate insertion and removal from the rack.

- Operation—Section 1104.07(c)2

- Modes—Section 1104.07(c)2

- Sensing Elements—Section 1104.07(c)2

- Indicators and Switches—Section 1104.07(c)2, excluding overcurrent protection.

- Output—Section 1104.07(c)2

- Connector—Cinch Jones Number 50-40-A-30M, 22-pin edge connector, with the following pin assignments:

  **Pin Function**

  | | |
  |---|---|
  | A | dc Ground |
  | B | +24 V (dc) |
  | C | Reset |
  | D | Sensing Element #1 Input |
  | E | Sensing Element #1 Input |
  | F | Control Unit Output #1 (Collector) |
  | H | Control Unit Output #1 (Emitter) |
  | J | Sensing Element #1 Excitation |
  | K | Sensing Element #1 Excitation |
  | L | Equipment Ground |
  | M | Reserved |
  | N | Reserved |
  | P | Sensing Element #2 |
  | R | Sensing Element #2 |
  | S | Control Unit Output #2 (Collector) |
  | T | Control Unit Output #2 (Emitter) |
  | U | Sensing Element #2 Excitation |
  | V | Sensing Element #2 Excitation |
  | W | NA |
  | X | NA |
  | Y | NA |
  | Z | NA |

  Connector—Slotted for keying (Between Pins B&C and Pins M&N).

- Power Requirements—Maximum current 300 mA from 33 V to 28 V (dc).

- Environmental—NEMA TS 1, Section 2.

**(d) Magnetic Detector.**

**1. Magnetic Sensor.**

- Physical—Cylindrical case, nonferrous, moisture-proof, suitable for burial within rigid nonmetallic conduit, and with a lead-in of sufficient length.

- Operation—No moving parts and compatible with the magnetic-detector amplifier furnished.

**2. Magnetic Amplifier, Shelf-Mounted.** Shelf-mounted, enclosed in a shock-proof housing, and as follows:

- Operation—Solid-state design, with one channel in each unit.

- Sensing Elements—One or more magnetic sensor capability at a distance of up to 305 m (1,000 feet) between the sensor and amplifier.

- Indicators and Switches—Provide on front panel: indicator for detection of a vehicle, fused or circuit breaker overcurrent protection, calibration controls, and a switch or switch position for disabling the output and placing a call.

- Output—Section 1104.07(c)2

- Connector—Relay output—MS3106A-18-1S, Solid-State (Isolated)—MS3106A-8-15W.

- Power Requirements—Maximum power consumption of 2 W at 120 V (ac) and 60 Hz.

- Environmental—NEMA TS l, Section 2.

**3. Magnetic Amplifier, Rack-Mounted.** Mounted on an edge-connected, printed circuit board for rack-mounting and as follows:

- Physical—With a handpull to facilitate insertion and removal from the rack. The four-channel, magnetic-detector amplifier in the front panel space of two, two-channel magnetic-detector amplifiers.

- Operation—Solid-state design with two or four independent detection channels in each unit, as indicated, designed that the sensing element of one channel has no effect on the other.

- Sensing Element—One or more magnetic sensors per channel, capable of sensing at a distance of up to 305 m (1,000 feet) between the sensor and amplifier.

- Indicators and Switches—Section 1104.07(c)2, excluding overcurrent protection.

- Output—Section 1104.07(c)2

- Connector—Cinch-Jones Number 50-40-A-30M, 22-pin edge connector, with the following pin assignments:

**Pin Function**

A dc Ground
B +24 V (dc)
C Not Connected
D Detector #1 Element

E Detector #1 Element
F Detector #1 Output (C)
H Detector #1 Output (E)
J Detector #2 Element
K Detector #2 Element
L Chassis Ground
M Reserved
N Reserved
R Detector #3 Element
S Detector #3 Output (C)
T Detector #3 Output (E)
U Detector #4 Element
V Detector #4 Element
W Detector #2 Output (C)
X Detector #2 Output (E)
Y Detector #4 Output (C)
Z Detector #4 Output (E)

Connector—Slotted for keying
(C)—Collector
(E)—Emitter

- Power Requirements—Maximum of 60 mA per channel from a 24 V (dc) power supply.

- Environmental—NEMA TS 1, Section 2.

**4. Rigid, Nonmetallic Conduit.** Section 1104.05(a)2

**(e) Pedestrian Pushbutton.** Capable of completing a momentary circuit closure and as follows:

- General—Furnish a tamper and weatherproof assembly with pushbutton contacts, entirely insulated from the housing and buttons. Furnish sign and mounting assembly as indicated. Conform to the regulations for the sign legend and Section 1103.04 for the fabrication. Use stainless steel hardware to mount the pushbutton assembly.

- Housing—Die-cast aluminum alloy housing, with a curved back or a flat back as required to conform to the mounting surface. Paint the assembly highway yellow, as specified in Section 1104.06(a)1. Provide a rear cable entry.

- Electrical—Provide a switch mechanism consisting of a direct push-type button, with a single momentary contact switch, contacts rated at 10 A minimum, 125 V (ac) for operation at 24 V (dc).

## 1104.08 COMMUNICATIONS—

**(a) Control Cable.** Furnish control cable conforming to IMSA Specification 19-1 or 20-1 for cable in conduit and IMSA Specification 20-3 for aerial cable. Provide stranded conductors, 2.08 $mm^2$ (14 AWG), minimum.

**(b) Communication Cable.** Furnish communication cable conforming to IMSA Specification 19-2 or 20-2 for cable in conduit and IMSA Specification 20-4 for aerial cable. Provide as indicated, stranded conductors, 0.65 $mm^2$ (19 AWG), minimum.

**(c) Instrument Cable.** Shielded cable with three solid 0.517 $mm^2$ (20 AWG) conductors and one drain wire and as follows:

- Insulation—Moisture and heat resistant (75 °C (167F)) polyethylene conforming to ASTM D 1248, Type I, Class B, Category 5, Grade E4, 600 V rating applied concentrically about the conductor.

- Color Code—(1) yellow, (1) blue, (1) orange.

- Shield—Mylar/aluminum tape shielding, applied with a nominal overlap of 20%, with the aluminum side in contact with the drain wire.

- Jacket—Polyvinyl chloride, having an average wall thickness of 1.14 mm (0.045 inch), conforming to IMSA Specification 19-l, and rated at 80 °C (176F).

- Electrical—dc resistance of each conductor, less characteristics than 11 ohms per 305 m (1,000 feet). Capacitance between each insulated wire and all other less than 157.5 pF/m (48 pF per foot).

- Finished outside diameter—Less than 7.6 mm (0.300 inch).

# SECTION 1105—FABRICATED STRUCTURAL STEEL

## 1105.01 GENERAL REQUIREMENTS—

**(a) Prequalification.** Structural steel fabricators performing work for the Department are required to prequalify according to the AISC Quality Certification Program and obtain approval from the Structural Materials Engineer. Plants and shops must be registered and certified under the AISC program with Simple Steel Bridge Structures or Major Steel Bridges certification and must submit a valid certificate to the Structural Materials Engineer, MTD, 1118 State Street, Harrisburg, Pennsylvania 17120. Annual submission of an endorsed copy of the certificate is required for continued prequalification. New fabricators or certified fabricators wishing to upgrade certification are required to furnish references for which the fabricator has successfully completed fabrication of similar members. If unable to furnish references, the fabricator must satisfactorily produce a sample member before receiving Department approval and listing in Bulletin 15.

Only fabricators having Major Steel Bridges with Certified Fracture Critical certification may fabricate the following:

Fracture critical members and attachments.

Only fabricators having Major Steel Bridges certification may fabricate the following:

Main members, except for rolled beams
Welded floorbeams
Cross frames and diaphragms for curved bridges
Bracing, portals, and stiffening members for arches, trusses, cable-stayed and suspension bridges
Rolled beams with butt welds, or that are heat-curved or heat-cambered.

Fabricators having Major Steel Bridges or Simple Steel Bridge Structures certification may fabricate the following:

Expansion dams
Bridge drainage material
Welded bearings
Rolled beams with bearing stiffeners and diaphragm connection or cover plates
Cross frames and diaphragms for straight bridges*
Inspection walks
Steel grid flooring
Shop-fabricated material for reinforcing existing bridges*
Sign structures
Lateral bracing except for arches, trusses, cable-stayed and suspension bridges*
Lighting poles and anchor bases
Welded sound barrier support
Railings

* Fabricate in a Major Steel Bridges certified shop if welding is required.

AISC certification is not required for the following:

Castings, forgings, and machined parts not welded
Non-metallic bearings
Protective barriers
Protective fence
Material not requiring shop fabrication or shop welding, such as plates and shapes for strengthening existing bridges and manufactured items accepted by certification.

**(b) Standard Reference.** Section 105.04
**(c) Shop Drawings.** Section 105.02 and as follows:

Bridge members are generally designed in lengths, depths, and widths that can be transported from the fabrication source to the project. Field splices, if required, are indicated. Do not add or eliminate field splices on the shop drawings for shipping purposes unless approved by the District Executive in writing. If the addition or elimination of field splices is approved, provide a sketch. If required by the District Executive, submit design computations prepared by a Professional Engineer registered in the State according to the Design Manual, Part 4, Structures. The District Executive will not review requests for elimination of field splices unless a notice is included from the TEOD that a hauling permit can be obtained to ship beams exceeding the dimensions shown on the structure drawings.

**(d) Erection Drawings.** Section 1050.3(c)2.d

**(e) Inspection.**

**1. General.** The MTD will supervise shop inspection. Notify the MTD a minimum of 48 hours before the beginning of work so that arrangements can be made for inspection.

The Representative may waive shop inspection and make a complete inspection at a later stage in the construction sequence. Furnish certified mill reports, in duplicate, covering the structural steel used.

**2. Facilities for Inspection.** Furnish necessary facilities for the inspection of material and workmanship. Furnish an Inspector's Field Office, Type C, as specified in Section 714.5(a), except provide a four-drawer, fire-resistant (D-label) metal file cabinet in place of a two-drawer, fire-resistant (D-label) metal file cabinet. Allow inspectors employed by the Department unrestricted access to work in process and stored material during plant working hours.

**3. Plant Inspector's Authority.** Plant Inspectors have the authority to reject any material or work not conforming to the requirements of these Specifications. In case of dispute, the Contractor may appeal to the Representative, whose decision will be final.

**4. Rejections.** Material, workmanship, or finished members accepted by the inspector at the shop may be rejected later if they do not conform to the specifications. Repair or replace rejected material or members.

**5. Testing.** If directed, furnish test specimens of material, as well as equipment, tools, and labor necessary to prepare the specimens and to make the tests.

**6. Mill Orders and Shipping Statements.** Furnish copies of mill orders and shipping statements as directed. Show the mass (weights) of the individual members on the statement. Ensure that the fabricator submits a copy of the shipping invoice to the Department's Shop Inspector to be stamped for verification of inspection and acceptance of steel items before shipment. Forward the stamped copy of the shipping invoice with the shipment for the project file. The Shop Inspector will review and accept mill certifications and return them to the fabricator.

**(f) Storage of Materials.** Section 106.05 and as follows:

Place materials stored aboveground on platforms, skids, or other supports. Place and support materials to avoid overstress, deformation, or damage. Exercise special care for curved members. Keep materials free from dirt, grease, and other foreign materials. Ensure proper drainage and protect materials from corrosion.

**(g) QC.**

**1. General.** Establish and maintain a level of QC based on uniform fabrication practices. Do not initiate fabrication without an approved QC process.

**2. QC Plan.** Shops seeking prequalification must submit a QC Plan to the Chief Structural Materials Engineer, MTD, for review and approval. Develop the plan in accordance with the criteria established in AASHTO-NSBA Steel Bridge Collaboration document S4. 1-2002 "Steel Bridge Fabrication QC/QA Guide Specification" (refer to Publication 135 for an outline of the QC plan criteria). Facilities performing welding that requires non-destructive testing must submit their written practice according to the current version of ASNT- SNT-TC-1A. Pre-qualified shops must submit an updated QC Plan to the Chief Structural Materials Engineer, MTD, if there are any changes in materials, processes, or personnel.

**3. QC Personnel.** Assign sufficient qualified personnel with structural steel fabrication experience to be

responsible for QC during the fabrication process, storage, and shipment. Do not proceed with fabrication until qualified QC personnel are present and approved by the Department. Provide an AWS Certified Welding Inspector (CWI) on site as the Fabricator's designated QC Representative to oversee all processes of fabrication that involve welding, heat cambering, or straightening of material.

**1105.02 MATERIAL—**

**(a) Structural Steel.**

**1. General.** AASHTO M 160/M 160M (ASTM A 6/A 6M)

**2. Carbon Steel.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36), ASTM A 36.

**2.a Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.** ASTM A 500, Grade C.

**2.b Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.** ASTM A 501

**3. High-Strength Low-Alloy Structural Steel for Welding.**

**3.a High-Strength Low-Alloy, Quenched and Tempered Structural Steel Plate.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade HPS 485W (Grade HPS 70W).

**3.b High-Strength Low-Alloy TMCP Structural Steel Plate.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade HPS 485W (Grade HPS 70W), up to 50.8 mm (2 inches) thick.

**3.c High-Strength Low-Alloy Structural Steel.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grades 345 or 345W (Grades 50 or 50W), ASTM A 572, Grade 345 (Grade 50), of a quality suitable for welding.

**3.d High-Strength Low-Alloy Columbium-Vanadium Steel of Structural Quality.** AASHTO M 270/M 270M (ASTM 709/A 709M), Grade 345 (Grade 50), ASTM A 572, Grade 345 (Grade 50).

**3.e High-Strength Low-Alloy Structural Steel with 345 MPa (50,000 pounds per square inch) Minimum Yield Point to 100 mm (4 inches) Thick.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 345W (Grade 50W), ASTM A 588 (Grades A, B, and C only – see Note 1).

Note 1: Plate thicknesses greater than 100 mm (4 inches) are required to conform to the physical properties listed in the specification for plate thicknesses 100 mm (4 inches) and under.

**3.f High-Yield Strength, Quenched and Tempered Alloy Steel Plate.**

**3.f.1 High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grades 690 or 690W (Grades 100 or 100W).

**3.f.2 High-Strength Alloy Steel Plates, Quenched and Tempered, for Pressure Vessels.** ASTM A 517/A 517M. Conforming to the supplementary notch toughness requirements of AASHTO M 244/M 244M.

**3.f.3 Quenched and Tempered Alloy Steel Structural Shapes and Seamless Mechanical Tubing.** Products conforming to all of the mechanical and chemical requirements of ASTM A 709/A 709M, Grades 690 or 690W (Grades 100 or 100W) steel, except with a maximum tensile strength of 965 MPa (140,000 pounds per square inch) for structural shapes and 1000 MPa (145,000 pounds per square inch) for seamless mechanical tubing, are to be considered as ASTM A 709/A 709M.

**4. Supplemental Requirements for Notch Toughness.** Provide structural steel conforming to the supplementary notch toughness requirements for the longitudinal Charpy V-notch tests specified for Zone 2 in Table S1 of the applicable AASHTO Materials Specifications. Unless otherwise indicated, the supplemental requirements are mandatory for the following load-carrying member components subject to tensile stress:

- Rolled shapes
- Webs
- Tension flanges of built-up beams
- Beam splice material
- Truss members and gusset plates attached to such truss members.
- Diaphragms, X-frames, bracing, and connecting plates for curved girder bridges or straight girder bridges if the skew is less than 70 degrees.

The requirements are not mandatory for:

- Stiffeners
- Drainage material
- Expansion dams
- Bearings
- Other secondary material
- Diaphragms, X-frames, bracing, and connecting plates for straight girder bridges if the skew is 70 degrees or greater, or unless otherwise indicated as requiring notch toughness.

If directed at a prefabrication meeting, provide samples for Charpy V-Notch testing from steel used in fabricating fracture-critical plates and shapes. Submit the samples to the Structural Materials Engineer, MTD, 1118 State Street, Harrisburg, PA 17120. Obtain the samples from plates delivered to the fabricator.

**(b) Bedding Material for Bridge Shoes.** Section 1113.03(h)

**(c) Bolts, Nuts, and Washers.** From a manufacturer listed in Bulletin 15 and as follows, unless otherwise indicated or specified:

**1. Bolts for General Application.**

- ASTM F 568, Class 4.6
- ASTM A 307, Grade A

**1.a Nuts.**

- ASTM A 563M, Hex Nut, Style 1
  - M16 to M36, Class 5
- ASTM A 563M, Heavy Hex
  - M42 to M100, Class 5

- ASTM A 536M, Heavy Hex
  - All Diameters, Class A

**1.b Washers.** ANSI B18.22M

**2. Anchor Bolts.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36), anchor bolts (headed or nonheaded, either straight or bent) and cap screws, hot-dip or mechanically galvanize as specified in Section 1105.02(s).

**2.a Nuts.** ASTM A 563/A 563M

**2.b Washers.** ASTM F 436/F 436M

**3. Anchor Bolts.** ASTM F 1554, Grades 36, 55, 105, anchor bolts (headed or non-headed, either straight or bent) and cap screws (fully threaded shank), hot-dip or mechanically galvanize as specified in Section 1105.02(s).

**3.a Nuts.** ASTM A 563/A 563M

**3.b Washers.** ASTM F 436/F 436M

**(d) High-Strength Bolts.** Use bolts, nuts, and washers mechanically galvanized as specified in Section 1105.02(s), unless otherwise indicated or specified. For AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 345W (Grade 50W) steel, unpainted, use bolts, nuts, and washers conforming to atmospheric corrosion resistance requirements of AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 345W (Grade 50W). Use mechanically galvanized bolts, nuts, and washers on painted portions of weathering steel structures.

Provide high-strength, carbon steel bolts; suitable nuts; and plain hardened washers for structural joints from a manufacturer listed in Bulletin 15, and, unless otherwise indicated or specified, conforming to the following requirements:

**1. Identifying Marks.** Identify bolts manufactured to AASHTO M 164 (ASTM A 325) and nuts manufactured to specifications referenced in AASHTO M 164 (ASTM A 325) by specific markings on the top of the bolt head and on the face of the nut. Identify the bolt strength grade by the symbol "A325," the bolt manufacturer, and the bolt type using head markings. Identify the nut strength grade, the nut manufacturer, and, if Type 3, the nut type using nut markings.

Identify bolts manufactured to AASHTO M 253/M 253M (ASTM A 490/A 490M) and nuts manufactured to specifications referenced in AASHTO M 253/M 253M (ASTM A 490/A 490M) by specific markings on the top of the bolt head and on the face of the nut. Identify the bolt strength grade by the symbol "A490M" ("A490"), the bolt manufacturer, and the bolt type. Identify the nut strength grade, the nut manufacturer, and, if Type 3, the nut type using nut markings.

Identify washer manufacturer and, if Type 3, the washer type using washer markings.

**2. Dimensions.** Ensure bolt and nut dimensions conform to the requirements for Metric Heavy Hex Structural Bolts (Heavy Hex Structural Bolts) and for Hex Nuts, Heavy, Metric (Hex Nuts, Heavy) given in ANSI Standards B18.2.1 and B18.2.2, respectively.

**3. Bolts.** AASHTO M 164 (ASTM A 325), except as amended and revised below:

Provide a lot number on the supplier's certification corresponding to that appearing on the shipping package and certification Form CS-4171. Note on the supplier's certification when and where all testing was done, including the rotational capacity tests specified. If galvanized bolts are used, include zinc thickness on the supplier's certification.

Furnish bolts with diameters of 12.7 mm to 25.4 mm (1/2 inch to 1 inch) inclusive, and a hardness of 24 to 33 HRC. Provide black bolts "oily" to the touch when installed.

**4. Nuts.** AASHTO M 292/M 292M (ASTM A 194/A 194M) or AASHTO M 291 (ASTM A 563), as applicable.

Provide galvanized, heat-treated nuts, Grade 2H, DH, or DH3, and mechanically galvanized nuts as specified in Section 1105.02(s) (AASHTO M 232 or AASHTO M 298).

Provide plain (ungalvanized) nuts, which are Grade 2, C, D, or C3, having a Rockwell Hardness of 89 HRB; or heat-treated, Grade 2H, DH, or DH3.

Lubricate all galvanized nuts. Use a lubricant containing a dye of any color that contrasts with the color of the galvanizing so that a visual check can be made for the lubricant at the time of field installation.

Furnish nuts to be galvanized that are tapped oversize the minimum amount required to allow assembly on the bolt thread in the coated condition. Ensure nuts conform to the requirements of AASHTO M 291 (ASTM A 563) and the rotational capacity test specified.

**5. Washers.** AASHTO M 293 (ASTM F 436/F 436M), unless otherwise indicated. When indicated, galvanize as specified in Section 1105.02(s) (AASHTO M 232 or AASHTO M 298).

**6. Direct Tension Indicator (DTI) Devices.** ASTM F 959 and as follows:

Provide Direct Tension Indicator (DTI) devices having a hardness of 38 to 45 HRC. Furnish plain DTI devices for use with plain bolts, and, if galvanized bolts are indicated or specified, provide galvanized DTI devices. Galvanize as specified in Section 1105.02(s) (ASTM B 695).

In addition to the bolt tension tests specified in ASTM F 959, test plain finish DTI devices a second time by applying the compression load until the average gap measures 125 µm (0.005 inch). Ensure that the loading remains within the acceptable range according to Table 3 of ASTM F 959 for the applicable type.

Ship each lot in protective containers marked with the type, lot number, quantity, and total lot size. Include a copy of the certification with each shipment.

Handle and store DTI devices according to the manufacturer's recommendations.

Obtain a minimum of eight samples from each lot according to PTM No. 1 for testing at the MTD. Obtain approval before using DTIs.

**7. Testing.** Test bolts, nuts, washers, and assemblies as follows:

**7.a Bolts.** Perform proof load tests according to ASTM F 606/F 606M, Method 1, at the minimum frequency specified in AASHTO M 164 (ASTM A 325), Section 9.2.4.

Perform wedge tests on full size bolts according to ASTM F 606/F 606M, Section 3.5. If bolts are to be galvanized, perform testing after galvanizing. Use the minimum testing frequency specified in AASHTO M 164 (ASTM A 325), Section 9.2.4.

If galvanized bolts are supplied, determine the thickness of zinc coating by taking measurements on the wrench flats or top of bolt head.

**7.b Nuts.** Perform proof load tests according to ASTM F 606/F 606M, Section 4.2, at the minimum frequency specified in AASHTO M 291 (ASTM A 563), Section 9.3, or AASHTO M 292/M 292M (ASTM A 194/A 194M), Section 7.1.2.1. If nuts are to be galvanized, perform testing after galvanizing, overtapping, and lubricating.

If galvanized nuts are supplied, determine the thickness of zinc coating by taking measurements on the wrench flats.

**7.c Washers.** If galvanized washers are supplied, perform hardness testing after galvanizing. Remove the galvanized coating before taking hardness measurements.

If galvanized washers are supplied, measure the thickness of zinc coating.

**7.d Assemblies.** Perform rotational-capacity tests on all black or galvanized bolt, nut, and washer assemblies before shipping. Test galvanized assemblies after galvanizing. Washers are required as part of the test, even if not required as part of the installation procedure. Perform the rotational-capacity test according to AASHTO M 164 (ASTM A 325), except as modified below:

- For long bolts or bolts too short to fit the tension calibrator, test according to PTM No. 427.
- Test each bolt production lot, nut lot, and washer lot in combination as an assembly. If washers are not required as part of the installation procedure, do not include in the lot identification.
- Assign a rotational-capacity lot number to each combination of lots tested.

- Test a minimum of two assemblies per rotational-capacity lot
- Test the bolt, nut, and washer assembly in a Skidmore-Wilhelm Calibrator or an equivalent approved device.

**8. Documentation.** Report the results of all tests (including zinc coating thickness) on the appropriate test report as required in the applicable AASHTO or ASTM standards and as specified below. Report the location where tests were performed and date of testing. Ensure that the manufacturer or distributor performing tests certifies that the results recorded are accurate.

**8.a Mill Test Report (MTR).** Furnish a MTR for all mill steel used in manufacturing bolts, nuts, and washers. Indicate where the material was melted and manufactured.

**8.b Manufacturer Certified Test Report (MCTR).** Provide a MCTR for each item furnished. Ensure that the manufacturer performing the rotational-capacity test include the following on the MCTR:

- The Lot Number of each of the items tested.
- The Rotational-Capacity Lot Number.
- The results of required tests.
- The location where tests were performed and date of testing.
- Certification that the MCTR's for the items conform to this specification and the applicable AASHTO or ASTM standards.
- The location where the bolt, nut, and washer assembly components were manufactured.

**8.c Distributor Certified Test Report (DCTR).** Ensure that the distributor performing tests furnish a certified test report including the following:

- The MCTR for the various bolt, nut, and washer assembly components.
- The results of all required tests, including the rotational-capacity test if performed by the distributor instead of the manufacturer.
- The location where tests were performed and date of testing.
- The Rotational-Capacity Lot Number.
- Certification that the MCTR's conform to this specification and the applicable AASHTO or ASTM standards.

**(e) Welded Stud Shear Connectors.**

**1. Materials.** Provide shear connector studs conforming to AASHTO M 169 (ASTM A 108), cold drawn bars, Grade 1015, 1018, or 1020, either semi-or fully-killed. If flux retaining caps are used, furnish caps of low carbon grade steel suitable for welding and conforming to ASTM A 109/A 109M.

**2. Testing.** Determine tensile properties of either bar stock after drawing or of finished studs according to the applicable sections of ASTM A 370. Perform tensile tests of finished studs on studs welded to test plates using a test fixture similar to that shown in Figure 7.2 of ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002. If fracture occurs outside of the middle half of the gage length, repeat the test.

The required tensile properties are:

| | |
|---|---|
| Tensile Strength | 415 MPa (60,000 psi) (min.) |
| Yield Strength* | 345 MPa (50,000 psi) (min.) |
| Elongation | 20% in 50 mm (2 inches) (min.) |
| Reduction of area | 50% (min.) |

* As determined by a 0.2% offset method.

**3. Finish.** Provide finished studs of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Produce finish by cold drawing, cold rolling, or machining.

**4. Certification.** Provide the manufacturer's certification that the studs, as delivered, conform to the material requirements of this section. Furnish certified copies of in-plant QC test reports to the Representative upon request.

**5. Check Samples.** If required, provide check samples of studs of each type and size used under the contract. The Representative will select the samples.

**(f) Steel Forgings and Steel Shafting.**

**1. Steel Forgings.** Furnish steel forgings conforming to AASHTO M 102 (ASTM A 668/A 668M), Classes C, D, F, or G.

**2. Cold-Finished Carbon Steel Shafting.** Furnish cold-finished carbon steel shafting conforming to AASHTO M 169 (ASTM A 108), UNS Designations G10160-G10300, inclusive, unless otherwise indicated or specified.

**(g) Steel Castings.**

**1. Mild Steel Castings.** Furnish steel castings for use in highway bridge components conforming to AASHTO M 103/M 103M (ASTM A 27/A 27M). Provide steel of Class 485 (Class 70) or Grades 485-250 (Grades 70-36), respectively, unless otherwise indicated or specified.

**2. Chromium-Alloy Steel Castings.** Furnish chromium, alloy-steel castings conforming to AASHTO M 163/M 163M (ASTM A 743/A 743M), Grade CA-15, unless otherwise indicated or specified.

**3. Workmanship and Finish.** Furnish castings true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow-holes, and other defects in positions affecting the castings' strength and value for the service intended. Provide boldly filleted angles and sharp and perfect arrises.

The Contractor may correct defects not affecting the strength and value of the casting for the service intended if allowed in writing by the Chief Bridge Engineer. The Representative may reject castings containing:

- A blow-hole having a length greater than 25 mm (1 inch), a cross-sectional area greater than 320 $mm^2$ (1/2 square inch), or a depth greater than 13 mm (1/2 inch).

- A group of holes in a straight line with a total length greater than or equal to 300 mm (1 foot), measured on the surface of the casting, and with an aggregate length greater than 25 mm (1 inch).

**4. Testing.**

**4.a Major Castings.** Major castings are those subject to high loading whose failure in service would cause major damage (e.g., bridge bearings or machinery parts in movable bridges). All castings over 450 kg (1,000 pounds) are major castings. Test major castings by radiographing with x-ray or gamma ray apparatus according to ASTM E 186, E 280 or E 446, as applicable, and according to Table A below.

**4.b Minor Castings.** Minor castings are those whose failure would not lead to failure of main bridge members (e.g., scuppers or gratings). Test minor castings by suspending them and hammering them all over.

**4.c Rejection.** The Representative may reject castings that contain cracks, flaws, or other defects that appear during or after testing.

**(h) Iron Castings.**

**1. Gray Iron Castings.** Furnish gray iron castings conforming to AASHTO M 105 (ASTM A 48), Class No. 207, unless otherwise indicated or specified.

**2. Malleable Iron Castings.** Furnish malleable iron castings conforming to ASTM A 47/A 47M, Grade 24018, unless otherwise indicated or specified.

**3. Ductile Iron Castings.** Furnish ductile iron castings conforming to ASTM A 536, Grade 60-40-18, unless otherwise indicated or specified. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, for castings having a mass (weight) more than 450 kg (1,000 pounds). Ensure that the required quality is obtained in the castings in the finished condition.

**TABLE A**
**Severity Levels - Radiographically Inspected Castings***

| Specification ASTM Designation | Discontinuity Type Designation | Acceptable** Severity Level | Remarks |
|---|---|---|---|
| E 466 | A | 3 | |
| | B | 3 | |
| | C-1 | 3 | |
| | C-2 | 3 | |
| | C-3 | 3 | |
| up to 50 mm (2 inches) | C-4 | 3 | |
| | D | - | None Allowed |
| | E | - | None Allowed |
| | F | - | None Allowed |
| | G | - | None Allowed |
| E 186 | A | 3 | |
| | B | 3 | |
| | C-1 | 2 | |
| | C-2 | 3 | |
| 50 mm (2 inches) to 115 mm (4 ½ inches) | C-3 | 3 | |
| | D | - | None Allowed |
| | E | - | None Allowed |
| | F | - | None Allowed |
| E 280 | A | 3 | |
| | B | 3 | |
| | C-1 | 2 | |
| | C-2 | 3 | |
| 115 mm (4 1/2 inches) to 300 mm (12 inches) | C-3 | 3 | |
| | D | - | None Allowed |
| | E | - | None Allowed |
| | F | - | None Allowed |

* Radiograph all critical areas, but not less than 25% of each casting, or 25% of all castings, as indicated or as directed.

** If unacceptable defects are found in more than 10% of the radiographs, radiograph 100% of castings until the accumulated rejection level falls to 10% or less. The Contractor may then resume testing 25% of castings.

**4. Workmanship and Finish.** Furnish iron castings true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting the castings' strength and value for the service intended. Provide boldly filleted angles and sharp and perfect arises.

**5. Cleaning.** Remove scale and sand from all castings to provide a smooth, clean, and uniform surface.

**(i) Bronze Bearing and Expansion Plates.** AASHTO M 107 (ASTM B 22), Alloy No. C91100 or C91300, except with a maximum of 2 1/2% lead, unless otherwise indicated or specified.

If indicated, make surfaces permanently self-lubricated. Provide a coefficient of friction of less than 0.10 or as indicated.

**(j) Steel Pipe.**

**1. Pipe and Couplings.** ASTM A 53

**2. Flanges and Pipe Fittings.** ASTM A 338

**3. Welded Fittings.** ASTM A 234/A 234M

**4. Threaded Parts.** Apply one coat of primer to all threads immediately before assembly. Wipe clean after assembly.

**(k) Low-Alloy Steel Pipe.**

**1. Pipe and Couplings.** Manufactured from low-alloy steel AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 345 or 345W (Grade 50 or 50W), Type 2 or AASHTO M 270/M 270M (ASTM A 709/A 709M) Grade 345W (Grade 50W), and conforming to either ASTM A 53, or to ASTM A 714, Class 4, Grade V.

**2. Flanges and Pipe Fittings.** ASTM A 338

**3. Welding Fittings.** ASTM A 234/A 234M

**4. Threaded Parts.** Apply one coat of primer to all threads immediately before assembly. Wipe clean after assembly.

**(m) Steel Tubing.** ASTM A 500 or ASTM A 501

**(n) Cast Iron Pipe.** ASTM A 74 or ASTM A 377

**(p) Sheet Copper.** AASHTO M 138/M 183M (ASTM B 152/B 152M), and conforming to the requirements of the Embrittlement Test, Section 12 of AASHTO M 138/M 138M (ASTM B 152/B 152M) and ASTM B 577.
Make lapped joints by soldering or by riveting and soldering.

**(q) Sheet Zinc.** ASTM B 69, Type II.
Make lapped joints by soldering.

**(r) Sheet Lead.** Common desilverized lead A, as specified for pig lead, ASTM B 29.

**(s) Galvanizing.** From a galvanizer listed in Bulletin 15 and as follows:

**1. General.** If indicated or specified, galvanize materials as specified in the applicable material specifications. If the applicable material specifications do not include galvanizing, galvanize according to ASTM A 53; ASTM B 633; ASTM A 392, Class 2 coating; ASTM B 695 and B 696 (AASHTO M 298 and M 299); ASTM A 123 (AASHTO M 111); or ASTM A 153 (AASHTO M 232), as applicable.
Test for the specified mass (weight) of galvanizing according to ASTM A 90/A 90M (AASHTO T 65).
Comply with ASTM A 143 and ASTM A 385.

**2. Repair of Damaged Galvanizing.** After erecting galvanized material in place, clean damaged areas and apply two coats of zinc dust—zinc oxide paint, or other acceptable material.

**3. Quenching after Galvanizing.** Quenching after galvanizing is allowed for the following items:

Non-welded secondary bridge members
Railings
Drainage Scuppers
Downspouts
Inlet grates
Utility brackets
Angle Supports
Embedded plates

Quenching after galvanizing is not allowed for the following items without approval of the Engineer:

Primary bridge members

Welded secondary members
Sign Structures
Traffic and lighting poles
Any member to be painted after galvanizing

Items not listed may not be quenched without approval of the Engineer.

**(t) Welding Material.** ANSI/AASHTO/AWS D1.5-2002 Bridge Welding Code, modified as specified in Section 1105.03(m)1.

**(u) Paint.** Section 1060.2

**(v) Certification.** Section 106.03(b)3

**(w) Eyebars.** Furnish a weldable grade of steel for eyebars. Acceptable grades include:

- Structural steel for bridges, AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36), ASTM A 36.
- Structural steel for bridges, AASHTO M 270/M 270M (ASTM A 709/A 709M), Grades 345 and 345W (Grades 50 and 50W), ASTM A 572, Grade 345 (Grade 50), ASTM A 588, Grades A, B, and C only.

**1105.03 FABRICATION—**

**(a) Straightening Material and Curving Rolled Beams and Welded Girders.** Section 1050.03(c)5 and as follows:

**1. Materials.** Do not heat straighten or heat curve steels that are manufactured to a specified minimum yield point greater than 345 MPa (50,000 pounds per square inch) without approval.

**2. Type of Heating.** Curve beams and girders by either continuous or V-type heating, as approved.

**2.a Continuous Heating.** For the continuous method, heat a strip or intermittent strips along the edge of the top and bottom flange approximately simultaneously depending on flange widths and thicknesses. Use a strip of sufficient width and temperature to obtain the required curvature.

**2.b V-type Heating.** For the V-type heating, heat the top and bottom flanges in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange. Use the spacing and temperature necessary to obtain the required curvature and to allow heating to progress along the top and bottom at approximately the same rate. Terminate the apex of the truncated triangular area applied to the inside flange surface just before the junction of the web and the flange is reached. When heating the inside flange surface (the surfaces that intersect the web), do not apply heat directly to the web. If the radius of curvature is 300 000 mm (1,000 feet) or more, extend the apex of the truncated triangular heating pattern applied to the outside flange surface to the juncture of the flange and web. If the radius of curvature is less than 300 000 mm (1,000 feet), extend the apex of the truncated triangular heating pattern applied to the outside flange surface past the web for a distance equal to one-eighth of the flange or 75 mm (3 inches), whichever is less. For the truncated triangular pattern, provide an included angle of approximately 15 to 30 degrees, but do not exceed 250 mm (10 inches) for the base of the triangle. Do not make variations in the patterns prescribed above unless permitted.

For both types of heating, heat the flange edges that will be on the inside of the horizontal curve after cooling. Heat both the inside and outside flange surfaces only if the flange thickness is 32 mm (1 1/4 inches) or greater. Heat the two surfaces concurrently.

**3. Temperature.** Conduct the heat-curving operation in such a manner that the steel temperature does not exceed 620 °C (1,150F) as measured by temperature indicating crayons or other suitable means. Do not artificially cool the girder until after it naturally cools to 315 °C (600F). Obtain approval for the method of artificial cooling.

**4. Position for Heating.** Heat-curve the girder with the web in either a vertical or a horizontal position.

If curved in the vertical position, brace or support the girder in such a manner that the tendency of the girder to deflect laterally during the heat-curving process will not cause the girder to overturn.

If curved in the horizontal position, support the girder near its ends and at intermediate points, as necessary, to obtain a uniform curvature. Do not allow the bending stress in the flanges due to the dead weight of the girder to exceed the usual allowable design stress. Maintain intermediate safety catch blocks at the mid-length of the girder within 50 mm (2 inches) of the flanges at all times during the heating process to guard against a sudden sag due to plastic flange buckling.

**5. Sequence of Operations.** Heat-curve the girder in the fabrication shop before it is painted. Conduct the heat curving operation either before or after all the required welding of transverse intermediate stiffeners is completed. However, unless provisions are made for girder shrinkage, locate and attach connection plates and bearing stiffeners after heat curving. If longitudinal stiffeners are required, heat-curve or oxygen-cut them separately and then weld them to the curved girder. When cover plates are to be attached to rolled beams, attach them before heat curving if the total thickness of one flange and cover plate is less than 65 mm (2 1/2 inches) and the radius of curvature is greater than 300 000 mm (1,000 feet). For other rolled beams with cover plates, heat-curve the beams before the cover plates are attached; either heat-curve or oxygen-cut cover plates separately, then weld them to the curved beam.

**6. Camber.** Camber girders before heat curving. Obtain camber for rolled beams using approved heat-cambering methods. For plate girders, cut the web to the prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat-curving. However, if permitted, correct moderate deviations from specified camber by a carefully supervised application of heat. Correct deviations from the specified camber according to Publication 135.

**7. Measurement of Curvature and Camber.** Measure horizontal curvature and vertical camber after all welding and heating operations are completed and the flanges have cooled to a uniform temperature. Check horizontal curvature with the girder in the vertical position.

**(b) Finish.** Finish exposed work. Shear, flame cut, and chip carefully and accurately. Make sharp corners and round edges by grinding or other acceptable means.

When AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 345W (Grade 50W), ASTM A 588, Grades A, B, and C only steel is specified for beams or girders, blast clean only the fascia side of exterior beams or girders in the field according to SSPC-SP6-85, Commercial Blast Cleaning. Blast clean from the top outside (fascia) edge of the top flange to the inside edge of the bottom flange including the bottom of the bottom flange. Blast clean the faying surfaces of splices and connections of all structural elements according to SSPC-SP-1085. Reblast unpainted elements that remain unassembled for a period of 12 months following the initial cleaning.

**(c) Bolt Holes.**

**1. General.** Either punch or drill all holes for bolts.

Unless subpunching and reaming are specified in Section 1105.03(d), punch material forming parts of a member composed of not more than five thicknesses of metal 2 mm (1/16 inch) larger than the nominal diameter of the bolts whenever the thickness of the material is not greater than 20 mm (3/4 inch) for structural steel, 16 mm (5/8 inch) for high-strength steel or 12 mm (1/2 inch) for quenched and tempered alloy steel. If there are more than five thicknesses or if any of the main material is thicker than 20 mm (3/4 inch) for structural steel, 16 mm (5/8 inch) for high-strength steel, or 12 mm (1/2 inch) for quenched and tempered alloy steel, either subdrill and ream or drill all holes full size.

When specified, either subpunch (or subdrill if thickness limitation governs) all holes 5 mm (3/16 inch) smaller than the nominal diameter of the bolts and, after assembling, ream to 2 mm (1/16 inch) larger than the nominal diameter of the bolts, or drill all holes full size to 2 mm (1/16 inch) larger than the nominal diameter of the bolts.

When indicated, provide enlarged or slotted holes with high-strength bolts.

**2. Punched Holes.** Furnish dies with diameters that do not exceed the diameter of the corresponding punch by more than 2 mm (1/16 inch). Ream any holes that must be enlarged to admit the bolts. Cut holes clean without torn or ragged edges.

**3. Reamed or Drilled Holes.** Furnish reamed or drilled holes perpendicular to the member, cylindrical, and conforming to the size requirements specified in Section 1105.03(c)1. Where practical, direct reamers by mechanical means. Remove burrs on the outside surfaces. Use twist drills, twist reamers, or rotobroach cutters for reaming and drilling. Assemble and securely hold connecting parts while they are being reamed or drilled. Match mark the connecting parts before disassembling.

**4. Accuracy of Holes.** Furnish holes not more than 1 mm (1/32 inch) larger in diameter than the true decimal equivalent of the nominal diameter. The slightly conical hole that results from punching operations is acceptable. Ensure that the width of slotted holes produced by flame cutting or a combination of drilling and flame cutting or punching and flame cutting are not more than 1 mm (1/32 inch) greater than the nominal width. Grind the flame cut surface smooth.

**5. Numerically-Controlled Drilled Field Connections.** Instead of reaming sub-sized holes or drilling full-sized holes while assembled, the Contractor may use numerically controlled (N/C) drilling or punching equipment to drill or punch full-sized bolt holes in unassembled pieces, connections, and templates for use with matching sub-sized and reamed holes. The Contractor may use N/C equipment to either drill or punch holes through individual pieces or drill through any combination of pieces held tightly together. Full-size punched holes shall meet the requirements of Section 1105.03(c)2.

If N/C drilling or punching equipment is used, demonstrate the accuracy of the drilling or punching procedure by means of check assemblies as specified in Section 1105.03(g).

**6. Holes for Turned Bolts or Other Approved Bearing Type Bolts.** Subpunch or subdrill all holes 5 mm (3/16 inch) smaller than the nominal diameter of the bolt for turned bolts or other approved bearing-type bolts. After assembling, either ream, drill to a steel template, or drill from the solid. Provide a driving fit for the finished holes as indicated or as specified in the special provisions.

**(d) Preparation of Field Connections.** Unless otherwise approved, prepare bolt holes for field connections and field splices as follows:

- Field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames – subpunch or subdrill and subsequently ream while assembled or drill full size through a steel template while assembled.

- Field splices of rolled beam stringers continuous over floor beams or cross frames – the fabricator may drill full size unassembled to a steel template.

- Floor beams or cross frames – the fabricator may drill full size unassembled to a steel template.

- Floor beam and stringer field end connections – subpunch and ream while assembled or drill full size to a steel template while assembled.

- For any connection, instead of subpunching and reaming, or subdrilling and reaming, the fabricator may drill holes full size with all thicknesses of material assembled in proper position.

When using a steel template, ream and drill full size all field connection holes through the template after the template has been placed in the proper position and angle and firmly bolted into place. Use templates that are exact duplicates for reaming matching members or the opposite faces of a single member. Accurately locate templates used for connections on like parts or members so that the parts or members are duplicates and require no match-marking.

**(e) Accuracy of Hole Group.**

**1. Accuracy Before Reaming.** Punch full size, subpunch, or subdrill holes such that after assembling, and before any reaming is done, a cylindrical pin 3 mm (1/8 inch) smaller in diameter than the nominal size of the hole may be entered perpendicularly to the face of the member without drifting in at least 75% of the contiguous holes in the same plane. The Representative will reject pieces that do not conform to this requirement. Also, the Representative may reject any piece that contains at least one hole that will not pass a pin 5 mm (3/16 inch) smaller in diameter than the nominal size of the hole.

**2. Accuracy After Reaming.** After holes are reamed or drilled, ensure that the offset between adjacent thicknesses of metal is no greater than 1 mm (1/32 inch) for at least 85% of the holes in any contiguous group.

For all steel templates, provide hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. Use the centerlines to accurately locate the template from the milled or scribed ends of the members.

**(f) Bolting.** Clean surfaces of metal in contact before assembling. Assemble, pin, and firmly draw together the parts of a member before drilling, reaming, or bolting. If necessary, dismantle assembled pieces to remove burrs and shavings produced by the operation. Furnish members free from twists, bends, and other deformation.

When assembling, allow enough drifting to bring the parts into position, however, do not allow the drifting to enlarge the holes or distort the metal.

**(g) Preassembly of Field Connections.**

**1. General.** As necessary, preassemble field connections of main members of trusses, arches, continuous beams, plate girders, bents, towers and rigid frames before erection to verify the geometry of the completed structure or unit and to verify or prepare field splices.

Submit an appropriate method of preassembly for approval. Provide a method and details of assembly consistent with the erection procedure indicated on the approved erection plans and camber diagrams. At a minimum, provide a preassembly procedure consisting of assembling three contiguous panels accurately adjusted for line and camber. Provide a procedure for progressive assemblies consisting of at least one section or panel of the previous assembly (repositioned if necessary and adequately pinned to ensure accurate alignment) plus two or more sections or panels added at the advancing end. For structures longer than 46 000 mm (150 feet), furnish a procedure for assemblies not less than 46 000 mm (150 feet) long regardless of the length of individual continuous panels or sections. The Contractor may start the sequence of assembly from any location in the structure and proceed in one or both directions provided that the preceding requirements are satisfied.

Use the Progressive Truss and Girder Assembly unless otherwise specified in the proposal.

**2. Bolted Connections.** For bolted connections, prepare holes as specified in Section 1105.03(c). Where applicable, assemble major components of compression members with milled ends in full bearing, and then ream the sub-sized holes to the specified size.

**3. Check Assembly-Numerically Controlled Drilling.** When using numerically controlled drilling, furnish a check assembly for each major structural type of each project unless otherwise indicated or specified in the special provisions. Provide check assemblies consisting of at least three contiguous shop sections or, for a truss, all members in at least three contiguous panels but not less than the number of panels associated with three contiguous chord lengths (i.e., length between field splices). Base check assemblies on the proposed order of erection, joints in bearings, special complex points, and similar considerations. Special complex points include the portals of skewed trusses.

Use the first sections of each major structural type to be fabricated as the check assemblies.

Obtain approval for each N/C drilled check assembly before reaming or dismantling the assembly. If a check assembly fails to demonstrate that the required accuracy is being obtained for camber, alignment, accuracy of holes, and fit of milled joints, the Representative may require additional check assemblies. Additional check assemblies will be at no additional cost to the Department.

**4. Field Welded Connections.** Preassemble field welded connections as specified in Section 1105.03(g)1 and verify the fit of members, including the proper space between abutting flanges.

**(h) Match-Marking.** Match-mark connecting parts preassembled in the shop to ensure proper fit in the field. Furnish a diagram showing match-marks to the Representative.

**(i) Connections Using Unfinished or Turned Bolts.**

**1. General.** When unfinished bolts are specified, furnish unfinished or turned bolts conforming to ASTM A 307, Grade A Bolts. Provide bolts with single self-locking nuts or double nuts unless otherwise indicated or specified in the special provisions. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

For bolted connections fabricated with high-strength bolts, assemble connections as specified in Section 1105.03(j).

**2. Turned Bolts.** Provide turned bolts with an ANSI roughness rating value of 125 for the surface of the body of the bolts. Furnish hexagonal heads and nuts with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Provide thread diameters equal to the body of the bolt or the nominal diameter of the bolt specified. Carefully ream holes for turned bolts with bolts furnished to provide for a light driving fit. Furnish bolts with threads that are entirely outside of the holes. Provide a washer under the nut.

**(j) Connections Using High Strength Bolts.**

**1. General.** Provide AASHTO M 164 (ASTM A 325) or equivalent high strength bolts . Furnish bolt holes as specified in Section 1105.03(c). When Turn-of-Nut Tightening Method is used, provide hardened washers as specified in Section 1105.02(d)5, under the element turned in tightening.

**2. Bolted Parts.** Use steel for all material within the grip of the bolt; do not use compressible material such as gaskets or insulation within the grip. Ensure that bolted steel parts solidly fit together after the bolts are tightened. Bolted steel parts may be coated or uncoated. Do not exceed a slope of 1:20 (20:1) for the surfaces of parts in contact with the bolt head or nut with respect to a plane normal to the bolt axis.

**3. Surface Conditions.** At the time of assembly, ensure that all joint surfaces, including surfaces adjacent to the bolt head and nut, are free of scale (except tight mill scale), dirt, or other foreign material. Remove burrs that would prevent solid seating of the connected parts.

Paint is allowed on the faying surface in connections except for slip-critical connections as defined in Article 6.13.2.1.1 of the LRFD Specification. Prepare faying surfaces for slip-critical connections according to the following requirements, as applicable:

**3.a Non-coated Joints.** Exclude paint, including any inadvertent over spray, from the area within the bolt pattern and areas closer than one bolt diameter, but not less than 25 mm (1 inch), from the edge of any hole.

**3.b Joints with Painted Faying Surfaces.** Blast clean joints specified to have painted faying surfaces. Except as specified in Section 1105.03(j)3.c, coat the joints with a Class A or B paint according to Section 6.13.2.8 of the LRFD Specification.

**3.c Coatings with Low Slip Coefficient.** If permitted, and provided that the mean slip coefficient is established (tested according to Section 6.13.2.8 of the LRFD Specification) and the allowable slip load per unit area is achieved, the Contractor may use a coating providing a slip coefficient less than 0.33.

**3.d Minimum Coating Curing Time.** Do not assemble coated joints before the coating has cured for the minimum time used in the qualifying test.

**3.e Galvanized Faying Surfaces.** Hot-dip galvanize faying surfaces specified to be galvanized according to AASHTO M 111 (ASTM A 123). Subsequently roughen galvanized surfaces by hand wire brushing. Do not roughen using power wire brushes.

**3.f Existing Field Surfaces.** For connections to existing structures, provide surface conditions according to the contract documents.

**(k) Plate Cut Edges.**

**1. Edge Planing.** Plane, mill, grind, or thermal cut to a depth of 5 mm (3/16 inch) the sheared edges of plates more than 16 mm (5/8 inch) thick that carry calculated stress.

**2. Oxygen Cutting.** Conduct oxygen cutting of structural steel according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002.

**3. Visual Inspection and Repair of Plate Cut Edges.** Perform visual inspection and repair of plate cut edges according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002.

**(l) Not used.**

**(m) Welding.** Conduct welding, welder qualifications, prequalification of weld details, and inspection of welds according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002. Unless otherwise indicated or specified, for tubular structures, conduct welding, welder qualifications, prequalification of weld details, and inspection of welds according to ANSI/AASHTO/AWS D1.1-2002 subject to the following limitations:

- Do not use grade 60 electrodes.
- Use only low-hydrogen electrodes.
- Provide a minimum preheat and interpass temperature of at least 10 ºC (50F).

Do not weld or tack brackets, clips, shipping devices or other material not indicated or specified in the Special Provisions to any member unless shown on the shop drawings and approved.

**1.** Weld structural steel for highway bridges according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002 with the following modifications:

- Section 1.1.3. Revise completely as follows:
  All references to acceptance or approval will denote acceptance or approval by the Engineer. The term Engineer refers to the Chief Bridge Engineer or the Chief Bridge Engineer's representative; namely, the Chief Structural Materials Engineer.
- Section 1.3.2. Delete this section.
- Section 1.3.6, Welding of Ancillary Products. Delete items (1) and (2).
- Section 2.3.3, Plug and Slot Welds. Delete this section.
- Section 9, Details of Plug and Slot Welds. Delete this section.
- Section 3.5.1.6(2). Panels are designated as unstiffened (no intermediate stiffeners) in any location along the girder where the spacing of stiffeners, including diaphragm connection plates, exceeds 1.5 times the web depth for straight girders and 1.0 times the web depth for curved girders. Web flatness must be checked for conformance in all girder panels by the fabricator, and witnessed by the Department's agency inspector. Flatness variations exceeding the tolerance must be documented. Submit a repair procedure to the chief Structural Materials Engineer for review and approval prior to repair.
- Section 3.5.1.9. Revise completely as follows:
  Bearing stiffeners will be flush and square with the web. Fit of bearing stiffeners as specified in Section 1105.03(u). Flatness and tolerance of side plate after welding as specified in Section 1111.03(c).

- Section 4.1.6. Delete this section.
- Table 4.2, Matching Filler Metal Requirements for WPSs Qualified in Accordance with 5.13. Delete all references to electroslag or electrogas welding.
- Section 4, Part E, Electroslag Welding (ESW) and Electrogas Welding (EGW). Delete this part.
- Section 4, Part F, Plug and Slot Welds. Delete this part.
- Section 5.3, Duration. Add the following:
  Unless directed.
- Section 5.14, Electroslag and Electrogas Welding. Delete this section.
- Table 5.4, Additional PQR Essential Variable Changes Requiring WPS Requalification for Electroslag or Electrogas Welding. Delete this table.
- Section 5.16.4. Delete Item (2).
- Section 5.19.5.2, ESW and EGW Specimens. Delete this section.
- Section 6.7.1. Revise completely as follows:
  Non-destructively test complete penetration groove welds as specified in Section 1105.03(m)8.
- Section 6.7.1.1. Delete this section.
- Section 6.7.1.2(2). Revise completely as follows:
  Twenty-five percent of each joint subject to compression or shear.
- Section 6.7.1.2(2)(d). Delete this section.
- Section 6.7.2.1. Revise the first sentence as follows:
  At least 300 mm (12 inches) will be tested in every 3 m (10-foot) length and 300 mm (12 inches) of such welds less than 3 m (10 feet) in length of each size of weld and type joint in main members including the end connections of such members.
- Section 2.17.6.1. Revise second sentence as follows:
  Connections or splices made with fillet welds will be designed for the average of the calculated stress and the strength of the member, but no less than 75% of the strength of the member.
- Section 12.6 Consumable Requirements – Delete all references to optional supplemental diffusible hydrogen designator H16.

**2.** Do not weld to flanges in tension areas unless indicated.

**3.** Show types of steel on shop drawings.

**4.** Do not weld temporary fabrication and construction details, such as rails for deck finishing equipment, bar supports, or deck-forming devices, to beams, girders, or other main members, unless permitted. Identify locations of such welds on the shop drawings.

**5.** Do not use electroslag or electrogas welding.

**6.** Do not use the gas metal arc welding (GMAW) process for main load-carrying members, including rolled shapes, web-to-web welds, web-to-flange welds, flange-to-flange welds, and stiffener and connection plate welds to flanges or webs, truss members, or gusset plates. The Contractor may use the GMAW process for welding drainage material, expansion dams, X-frames, diaphragms, bearings, bracing, and other secondary material, unless otherwise indicated.

The Contractor may use the gas shielded flux cored arc welding (FCAW) process for shop application only of stiffener and connection plate welds to flanges and webs, gusset plates, drainage material, expansion dams, X-frames, diaphragms, bearings, bracing, other main load-carrying members or secondary material, unless otherwise indicated. Do not use FCAW on primary member welds, including girders, trusses and fracture critical members (e.g., web splicing, flange splicing, or web-to-flange weld), unless otherwise indicated.

**7.** Do not use plug welds to repair misplaced holes.

**8.** Non-destructively test all groove welds in main members according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002. Unless otherwise indicated or specified, use radiographic testing on butt joints. Use radiographic or ultrasonic testing for corner or "T" joints. Use magnetic particle testing according to ANSI/AASHTO/AWS D1.5-2002, Section 6.7.2.

**9**. All welding consumables (electrodes and electrode/flux combinations) used for welding of fracture critical members will conform to the diffusible hydrogen requirements of the AWS filler metal specifications optional supplemental designator H4 or H8 only.

**10.** Perform weld repairs according to specified welding code and Department approved procedure(s). Do not repair individual locations more than three times without written permission of the Engineer. Following the third unsuccessful attempt, submit a proposed repair procedure for review.

**11.** Do not repair any individual area on welded pole to base connections for luminaire supports, traffic signal supports, and sign structure supports more than one time without written permission of the Engineer.

**(n) Weld Repairs and Geometric Corrections using Applied Heat.** For non-fracture critical members only, refer to Publication 135 for pre-approved base metal repair procedures and heat correction procedures. The fabricator may use the pre-approved procedures after the Department's inspector has verified that the discontinuity to be repaired is covered by the specific procedure. Any repairs performed are subject to inspection by the Department's inspector.

**(o) Not used.**

**(p) Oxyfuel Gas Cutting and Plasma Arc Cutting.** Cut steel and weld metal using oxyfuel gas, air plasma arc, or oxygen plasma arc processes. Conduct cutting for all processes according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002 with the modifications specified in Section 1105.03(m)1. Air plasma arc cutting and oxygen plasma arc cutting may be used for AASHTO M 270/M 270M (ASTM A 709/A 709M), Grades 250, 345, 345W, and 485W (Grades 36, 50, 50W, and HPS 70W) and for stainless steels. Do not cut materials thicker than 16 mm (5/8 inch) with air plasma arc cutting. Do not cut materials thicker than 25 mm (1 inch) with oxygen plasma arc cutting. Do not apply water to the base metal during any cutting process except as otherwise indicated. Do not cut fracture critical members with either air plasma arc cutting or oxygen plasma arc cutting.

**(q) Facing of Bearing Surfaces.** Ensure that the surface finishes of bearing and base plates and other bearing surfaces in contact with each other or concrete conform to the ANSI surface roughness requirements defined in ANSI/ASME B46.1 and listed below:

- Steel slabs — ANSI 50 µm (2 mils)
- Heavy plates in contact with shoes to be welded — ANSI 25 µm (1 mil)
- Milled ends of compression members, milled or — ANSI 12.5 µm (0.5 mil)

| | |
|---|---|
| ground ends of stiffeners and fillers | |
| • Bridge rollers and rockers | ANSI 6.3 µm (0.25 mil) |
| • Pins and pin holes | ANSI 3.2 µm (0.13 mil) |
| • Sliding bearing | ANSI 3.2 µm (0.13 mil) |
| • Sliding bearings—Stainless Steel to Polytetrafluoroethylene (PTFE) | ANSI 0.20 µm (0.008 mil) |

Fabricate bearing surfaces according to the following additional requirements:

- Machine sliding bearings having a surface roughness of 1.6 µm (0.063 mil) or rougher so the lay of the cut is parallel to the direction of movement.
- Provide machined surfaces plane and true, conforming to the indicated dimensions.
- For surfaces designed to be flat, machine surfaces to within 0.25 mm (0.01 inch) of flatness. Determine flatness as specified in Section 1111.03(c).
- Maintain uniform and even contact when assembling adjacent bearing surfaces. Unless a closer tolerance is indicated or specified, do not exceed a gap of 1.0 mm (0.040 inch) between bearing surfaces. Machine all sliding surfaces of base plates.
- Do not machine any surfaces of fabricated members until all fabrication and welding of the assembly or subassembly is complete. Machine heat-treated components after completion of heat treating.

**(r) Abutting Joints.** Mill or saw-cut abutting joints in compression members of trusses and columns to obtain a square joint and uniform bearing. Do not allow the opening at other joints not required to be faced to exceed 10 mm (3/8 inch).

**(s) Plates: Direction of Rolling. Fabrication of Members.** Unless otherwise indicated, cut and fabricate steel plates for main members and splice plates for flanges and main tension members (not secondary members) so that the primary direction of rolling is parallel to the direction of the main tensile and compressive stresses.

Unless otherwise indicated or specified, fabricate I-shaped beams and girders so that when erected and under their own weight, the webs are within the allowable tolerance of vertical. Provide flanges normal to the web, unless otherwise indicated.

**(t) Bent Plates.**

**1. General.** Fabricate bent, unwelded, load-carrying, rolled-steel plates from the stock plates so that the bend lines will be at right angles to the direction of rolling. If permitted, cold-bent ribs for orthotropic-deck bridges may be bent with bend lines in the direction of rolling.

Before bending, round the corners of the plate where bending is to occur to a radius of 2 mm (1/8 inch).

**2. Cold Bending.** Cold bend such that no cracking of the plate occurs. Provide minimum bend radii, measured to the concave face of the metal, according to the following table:

| Thickness in mm (inches) (t) | Up to 12 (1/2) | Over 12 (1/2) to 25 (1) | Over 25 (1) to 38 (1 1/2) | Over 38 (1 1/2) to 65 (2 1/2) | Over 65 (2 1/2) to 100 (4) |
|---|---|---|---|---|---|
| Bend radii for all grades of structural steel in this specification | 2t | 2 1/2t | 3t | 3 1/2t | 4t |

Provide allowance for springback of Grades 690 and 690W (Grades 100 and 100W) steels of about three times that for Grade 250 (Grade 36) steel. For break press forming, provide a lower die span of at least 16 times the plate thickness. Multiple hits are advisable.

**3. Hot Bending.** If a radius shorter than the minimum specified for cold bending is necessary, hot bend the plates at a temperature not less than 430 °C (800F) and not greater than 650 °C (1,200F). If Grades 690 and 690W (Grades 100 and 100W) steel plates are heated to a temperature greater than 610 °C (1,100F), requench and temper them according to the producing mill's practice.

**(u) Fit of Stiffeners.** Ensure that at least 75% of the bearing area of end bearing stiffeners for girders and stiffeners intended as supports for concentrated loads have full bearing on the flanges that they transmit load to or receive load from. The gap between the bearing stiffener and the flange may not exceed 0.8 mm (1/32 inch). Mill or grind the ends of bearing stiffeners to achieve the required bearing on the flanges. For weldable steel in compression areas of flanges, weld stiffeners as indicated or specified.

Provide a tight fit against the compression flange for intermediate stiffeners not intended to support concentrated loads unless otherwise indicated or specified.

**(v) Eyebars.** Flame cut pin holes at least 50 mm (2 inches) smaller in diameter than the finished pin diameter. Securely fasten together all eyebars that are to be placed side by side in the structure in the order that they will be placed on the pin and bore both ends while clamped. Pack and match-mark eyebars for shipment and erection. Stamp all identifying marks on the edge of one head of each member with steel stencils after fabrication is completed so that the marks are visible when the bars are nested in place on the structure. Provide low stress type steel die stamps.

Furnish eyebars straight and free from twists. Accurately locate pin holes on the centerline of the bar. Limit inclination of any bar to the plane of the truss to 1 mm per 200 mm (1/16 inch to a foot).

Simultaneously cut the edge of eyebars that lie between the transverse centerline of their pin holes with two mechanically operated torches abreast of each other and guided by a substantial template. Prevent distortion of the plates.

**(w) Annealing and Stress Relieving.** Anneal (full annealing) and normalize structural members indicated according to ASTM A 941. Finish machining, boring, and straightening structural members subsequent to heat treatment. Maintain the temperature uniformly throughout the furnace during heating and cooling so that the temperatures of any two points on the member differ by no more than 55 °C (100F) at any one time.

Do not anneal or normalize members consisting of Grades 690 and 690W (Grades 100 and 100W) or Grade 485W (Grade 70W) steel. Stress relieve these members only if permitted. Do not allow the holding temperatures for stress relieving Grades 690 and 690W (Grades 100 and 100W) and Grade 485W (Grade 70W) steels to exceed 610 °C and 580 °C (1,100F and 1,050F), respectively.

Furnish a record of each furnace charge identifying the pieces in the charge and showing the temperature and schedule actually used. Provide proper instruments, including recording pyrometers, to determine the temperatures of members in the furnace at any time. Submit the records of the treatment operation for approval.

When indicated or specified, stress relieve members such as bridge shoes, pedestals, or other parts that are built up by welding sections of plate together according to Section 4.4 of the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002.

**(x) Pins and Rollers.** Turn pins and rollers to the dimensions indicated and ensure that they are straight, smooth, and free from flaws. Forge and anneal pins and rollers more than 225 mm (9 inches) in diameter. Either forge and anneal or use cold-finished, carbon-steel shafting for pins and rollers 225 mm (9 inches) or less in diameter.

In pins larger than 225 mm (9 inches) in diameter, bore a hole not less than 50 mm (2 inches) in diameter full length along the axis of the pin after the forging has cooled to a temperature below the critical range and before annealing. Bore the hole under suitable conditions to prevent damage by cooling too rapidly.

**(y) Boring Pin Holes.** Bore pin holes true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise indicated or specified. Produce the final surface by a finishing cut.

Do not allow the diameter of the pin hole to exceed that of the pin by more than 0.50 mm (1/50 inch) for pins 125 mm (5 inches) or less in diameter, or by more than 0.75 mm (1/32 inch) for pins larger than 125 mm (5 inches) in diameter. Do not allow the distance outside to outside of end holes in tension members and inside to inside of end holes in compression members to vary more than 0.75 mm (1/32 inch) from that indicated or specified. Bore pin holes in built-up members after the member has been assembled.

**(z) Threads for Bolts and Pins.** Provide threads for all bolts and pins for structural steel construction conforming to Unified Standard Series UNC ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except furnish pin ends having a diameter of 34.9 mm (1 3/8 inches) or threaded more than six threads to 25 mm (1 inch).

**(aa) Full Size Tests.** When full size tests of fabricated structural members or eyebars are indicated or specified, provide suitable facilities, material, supervision, and labor necessary for making and recording the required tests.

**(bb) Marking and Shipping.** Paint or mark each member with an erection mark for identification. Furnish an erection diagram to the Representative indicating the location of the erection marks on each member, so that the marks can be located in the field.

Furnish copies of material orders, shipping statements, and erection diagrams to the Representative. Show the masses (weights) of the individual members on the statements. Mark the masses (weights) of members with a mass (weight) greater than 2700 kg (3 tons) on the members. Load structural members on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.

Pack bolts of one length and diameter and loose nuts or washers of each size separately. Ship pins, small parts and packages of bolts, washers, and nuts in boxes, crates, kegs, or barrels, but do not allow the gross mass (weight) of any package to exceed 135 kg (300 pounds). Plainly display a list and description of contents on the outside of each shipping container.

**(cc) Painting.** Section 1060.3 and as follows:

Include the manufacturer of the complete self-curing inorganic zinc system consisting of the primer, intermediate tie, and finish coats on the shipping papers.

**(dd) Identification of Steel During Fabrication.** Use a system of assembly-marking individual pieces and issuing cutting instructions to the shop (generally by cross-referencing the assembly-marks indicated on the shop drawings with the corresponding item covered on the mill purchase order) that maintains the identity of the original piece.

Only furnish steel from stock material that can be identified by heat number and mill test report.

During fabrication, up to the point of assembling members, clearly and legibly show the grade designation on each piece of steel other than Grade 250 (Grade 36) steel. Either write the grade designation on the piece or use the identification color code shown in Table B.

**TABLE B**
**Identification Color Codes**

| Grade Metric (English) | Color Code |
|---|---|
| 345 (50) | Green & Yellow |
| 345W (50W) | Blue & Yellow |
| 485W (70W) | Blue & Orange |
| 690 (100) | Red |
| 690W (100W) | Red & Orange |

Except for Grade 250 (Grade 36) steel, establish an individual color code for steels not covered in Table B or included in AASHTO M 160/M 160M (ASTM A 6/A 6M). Provide the color code to the Representative.

Die stamp or firmly attach a substantial tag to identify the grade designation of those pieces of steel, other than Grade 250 (Grade 36) steel, that before being assembled into members will be subjected to fabricating operations such as blast cleaning, galvanizing, heating for forming, or painting that might obliterate paint color code markings. Furnish low stress-type steel die stamps.

If requested by the Representative, furnish an affidavit certifying that the identification of the steel was maintained according to this specification throughout the fabrication operation.

**(ee) Welded Connections.** Ensure that surfaces and edges to be welded are smooth, uniform, clean, and free of defects that would adversely affect the quality of the weld. Prepare edges according to the ANSI/AASHTO/AWS Bridge Welding Code D1.5-2002.

**(ff) Numerically-Controlled Drilled Field Connections.** Section 1105.03(c)5

**(gg) Facing of Bolted Surfaces.** ASTM A 6/A 6M, and as follows:

- Provide surfaces plane and true, within the specified tolerances.
- Variations for surfaces designed to be flat: Conforming to ASTM A 6/A 6M, Tables A1.13, A1.14, and A1.15, unless otherwise indicated or specified.
- Complete all welded attachments to bolted surfaces before machining surfaces to required tolerances.
- Grind only on surfaces less than 50 mm (2 inches) wide, unless otherwise permitted.
- Use milling or other acceptable procedures to correct plate flatness to within the specified tolerances
- Provide plate thickness as indicated.
- Identify each plate and the methods used to correct plate flatness to the specified tolerances.
- Replace rejected plates at no additional cost to the Department.

**(hh) Determination of Surface Flatness.**

Furnish surfaces having flatness as determined by the following method:

- Place a precision straightedge that is a minimum of 150 mm (6 inches) longer than the surface to be measured in contact with and as parallel as possible to the surface. The straightedge may be located in any position on the surface being evaluated and not necessarily at 90 degrees to the edge.
- Attempt to insert a feeler gage having the required tolerance under the straightedge.
- Flatness is acceptable if the feeler gage does not pass between the straightedge and the surface.

# SECTION 1107—PRESTRESSED CONCRETE BRIDGE BEAMS

## 1107.01 GENERAL REQUIREMENTS—

**(a) Description.** This work is the fabrication, storage, and transportation of prestressed concrete bridge beams.

**(b) Shop Drawings.** Section 105.02, and as follows:

**1. Drawing Details.** Include the following details:

- Items such as chairs, hold downs, tie rod tubes, inserts, and steel bearing plates incorporated into the beams. List inserts and steel bearing plates by source, type, and supplier.
- Incidental items such as plain neoprene bearings, tie rods, and anchor bolts.
- Subassemblies.
- Strand patterns.
- Type of strand.
- Debonding.
- Deviation from tolerances specified in Section 1107.03(e).
- Anticipated camber, based on the contract drawings.

If draped strands are used, show the following additional information:

- Hold up and hold down forces.
- Other required data.

**1.a Deviations from the Contract Drawings.** The total force and the center of gravity of the strands may be adjusted to fit the strand type selected.

Alternate strand patterns and the provision of additional strands in the beam for convenience may be used. Submit bridge shop drawings as specified in Section 105.02(d) for review and acceptance showing the alternate pattern and stress computation documenting the change.

**1.b Debonding of Strands.** Compute stresses in the beam end zones at each stress change location. Submit computations documenting these stresses. Stress calculations in the beam end zones for I-beams using debonding are not required.

Reduce tensile stresses due to initial prestress force in the end sections of box beams to a maximum of $0.25\sqrt{f'ci}$ ($3\sqrt{f'ci}$) by selective strand debonding. If this cannot be accomplished, provide additional reinforcement bars to carry the full tensile force of the tensile stress block. NOTE: f'ci = Cylinder strength of concrete (MPa (pounds per square inch)) at initial prestress. For box beam end block crack control, do not debond more than 25% of the total number of strands for the end 900 mm (36 inches) and 50% of the total number of strands for the end 150 mm (6 inches).

If debonding of I-beams is not specified, the fabricator may debond up to 50% of the total number of strands for the end 150 mm (6 inches). Do not debond more than 50% of the strands in any one row.

If debonding results in a fractional number of strands, the number of debonded strands may be rounded up to the next higher number. Do not debond corner strands. Show debonding on the shop drawings.

**2. Other Shop Drawings.** Prepare separate shop drawings for prestressed beam sub-items or items fabricated separately, such as steel bearings, moment connections, and post-tensioning operations.

Shop drawings are not required for such items as closed cell neoprene sponge, waterproofing, laminated metal shim neoprene bearing pads, and expansion joints.

**(c) Definitions of Terms.**

**1. Pretensioning.** Prestressing, with strands or wires called tendons, to a predetermined force before placing concrete. After the concrete hardens, the tendons are released and the concrete is stressed by bonding.

**2. Post-tensioning.** Stressing the concrete after it has hardened by tensioning the tendons, which are free to move in sheaths, and anchoring them at each end of the member, introducing the required force.

**3. Pre-Post-Tensioning.** A combination of pretensioning and post-tensioning.

**(d) Rejections.** The Representative may reject members accepted at the plant if they are found to be defective. Replace rejected items.

**1107.02 MATERIAL**—Conforming to the following requirements:

**(a) Cement.** Type I, IP, IS, II, or III—Section 701. Use the same cement source and type for all beams in the contract.

**(b) Pozzolan.** Section 724.

**(c) Fine Aggregate.** Type A—Section 703.1

**(d) Coarse Aggregate.** Type A, No. 8, or No. 67—Section 703.2

**(e) Water.** Section 720.1

**(f) Admixtures.** Section 711.3

**(g) Reinforcement Bars.** Section 709.1

**(h) Steel Dowels.** Certify as specified in Section 106.03(b)3.

- Plain bars—ASTM A 615/A 615M; Grade 300 or 420 (Grade 40 or 60)
- Threaded bars—ASTM A 663/A 663M; Grade 310, 345, 380, or 415 (Grade 45, 50, 55, or 60)
- Threaded bars—ASTM A 675/A 675M; Grade 310, 345, 380, or 415 (Grade 45, 50, 55, or 60)
- Threaded bars—ASTM A 615/A 615M; Grade 300 or 420 (Grade 40 or 60)

**(i) Steel Anchor Bolts.** Section 1105.02(c)

**(j) Corrosion Resistant Fabricated Structural Steel for Bearings.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 345 or 345W (Grade 50 or 50W). Certify as specified in Section 106.03(b)3.

**(k) Burlap.** Section 711.1(d)

**(m) Box Beam Void Forms.** Construct using preformed cellular polystyrene, ASTM C 578, Type 1; or another acceptable material.

Construct box beam void forms to be watertight and resistant to breakage and deformation during concrete placement. Waterproof the outside of forms if not constructed of approved preformed cellular polystyrene or an acceptable hot-melt wax coated, polymer coated, or asphalt-penetrated material.

Test load or subject box beam void forms to a successful member installation, as directed, before acceptance.

Certify as specified in Section 106.03(b)3.

**(n) Tendons.**

**1. General.** Include two copies of typical load-elongation curves with each shipment. Give one copy to the inspector. Attach identification tags to each shipment.

At the fabrication plant, a representative of the Department will select samples to be submitted to the MTD.

Do not use strand larger than 13.2 mm (0.52-inch) diameter.

Certify as specified in Section 106.03(b)3.

**2. Samples for Testing, Post-Tension Members.**

- 1.5 m (5 feet) of wire requiring heading.
- Enough wire, not requiring heading, to simulate 1.5 m (5-foot) parallel-lay cable.
- 1.5 m (5 feet) of strand between fittings.
- 1.5 m (5 feet) of bar between threads, one sample per heat, and not less than one sample per 100 bars.
- Two anchorage assemblies of each size and type; each assembly complete with distribution plates.

**3. Description.**

**3.a Prestressing Wire.** ASTM A 421

**3.b 7-Wire Strand.** ASTM A 416, Grade 250

**3.c 7-Wire, Uncoated, Stress-Relieved Strand.** AASHTO M 203 (ASTM A 416), Grade 1860 (Grade 270); except for 107.74 $mm^2$ (0.167-square inch) area strand, use strand conforming to the following requirements:

- Minimum breaking strength of strand 200.5 kN (45,080 lb.-force)
- Minimum load at 1% extension 170.4 kN (38,300 lb.-force)

**3.d 7-Wire, Uncoated, Low-Relaxation Strand.** AASHTO M 203 (ASTM A 416), Grade 1860 (Grade 270); except for 107.74 $mm^2$ (0.167-square inch) area strand, use strand conforming to the following requirements:

- Minimum breaking strength of strand 200.5 kN (45,080 lb.-force)
- Minimum load at 1% extension 180.4 kN (40,570 lb.-force)

**3.e High Tensile Strength Alloy Bars.** Manufacture and process from steel conforming to ASTM A 322 and A 29/A 29M. Stress-relieve by heat treatment and cold-stretch (proof stretch) to the minimum yield strength specified below.

Required physical properties after cold-stretching:

- Guaranteed minimum ultimate tensile strength, as certified by the manufacturer—1000 MPa (145,000 pounds per square inch)
- Minimum yield strength, measured by the 0.7% extension under load method—87% of ultimate
- Minimum modulus of elasticity—172 000 MPa (25,000,000 pounds per square inch)
- Minimum elongation length in 20 bar diameters after rupture—4%
- Minimum reduction of area after rupture—20%
- Diameter tolerance— +0.75 mm, -0.25 mm (+0.03 inch, -0.01 inch)

Calculate physical properties using nominal bar areas.

**3.f Special Grade High Tensile Strength Alloy Bars.** Required physical properties are identical to those for High Tensile Strength Alloy Bars as specified in Section 1107.02(n)3.e, except that a guaranteed minimum ultimate tensile strength of 1100 MPa (160,000 pounds per square inch) is required. Tag and identify these bars for verification with mill certification.

**(p) Neoprene Joint Material.** Identify neoprene material according to the type, class, and grade. Print, stencil, or otherwise affix this code to each pad at intervals of not more than 600 mm (24 inches) and in letters and numerals of not less than 5 mm (1/4-inch) height. Additional information such as lot or batch numbers, date, plant and place of manufacture, trademark, or name of manufacturer may also be added.

Certify as specified in Section 106.03(b)3.

**1. Closed-Cell Neoprene Sponge.** Pads may be manufactured as sponge neoprene or expanded neoprene and may be composed of laminations. Use material conforming to the following:

- ASTM D1056, Type 2, Class C, Grade 2, including the requirements of suffixes B3 and F1
- ASTM D 1171, Quality Retention Rating of 100% after 6 weeks exposure

## 1107.03 BEAM CONSTRUCTION—

### (a) Plants and Plant Sites.

**1. General.** Submit plans to the Chief Bridge Engineer for review and acceptance of the design, redesign, or change in the use of accepted beds, anchorage, abutments, and the deflecting facilities for draped strands.

Provide adequate lighting for operations not completed in the daylight. Provide a drainage system for the removal of rainfall and curing water. For member storage, stabilize areas and grade to a level surface.

Furnish necessary facilities for the inspection of material and workmanship. The necessary facilities for inspection include a plant office, as specified in Section 714.5(a), except a four-drawer fire-resistant (D-label) metal file cabinet will be required in place of a two-drawer fire-resistant (D-label) metal file cabinet. Allow inspectors employed by the Department unrestricted access to work in process and stored materials during plant working hours.

**2. Plant Chief Engineer.** Engage a Chief Engineer who has the overall responsibility for the adequacy of production facilities, QC, testing, and the fabrication of members and who will ensure that beams are fabricated as designed. For plants that offer design service, the Chief Engineer is required to be a Professional Engineer registered in the State.

**3. Beds and Forms.** Support casting beds on unyielding foundations.

For standard members, use fixed and movable steel forms. For nonstandard members and bulkheads that have limited use, forms may be of lumber, plywood, or other material.

Maintain accurate form alignment during the casting operation. Check alignment and grade for each setting and for proper strand clearance. Verify that the pallet is flat and level in the vicinity of the bearing area. Make joints smooth and tight to prevent leakage of mortar. Plug holes and slots in the forms.

For exposed members, use form ties, chairs, and inserts that are recessed in the concrete by at least 25 mm (1 inch), or use stainless steel accessories.

Do not use continuous soffit forms longer than 35 000 mm (120 feet) if the forms are rigidly anchored to the bed. If slight differential movements between forms and beds can cause damage to the member, anchor the forms to prevent differential movements, or loosen them so movements can occur without damage to the member or forms.

Clean beds and forms after each use. Prevent accumulation of coatings used for bond breakers.

**4. Plant Acceptance.**

**4.a General.** Do not begin fabrication before the Representative's inspection and acceptance of the plant. Plant expansions are subject to the same inspection and acceptance.

Provide a permanent building for new plants offered for the Department's acceptance. New plants will be required to satisfactorily produce a sample beam before receiving approval to begin production.

Currently accepted plants will retain approved status unless the acceptance is rescinded for failure to comply with the plant requirements specified in Section 1107.03(a), or until ownership changes. Reinstatement will be based on conformance with the plant requirements specified in Section 1107.03(a).

Material, equipment, testing procedures, methods of fabrication, handling, storage, and transportation are subject to inspection and acceptance.

Plants may be accepted to fabricate one or more of the following beam types:

Box beams—with straight strands
I-beams—with straight strands
PA Bulb-Tee Beams—with straight strands
Box beams—with straight and draped strands
I-beams—with straight and draped strands
PA Bulb-Tee Beams—with straight and draped strands
Box beams—with straight and debonded strands
I-beams—with straight and debonded strands
PA Bulb-Tee Beams—with straight and debonded strands
Box beams—with pre-post-tensioned tendons
I-beams—with pre-post-tensioned tendons
PA Bulb-Tee Beams—with pre-post-tensioned tendons
Nonstandard beam sections

Each beam type will be subject to inspection during manufacturing, storage, and shipment.

Register and certify the plant under the Prestress Concrete Institute (PCI) plant certification program and submit a valid certificate to the Structural Materials Engineer, MTD, 1118 State Street, Harrisburg, PA 17120. Submit an annual endorsed copy for continued qualification.

**4.b Bed Approval.** For each casting bed offered for production, submit construction drawings and design calculations to the Chief Bridge Engineer for review. Theoretical analysis must include the following:

- Overturning of abutments (safety factors)
- Stress analysis of uprights, including buckling analysis
- Buckling analysis of bed slab, including the effects of hold down forces for draped strands, when applicable

- Bulkhead design
- Shortening of bed under full design load
- Tilting of uprights into full load

When the above requirements are satisfactorily met, test load each bed for approval under the supervision of the Department. Divide the maximum bed moment during the test loading by 1.5 to arrive at the allowable bed moment (force and eccentricity) that may be used during production.

**(b) QC.**

**1. General.** Establish a level of QC based on uniform production practices. Submit the plant's QC Plan and mix design(s) to the Structural Materials Engineer, MTD, for review and approval. Include with the QC Plan a company organizational chart indicating a separate chain of command from the QC Manager to the Owner/Plant Manager independent of the Production Manager. Resubmit the QC Plan, mix design, and organizational chart, when required, due to changes in materials, processes, or personnel.

**2. QC Manager.** Provide a QC Manager who has overall responsibility for the adequacy of production facilities, QC, sampling and testing, and fabrication of the product, and who will ensure that items are fabricated as designed and specified.

**3. QC Personnel.** Assign sufficient qualified personnel with prestress concrete fabrication experience to be responsible for QC during the complete fabrication process, storage, and shipment. Technicians responsible for concrete sampling and testing must possess a current ACI Grade I Field Technician certification or have approval from the Structural Materials Engineer as a technician-in-training. Do not proceed with production until qualified personnel are present and approved by the Department.

**(c) Prestressing**. For all methods of tensioning, determine force in the tendons by monitoring either applied force or elongation and independently check by measuring the other. Verify at the completion of tensioning that the two control measurements, force and elongation, agree algebraically within 5% of the computed theoretical values. Suspend the tensioning operation if discrepancies are in excess of 5% until the source of error is determined and corrected. If the measurements do not agree within 5%, a load cell may be added at the 'dead end.' If force measurements agree within 5% between the gauge at the live end and the load cell, the elongation agreement may be waived.

**1. Safety.** Provide safety measures to prevent accidents due to breakage of prestressing steel or slippage of grips.

**2. Methods of Force Measurement.** Measure forces using a primary measuring system. Check primary measurements using a secondary measuring system. Acceptable methods of stressing force measurement consist of:

**2.a Curves.** Elongation, determined from current stress-strain or load-elongation curves furnished by the manufacturer. An average modulus may be used if acceptable, provided the force indicated falls within the specified tolerance limits.

**2.b Pressure Gages.** Pressure gages that measure force by the pressure applied to hydraulic jacks. Furnish digital readouts or dials for these gages, a minimum of 125 mm (5 inches) in diameter and calibrated with the jacking system.

**2.c Dynamometers.** Dynamometers that are connected in tension into the stressing system for the initial force application.

**3. Gaging System.** Equip tensioning systems with accurately calibrated gages for measuring the stressing forces. Calibrate hydraulic gages, dynamometers, load cells, or other devices for measuring the stressing load to an accuracy of reading within 2%. Ensure that a qualified testing laboratory calibrate and issue a certified calibration curve with each gage. Recalibrate if a gaging system shows indication of erratic results, and in any case at intervals not greater than one year. Gages for single strand jacks may be calibrated by an acceptable and calibrated load cell. Calibrate gages for large, multiple strand jacks, acting singly or in parallel, by proving rings or by load cells placed on either side of the movable end carriage.

Provide pressure gages and dynamometers with a full-pressure or load capacity of approximately twice their normal working ranges. Limit the loads to not less than 25% or more than 75% of the total graduated capacity, unless calibration data establish consistent accuracy over a wider range.

Each gage is required to indicate loads directly in newtons (pounds) or be accompanied by a chart with which the dial reading can be converted into newtons (pounds). Direct reading gages are preferred.

Equip tensioning systems employing hydraulic gages with appropriate by-pass pipes, valves, and fittings so the gage pointers remain steady until the jacking force is released.

Mount gages near eye level, within 1800 mm (6 feet) of the operator, and position so readings can be obtained without parallax.

**4. Control of Jacking Force.** Use either manual or automatic pressure cutoff valves for stopping the jacks at the required force. For automatic pressure cutoff valves, use valves capable of adjustment so that the jacking force corresponds to the required force. Verify the setting accuracy for automatic pressure cutoff valves whenever there is reason to suspect improper results, and at the beginning of each day's operation.

**5. Wire Failure in Tendons.** Locate wire breaks and tie the ends to the strand with wire to preclude the possibility of raveling during concrete vibration.

For seven-wire strands, remove and replace strands with more than one broken wire, or with more than the following number of wire breaks in a strand pattern:

- Less than 20 strands, no wire breaks allowed
- 20 to 39 strands, one wire break allowed
- 40 to 59 strands, two wire breaks allowed
- 60 and more strands, three wire breaks allowed

Failure of wires in parallel-wire, post-tensioned tendons is acceptable, provided the total area of wire failure is not more than 1% of the total area of tendons in any member or no more than one wire fails in any tendon.

**6. Pretensioning.**

**6.a General.** In systems of pretensioning, apply the load in two increments. Apply the initial load to the individual strands to straighten them, to eliminate slack, and to provide a starting or reference point for measuring elongation. Apply the final load for which elongation of tendons is computed and measured.

Without verification of strand tension by load cells, the maximum permissible holding time for tensioned strands before starting concrete placement is 72 hours. If it is anticipated that the holding time for tensioned strands will exceed 72 hours, place load cells during initial tensioning on two separate strands selected by the Representative to verify that the strand tension remains within 5% of the theoretical value.

**6.b Forms, Bond Breakers, Strand Surfaces.** Before stringing strands, inspect the bottom of forms for cleanliness and accuracy of alignment.

Apply bond breaker coating to the contact surface of forms. Use a form coating that dries to a surface hardness and does not contaminate the strands. Make sure the coating is dry before the strands come in contact with it.

**6.c Stringing Strands.** Furnish strands in either coils, packs without reels, or on reels. String strands individually or in multiples. Relieve the strand rotation when strands are pulled from coils or packs without reels.

Do not reuse strands containing former vise-grip points, unless the points are outside the new strand vise locations. Do not reuse portions of strands that have been in contact with draping mechanisms.

**6.d Strand Vises.** Use strand vises capable of anchoring stressing loads positively with a minimum of slippage. Assemble strand chucks with compatible components from the same manufacturer to avoid improper fit and seating on strands. Clean, lubricate, and inspect the vises between each use. Do not use grips that become visibly worn or distorted, or that allow slippage in excess of 6 mm (1/4-inch).

Clean and inspect a full set of strand vises before starting each stressing operation.

**6.e Measurement of Forces.** For gage readings, elongation measurements, and calculations for elongation, include appropriate allowances for operational losses in the tensioning system. Losses include strand slippage, movement of anchorages and abutments, elongation of abutment anchorage rods, strand rotation, temperature variation, friction, bed shortening, and other forces and influences acting on the strands. Make calculations for elongation available for inspection.

After applying initial tensioning, establish reference points for measuring the elongation due to final tensioning.

**6.f Operational Losses.**

**6.f.1 Friction in Jacking System.**

**6.f.1.a Single Strand Tensioning.** If rams used in jacks for single strand tensioning are small, friction losses in the jacking system may usually be ignored. Verify gage pressure by measured elongation or load cells.

**6.f.1.b Multiple Strand Tensioning.** In multiple strand tensioning systems, clean and lubricate the sliding surfaces to minimize friction. Determine and establish a force override (compensatory operational loss correction) for strand patterns if the primary and secondary force measurement systems exceed the allowable 5% variation.

**6.f.2 Thermal Effect.** Increase the design prestress force by 1/2% for each 3 °C (5F) ambient temperature below 27 °C (80F). No adjustment is required for ambient temperatures above 27 °C (80F). Prestress strands only if the ambient temperature is above 5 °C (40F). After the strands are tensioned, maintain the temperature of the air surrounding the strand at 5 °C (40F) or more.

**6.g Initial Tensioning.** Do not exceed 15% of the specified tensioning force, or 13.5 kN (3,000 pounds), whichever is greater.

Measure the initial load within a tolerance of ±450 N (±100 pounds). Do not use elongation measurement as an initial force measure.

In single strand tensioning, the initial and final loads may be applied in immediate succession on each strand.

Acceptable methods of applying initial stress are:

**6.g.1 Pressure Jacks.** Use the same jack for single strand tensioning as for initial tensioning, provided the jack is equipped with a proper gaging system for measuring the initial force.

**6.g.2 Fence Stretchers.** Apply load using fence stretchers and measure with a dynamometer. Refer to Section 1107.03(c)3 for capacity.

**6.g.3 Other Methods.** Acceptable methods that provide a definite and uniform load.

**6.h Final Tensioning.** Use paint to permanently mark the reference point on strands to be used to check slippage.

**6.h.1 Tensioning Straight Strands.**

**6.h.1.a Single Strand Tensioning.** Use jack-mounted pressure gages for the primary system of force measurement. Check elongation against pressure gage readings on the first and last strands tensioned and at least 10% of the remaining strands, but on not less than six strands. Check slippage at strand vises.

The computed elongation, including operational losses and equivalent elongation for initial tensioning converted into force, is required to be within 5% of the pressure gage reading.

At least every 90 calendar days, or when directed, use load cells as a check of the gaging or tensioning system.

**6.h.1.b Multiple Strand Tensioning.** Use jack-mounted pressure gages for the primary system of force measurement. For uniform application of load to strand, the face of the anchorage at final load is required to be in a plane parallel to its position under initial load. Verify parallel movement by equal measurements of movement on opposite anchorage sides and check the plumb position of the anchorage before and after final load application. Check slippage at strand vises.

At least every 90 calendar days, or when directed, use load cells as a check of the gaging or tensioning system.

**6.h.2 Tensioning Draped Strands.** Tension draped, pretensioned strands, initially and finally, by one of the following methods:

- Tensioned in the final design position.
- Tensioned first, and then deflected to the final design position.

Use primary and secondary force measuring systems approved by the Department.

**6.h.2.a Tensioning Strand in the Final Design Position.**

**6.h.2.a.1 Single Strand Tensioning.** Stress the strands to their final value in their design position for the full-length of the bed. Pass the strands over saddles, roller fixtures, or pins with a minimum 3/4-inch diameter to minimize friction at deflection points and to prevent strand damage.

Design hold-up and hold-down devices with an adequate factor of safety, but not exceeding 75% of the yield strength of the material used. Maintain strand positions within required tolerances under the induced loads. Design hold-down devices that are free to move and are able to bisect the drape angle. If devices are not free to move, use safety procedures to eliminate strand bonding or restrain at hold-up or hold-down.

Measure strand force and elongation, as specified in Section 1107.03(c)2.

When final tensioning is done by jacking strands from one end of the bed, place two load cells at the dead anchor end of two different strands selected by the Representative. The force indicated by these load cells is required to be not less than 95% of the specified design value.

If the computed elongation has not been attained at the jacking end when the load value shown by the pressure gage or load cells is exceeded by 5%, jack the strand from the other end to the balance of the computed elongation. If achieving the computed elongation results in an overstress in excess of 5%, as shown on the gage, reduce the number of deflection points and, consequently, the number of members on the bed until the elongation can be attained with not more than 5% overload.

**6.h.2.a.2 Multiple Strand Tensioning.** For draped strands, control the specified tension in strands without exceeding the force tolerance limits specified in Section 1107.03(c)6.h.2.a.1.

**6.h.2.b Tensioning of Strand in Straight Condition and Subsequent Deflection.** Arrange beams symmetrically to midbed. Position deflection devices in longitudinal and vertical directions to fit the anchor system. Measure the intermediate force value by pressure gage and elongation as specified in Section 1107.03(c)2.

Place two load cells on two separate strands selected by the Representative to verify the design load. At the discretion of the Representative, the application of these load cells may be required only at each third line of beams on the same bed for the same bed layout.

Provide for simultaneous lifting or depressing at all bed points in order to distribute friction and any restraint at deflection devices. However, if acceptable, depressing may be done on at least 50% of the deflection points simultaneously and alternately symmetrical to the bed center.

Load cell readings are required to be within 3% of each other and each within 5% of the gage reading.

**6.h.3 Debonded Strand at Ends of Member.** Debond as shown on the shop drawings. Use acceptable sleeves or taping.

**6.h.4 Strand Splices.** Only one splice per strand is allowed unless force measurement is by load cell.

For single strand tensioning, the number of strands that may be spliced in each bed is not restricted.

For multiple strand tensioning, either splice all strands and adjust the elongation for average slippage, or splice no more than 10% of the strands in which case no slippage allowance is required.

Place strands in the same lay or direction of twist. Cut the ends using shears or abrasive cutting wheels.

**6.h.5 Strand Position.** Position strands as indicated. Use chairs to eliminate sagging of strands in the bottom rows.

**6.i Detensioning.**

**6.i.1 General.** Transfer force to members after the concrete strength, determined by cylinder tests, has reached the specified transfer strength. Transfer force immediately following the curing period while the concrete is still warm and moist.

Remove or loosen forms, ties, inserts, hold-downs, or other devices that restrict the member's longitudinal movement along the bed, or perform alternate detensioning by a method and sequence to minimize longitudinal movement.

Keep the prestressing forces nearly symmetrical around the member's vertical axis and release the tension using a method to minimize sudden or shock loading. Limit eccentricity around the vertical axis to one strand.

**6.i.2 Detensioning of Draped Strands.** Detension using a procedure provided by the fabricator's Representative for the type of system used.

**6.i.3 Multiple Strand Detensioning for Straight Strands or Draped Strands.** Provide a length of 150 mm (6 inches) or more between bulkheads.

**6.i.4 Strand Detensioning by Cutting.** In single strand detensioning, release the strands by heat-cutting according to a pattern and cutting chart that is available at each cutting location along the bed. The fabricator's Engineer will provide a pattern and cutting chart for each plant and bed.

**7. Post-Tensioning.** Fabricate members as indicated and as specified in Section 1108. Perform post-tensioning at the plant unless otherwise designated or specified.

**8. Pre-Post-Tensioning.** Fabricate members as indicated.

**(d) Fabrication.**

**1. Protection of Prestressing Steel.** Store prestressing steel under shelter and keep free of deleterious material such as grease, oil, wax, dirt, paint, loose rust, or other similar contaminants that reduce the bond between steel and concrete.

Do not use steel showing corrosion, etching, pitting, or scaling of the surfaces. A light coating of surface rust is acceptable if it can be removed completely from the steel by wiping with a cloth.

Do not store prestressing steel on a surface that contributes to galvanic or battery action. Do not use as a ground for electric welding. Protect from electric welding sparks.

**2. Bars, Mesh Reinforcement, Inserts, and Chairs.** Fabricate and place bar and mesh reinforcement as indicated and within specified tolerances. Secure reinforcing to beds and forms using chairs, blocking, or ties to tendons, so that the reinforcing maintains its position during placement and vibration of concrete. Bars may be fabricated into cages by tying and tack welding using low-hydrogen electrodes. Use only qualified tack welders to perform tack welding. Inspect welds for soundness and for freedom from undercutting. Do not weld immediately adjacent to a cold bend. To provide maximum cover, bend tie-wire ends into the member. Do not support cages on tensioned strands.

Place inserts as shown on the shop drawings. Recess scaffolding inserts in the concrete at least 15 mm (1/2-inch) or as indicated. Recessing is not required for structural inserts intended to anchor threaded reinforcing bars for diaphragms or utility supports. Fabricate inserts for utility supports from corrosion-resistant material, galvanize, or apply another acceptable equal coating. Install self-drilling inserts only at the fabrication plant, and test for soundness.

Use chairs that support and space the strands and mild reinforcing within the tolerances specified in Section 1107.03(e). Use stainless-steel or plastic-coated legs for chairs set on the bottom pallet or set against a form side. Concrete block supports may be used on box-beam void form tops.

When indicated, place epoxy-coated reinforcement as specified in Section 1002 in the top slab of adjacent box beams.

**3. Bearing Areas.**

**3.a Embedded Steel Bearing Plates.** Set embedded plates level, align parallel to each other, and anchor in the exact location indicated.

**3.b Concrete Bearing Areas.** Finish concrete bearing areas that receive neoprene bearing pads to true, flat planes to ensure uniform bearing on the entire area. Use smooth and unyielding pallet forms.

**4. Forms for Internal Voids.** Use the type shown on the accepted shop drawings. During placement and vibration of concrete, maintain form positions within the limits of dimensional tolerances with respect to the horizontal and vertical axis of the member. Do not strap void forms to prestressed strands.

During vibration of the concrete, restrain the tendency of void forms to float.

Check void positions during casting at least every 3000 mm (10 feet).

Seal ends and splices by taping or by other acceptable means. Unless required, void forms manufactured to provide very tight seams need not be sealed.

Vent and drain rectangular void forms for each spliced sub-unit and for the full void compartment length.

Puncture box beam void forms at vent and drainage holes after removing the beam from the casting bed.

**5. Concrete.**

**5.a Testing.** Verify that the concrete attains the required 28-day minimum strength shown on the approved shop drawings. Test two acceptance cylinders per member no more than 28-days after casting. If the test results of the acceptance cylinders fail to meet the required 28-day minimum concrete strength, the disposition of the concrete beams will be resolved as specified in Section 110.11.

**5.b Air Content.** Provide an air content of 6% ± 1.5% for all mixes.

**5.c Mixture.** Provide concrete conforming to Bulletin 5 and the specified testing and design requirements.

Use enough water to obtain workability, but do not exceed a water cement ratio of 0.43. Use a maximum of 474 kg (800 pounds) and a minimum of 349 kg (590 pounds) of cement per cubic meter (cubic yard). Provide a mix conforming to the slump requirements of Section 704.

Make trial mixtures according to Bulletin 5. Mold, cure, and test cylinders using the procedures specified for the beam concrete.

**5.d Mixing and Placing Conditions.** Mix and deliver the concrete as specified in Section 704. Discard concrete that develops initial hardening or has become unsatisfactory for any reason. Do not remix or add water. Do not use materials containing frost, lumps, or crusts of hardened material.

Do not place concrete in forms, on casting beds, around reinforcement, on prestressing steel, or on other fixtures if the ambient temperature is below 5 °C (40F) or above 38 °C (100F). Place only concrete having a temperature of 21 °C ± 11 °C (70F ± 20F).

**5.d.1 During Cool Weather.** If the air temperature is below 10 °C (50F), but not lower than 5 °C (40F), heat the mixing water to not less than 10 °C (50F), or more than 65 °C (150F). Ensure that the aggregate is free of frozen lumps and maintain aggregate temperature at not less than 5 °C (40F), or more than 38 °C (100F) at the time the aggregate is charged into the mixer. Do not use water in excess of 32 °C (90F) until the cement has been mixed with the aggregate.

**5.d.2 During Inclement Weather.** Production during the winter season, from November 15 to March 15 inclusive, is allowed only on beds located in a completely enclosed structure that provides a controlled atmosphere for the protection of the casting operation and the product.

Production on any bed, inside or outside, is restricted to periods when air temperatures range from a minimum of 5 °C (40F) to a maximum of 32 °C (90F).

Do not perform outside concreting operations during rainfall. Should operations be stopped, process the beams as specified in Section 1107.03(d)5.e.

**5.e Placing Concrete.** Place concrete without segregation using an acceptable method. Deposit the concrete in its final position in each part of the form. Do not work or flow the concrete along the forms from the point of deposit. Work the concrete under and around the prestressing steel and reinforcement. Once concrete placement has begun, continue for all beams on the bed.

If the concreting operation is stopped for an extended period of time due to mechanical failure, inclement weather, or other causes, begin curing completed beams. Remove the concrete from unfinished beams. Strands may be reused if not damaged during concrete removal and if allowed.

Place concrete in lifts as shown on the shop drawings, or as otherwise directed.

Consolidate the plastic concrete by internal vibration. Use vibrators with 25 mm to 35 mm (1-inch to 1 3/8-inch) heads for penetrating the strand pattern. Use vibrators only to consolidate the concrete after it has been properly placed. Operate vibrators vertically, pushing into and pulling out of the concrete slowly. Do not hold the vibrators in one spot long enough to cause segregation.

External vibrators may be used to reduce surface blemishes.

**5.e.1 Test Cylinders.** Mold a minimum of four concrete acceptance cylinders for each beam cast under the supervision of a Department representative. Mold the cylinders according to PTM No. 631 from the concrete being placed into each unit. Handle and cure the cylinders in the same manner as the beam.

Remove test cylinders from the bed a minimum of 1 hour before the scheduled time for detensioning. Cool cylinders from heat-cured beds for approximately 1/2-hour before capping according to PTM No. 631. Cure the capped cylinders for 1/2-hour before testing.

Test the cylinders according to PTM No. 604 to verify minimum concrete transfer strength and 28-day minimum concrete strength. Test cylinders under the supervision of a Department representative. Match and mark test cylinders with the beams they represent and record test results so the beams can be readily identified. Submit the test results to the Department representative at the plant.

If acceptance test cylinders fail to meet the 28-day minimum strength requirement, refer to Section 110.11 for evaluation and disposition of the beam(s).

**5.e.2 Finishing.** Make concrete surfaces true and even, free from rough, open, or honeycombed areas, depressions, or projections. Do not use brush or bag finishing. Do not paint with grout or neat cement. Do not add water to the concrete to facilitate finishing.

After the concrete has been placed as specified in Section 1107.03(d)5.e, use a template to strike-off the top of beams level. Before the concrete has initially set, finish the top surface with a stiff wire bristle broom or an acceptable special template. Run the broom or template from edge to edge of the beam in a transverse direction to produce approximately six scores per 25 mm (inch), each approximately 2 mm (1/16 inch) in depth.

Finish the top of the beam with the type of finish shown on the shop drawings.

**5.f Repairs and Patching.** Do not repair damaged areas unless approved. Ensure uniform appearance and color. The Department's representative will inspect repairs.

Maintain a minimum 10 °C (50F) environment until the repaired areas have cured. If at any time during the curing period the curing temperature falls below 10 °C (50F), the Department's representative will consider the work deficient and will reject the work.

Before patching, clean holes left by tie rods, strand hold-down devices, recessed strand pockets, or other temporary inserts. Use a hammer to pack the holes with stiff dry mortar of the same material used in the concrete. Fill surface blemishes on the outside fascia beam surfaces with mortar as specified in Section 1001.2(d).

**5.g Curing Concrete.** Cure and protect concrete until prestress transfer has been accomplished. Construct and maintain a suitable curing enclosure to retain heat and moisture around the beams. Do not use membrane curing. The full concrete curing cycle consists of the initial curing phase, the intermediate curing phase, and the final curing phase.

**5.g.1 Initial Curing Phase.** The initial curing phase begins when each beam is completely covered with saturated covering.

After each beam has been cast and immediately after the concrete has initially set, cover exposed surfaces using a double thickness of saturated burlap or cotton or jute mats. Place covering carefully to avoid damaging the concrete. During the initial curing phase, which extends over a period of not less than 2 hours or more than the time required to achieve initial set, apply artificial heat, if necessary, to maintain the temperature at approximately 21 ºC (70F) within the enclosure.

**5.g.2 Intermediate Curing Phase.** Cure beams using either steam curing or saturated cover curing. Maintain curing for 12 hours or until at least one hour after the required transfer strength is attained, whichever is greater. An additional hour of curing is not required if the transfer strength is attained after 20 hours.

**5.g.2.a Steam Curing.** Raise the temperature within the enclosure to between 38 °C and 70 °C (100F and 160F), at a rate not exceeding 25 °C (45F) per hour. Use steam of 100% relative humidity. Ensure full circulation between the beams and the enclosure. Do not direct steam jets onto forms or beams.

**5.g.2.b Saturated Cover Curing.** Raise the temperature within the enclosure and the temperature of the covering material to between 50 °C and 70 °C (120F and 160F), at a rate not exceeding 25 °C (45F) per hour. Keep the covering thoroughly saturated throughout the curing process. Use water with a temperature that is not more that 5 °C (10F) from the enclosure temperature. Control the temperature of the water to maintain a uniform enclosure temperature at the beam surface. Forms may be removed after 5 hours; provided saturated cover curing is continued on all beam surfaces up to the time of transfer.

**5.g.2.c Record of Curing Temperatures.** Record curing temperatures for the full curing cycle, up to removal of beams from the bed. Provide one continuous record chart of curing temperatures for every 30 m (100 feet) of casting bed.

Use accurate, automatic recording devices with temperature pickup devices properly placed either within the curing enclosure or embedded in the beam. Locate the temperature pickup devices away from direct contact with steam or water jets. If enclosures are removed to facilitate form removal, place any non-embedded pickup devices on top of a 20 mm (3/4-inch) board directly on the saturated covering and overlay three additional layers of saturated covering. If embedded probes must be temporarily disconnected from the beam during this process, reattach immediately. Mark the curing chart to indicate the point at which this change of pickup location is made.

Use recording charts covering a minimum of 24 hours and a maximum of 72 hours per one full revolution, or as otherwise permitted. Record beam number, shop drawing number, date, start time and time concrete placement was completed, and time of prestress transfer on the chart.

Every year, certify the accuracy of the recording device. Display the certificate with the recorder. Place the recorder so the chart may be observed at all times during the curing cycle.

After completion of curing, submit the charts to the Inspector-in-Charge.

**5.g.3 Final Curing Phase.** This phase consists of prestress transfer and beam storage.

Following prestress transfer, lower the enclosure temperature to 38 °C (100F) at a rate not exceeding 25 °C (45F) per hour until ambient temperature is reached. Conduct transfer of prestress as specified in Section 1107.03(d)5.h. Store beams as specified in Section 1107.03(f) for a minimum of 48 hours.

**5.h Transfer of Prestress.** Do not transfer prestress before the specified concrete strength has been attained. Retain the saturated covering on the top and sides of the beams and continue curing until final prestress transfer is complete. Transfer prestress as specified in Section 1107.03(c)6.i.

Transfer prestress not later than 5 days after casting, provided the minimum specified concrete strength at transfer has been reached. If this strength has not been reached, the Representative will declare the concrete, "deficient in strength" and may reject the deficient member.

**(e) Tolerances.**

**1. Prestressed Concrete Members.** Fabricate members to plan dimensions within the following tolerances (tolerances are not cumulative). The Representative may reject members not conforming to tolerances. If members that deviate from tolerances can be acceptably corrected, the members may be used if accepted in writing by the Chief Bridge Engineer.

**1.a Prestressed Concrete I-Beams/PA Bulb-Tee Beams.**

| | |
|---|---|
| • Depth (flanges, web, and fillets) | +7 mm (+1/4 inch) |
| • Depth (overall) | +13 mm (+1/2 inch)<br>-7 mm (-1/4 inch) |
| • Width (flanges and fillets) | +10 mm (+3/8 inch)<br>-7 mm (-1/4 inch) |
| • Width (web) | +10 mm (+3/8 inch)<br>-7 mm (-1/4 inch) |
| • Length of beam (longitudinal tolerances based on design length, as indicated at centerline) | +12 mm (+1/2 inch)<br>-25 mm (-1 inch) |
| • Center-to-center of bearings | +12 mm (+1/2 inch)<br>-25 mm (-1 inch) |
| • Web Perpendicularity | Greater of 6 mm (1/4 inch) or 6 mm/500 mm (1/8 inch/vertical foot) |
| Measurement: | While the beam is on the fabrication bed, verify web perpendicularity at beam ends, midspan, and quarter points using a bubble level.<br><br>If the level indicates the web is not truly vertical, verify and record measurements establishing offset from center of top flange to center of bottom flange using a plumb bob, square, or other method acceptable to the Structural |

| | |
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| | Materials Engineer at beam ends, midspan, and quarter points along the length of the beam. |
| • Centerline of bearing to beam end | ±20 mm (±3/4 inch) |
| • Exposed beam ends (deviation from square or designated skew): | horizontal ±6 mm (±1/4-inch); vertical, ±1 mm per 100 mm (±1/8 inch per inch) of beam height, but not more than 13 mm (1/2 inch) for beams up to 1600 mm (63 inches) in depth and 20 mm (3/4 inch) for beams over 1600 mm (63 inches) in depth. |
| • Threaded inserts (spacing between the center of inserts and from center of inserts to ends of beams) | ±13 mm (±1/2 inch) |
| • Concrete bearing area (deviation from plane at bottom of beam) | ±1.5 mm (±1/16 inch) |
| • Dap depths, (deviation from the specified dap depth dimensions) as measured from a straight-edge, parallel to the centerline of the beam. | ±3 mm (±1/8 inch) |
| • Out of plane deviation from one beam end relative to the other beam end, measured on the bottom of the beam with a level at a right angle to the beam length.[(1)] | ±6 mm (±1/4 inch) |
| Stirrup bars (projection above top of beam) | ±20 mm (±3/4 inch) |
| • Stirrup bars (longitudinal spacing): | -50 mm (-2 inches), +25 mm (+1 inch) for 300 mm (12 inches) or greater spacing and ±13 mm (±1/2-inch) for spacing less than 300 mm (12 inches) |
| • Horizontal alignment (deviation from a straight line parallel to the beam centerline) | ±1 mm per 1000 mm (±1/8 inch per 10 feet) |
| • Horizontal misalignment of adjacent form sections | 5 mm Max. (3/16-inch max.) |
| • Location of each strand | ±6 mm (±1/4 inch) |
| • Location of each deflected strand at the beam end | ±13 mm (±1/2 inch) |
| • Position of post-tensioning duct | ±6 mm (±1/4 inch) |
| • Longitudinal position of hold-down points for deflected strands | ±250 mm (±10 inches) |
| • Longitudinal position of handling devices | ±150 mm (±6 inches) |

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| • Camber differential between adjacent beams**:** | 1 mm per 1000 mm (1/8 inch per 10 feet) of span up to a maximum of 30 mm (1 1/4 inches) for beams up to 30 000 mm (100 feet) in length and 40 mm (1 1/2 inches) for beams over 30 000 mm (100 feet) in length. |
| • Camber deviation from plan camber, as measured at release or at beginning of beam storage at the fabricating plant: | |
| Plan camber 25 mm (1 inch) or greater | ±50% |
| Plan camber less than 25 mm (1 inch) | ±13 mm (±1/2 inch) |
| • Position of positive moment connection reinforcement bars (beams made continuous): | |
| Horizontal position of the bar at end face of beam and end of projection, measured perpendicular to the end face of beam | ± 10 mm (3/8 inch) |
| Projection from end face of beam | ± 12 mm (1/2 inch) |

Note (1) - Verify tolerance approximately 2 weeks before shipping.

**1.b Prestressed Concrete Box Beams.**

| | |
|---|---|
| • Depth (overall) | +13 mm (+1/2 inch)<br>-7 mm (-1/4 inch) |
| • Width (overall) | ±7 mm (±1/4 inch) |
| • Beam length at centerline (longitudinal tolerances based on design length indicated) | +13 mm (+1/2 inch)<br>-25 mm (-1 inch) |
| • Wall thickness (web) | +10 mm (+3/8 inch)<br>-3 mm (-1/8 inch) |
| • Depth (top slab) | ±13 mm (±1/2 inch) spread box;<br>+13 mm (+1/2 inch),<br>-3 mm (-1/8 inch) adjacent box |
| • Depth (bottom slab) | +13 mm (+1/2 inch)<br>-3 mm (-1/8 inch) |
| • Web Perpendicularity | Greater of 6 mm (1/4 inch) or 6 mm/500 mm (1/8 inch/vertical foot) |
| Measurement: | While the beam is on the fabrication bed, verify web perpendicularity at beam ends, midspan, and quarter points using a bubble level. |

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| | If the level indicates the web is not truly vertical, verify and record measurements establishing offset from center of top flange to center of bottom flange using a plumb bob, square, or other method acceptable to the Structural Materials Engineer at beam ends, midspan, and quarter points along the length of the beam. |
| • Horizontal alignment (deviation from a straight line parallel to the beam centerline): | |
| Up to 12 000 mm (40-foot) lengths | 6 mm (1/4 inch) |
| 12 000 mm to 18 000 mm (40-foot to 60-foot) lengths | 10 mm (3/8 inch) |
| Greater than 18 000 mm (60-foot) lengths | 13 mm (1/2 inch) |
| • Horizontal misalignment of adjacent form sections | 5 mm max. (3/16-inch max.) |
| • Camber deviation from plan camber, as measured at release or at beginning of beam storage at the fabrication plant: | |
| Plan camber 25 mm (1 inch) or greater | ±50% |
| Plan camber less than 25 mm (1 inch) | ±13 mm (±1/2 inch) |
| • Camber differential between adjacent beams**:** | 1 mm per 500 mm (1/4 inch per 10 feet), but not greater than 20 mm (3/4-inch) for beams up to 27 000 mm (90 feet) in length and 32 mm (1 1/4 inches) for beams over 27 000 mm (90 feet) up to 49 000 mm (160 feet) in length. |
| • Camber differential between minimum and maximum camber in one span | 50 mm max. (2 inches max.) |
| • Location of each strand | ±6 mm (±1/4 inch) |
| • Stirrup bars (projection above beam top) | ±20 mm (±3/4 inch) spread box; ±6 mm (±1/4 inch) adjacent box |
| • Stirrup bars (longitudinal spacing): | -50 mm (-2 inches), +25 mm (+1-inch) for 300 mm (12 inches) or greater spacing and ±13 mm (±1/2-inch) for less than 300 mm (12-inch) spacing |
| • Longitudinal position of hold-down points for deflected strands | ±250 mm (±10 inches) |
| • Parapet/barrier bars (projection above top of beam) | +25 mm (+1-inch)<br>-0 mm (-0-inch) |
| • Longitudinal position of handling devices | ±150 mm (±6 inches) |

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| • Concrete bearing area (variation from plane surface, when tested with a straightedge through middle half of member) | ±3 mm (±1/8-inch) |
| • Dap depths, (deviation from the specified dap depth dimensions) as measured from a straightedge, parallel to the centerline of the beam. | ±3 mm (±1/8-inch) |
| • Out of plane deviation from one beam end relative to the other beam end, measured on the bottom of the beam with a level at a right angle to the beam length.(1) | ±6 mm (±1/4-inch) |
| • Dowel tubes (spacing between the tube centers and from the tube centers to the member ends) | ±13 mm (±1/2-inch) |
| • Tie rod tubes (spacing between the tube centers and from the tube centers to the member ends) | ±13 mm (±1/2-inch) |
| • Tie rod tubes (spacing from tube centers to the beam bottom) | ±10 mm (±3/8-inch) |
| • Threaded inserts (spacing between the center of inserts and from center of inserts to ends of beams) | ±13 mm (±1/2-inch) |
| • Square ends (deviation from square) | ±13 mm (±1/2-inch) |
| • Skew ends (deviation from designated skew) | ±13 mm (±1/2-inch) |
| • Vertical and slanted ends (deviation from plan dimension) | ±10 mm (±3/8-inch) for beams up to 1 200 mm (48 inches) in depth and ±16 mm (±5/8-inch) for beams over 1 200 mm (48 inches) in depth. |
| • Slab void position | ±13 mm (±1/2-inch) from end of void to center of post-tensioning hole<br><br>±25 mm (±1 inch) adjacent to end block |
| • Position of post-tensioning duct | ±6 mm (±1/4-inch) |
| • Position of positive moment connection reinforcement bars (beams made continuous): | |
| Horizontal position of the bar at end face of beam and end of projection, measured perpendicular to the end face of beam | ± 10 mm (3/8 inch) |
| Projection from end face of beam | ± 12 mm (1/2 inch) |

Note (1) - Verify tolerance approximately 2 weeks before shipping.

**2. Void Forms, Outside Dimensions.**

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|---|---|
| • Length | ±13 mm (±1/2 inch) |
| • Height and Width | -25 mm (-1 inch)<br>+3 mm (+1/8 inch) |

**3. Closed-Cell Neoprene Sponge.** Do not exceed ± 3 mm (± 1/8 inch) for laminate unevenness at the edge of finished, laminated, closed-cell neoprene sponge pads.

**4. Maximum Width of Deck.** (out-to-out of beams) Specified width plus 15 mm (1/2 inch) per joint for adjacent boxes.

**5. Steel Bearings.** Section 1105.03(q)

**(f) Handling and Storage.** Members may be handled immediately after completion of stressing. If stressing is not done in a continuous operation, do not handle members before they are sufficiently stressed to sustain the forces and bending moments due to handling. For handling, lift beams from the locations shown on the shop drawings using accepted devices.

If the air temperature is below 5 °C (40F), do not remove beams from the beds until they are surface-dry. If the air temperature is below 0 °C (32F), do not place beams outside the beds unless the differential between the beam temperature and the air temperature is less than 28 °C (50F).

Store beams to maintain the same direction of reactions as in the final position in the bridge deck. Support stored beams with battens between the center of the lift points shown on the shop drawings and the nearest beam end. Store the beams in areas that are suitable and accessible for inspection until the 28-day compressive strength is attained. Maintain beams in horizontal and upright positions at all times.

Separate stacked members and support them by battens placed across the full width of each bearing point. Stack members so lifting devices are accessible and undamaged. Do not use the upper members of a stacked tier as storage areas for shorter members or for heavy equipment.

Before shipment, provide a rough texture to the entire keyway on adjacent box beams and completely remove oil, grease, dirt, or other material that would prevent bonding by sandblasting or other methods approved by the Chief Structural Materials Engineer.

Before shipment, mark each beam with an individual and consecutive identification mark at a permanently exposed beam location. Use the identification mark shown on the approved shop drawings and erect beams according to the framing plan.

Do not ship beams until the Inspector places a stamp of acceptance on each beam.

**(g) Transportation.** Unless authorized by the Representative, do not ship beams until they have attained the minimum 28-day compressive strength shown on the shop drawings, or until 48 hours total storage time has elapsed following prestress transfer, whichever is greater.

Support the members as shown on the shop drawings using adequate bracing to maintain the vertical position. Ensure that supports, bracing, and shipment methods dampen vibrations. Provide adequate padding material between tie chains or cables to prevent concrete chipping.

For medium length members, pole-type trailers are satisfactory, with the member serving as the connection between truck and trailer. Trucks with double bolsters are generally satisfactory, provided that:

- Members are fully seated on the outer bolsters at not more than a distance equal to the member depth from the end of the member, and;
- The inner bolsters are not more than 900 mm (3 feet) from the member's end, or at the designated pickup point.

Observe hauling restrictions as specified in Section 107.23.

# SECTION 1108—POST-TENSIONING OPERATIONS

## 1108.01 GENERAL REQUIREMENTS—

**(a) Description.** This work is prestressing, grouting, and other work related to post-tensioning operations.

**(b) General.** Perform post-tensioning operations in the presence of an authorized representative of the Department, either in a prestressing plant or on the project site.

Retain a Professional Engineer registered in the State, experienced in post-tensioning operations, to be present and in charge of tensioning and grouting operations. Two weeks before the start of the post-tensioning operations, submit, in writing, to the District Bridge Engineer, the Engineer's name and the date and place of post-tensioning. A Professional Engineer registered in the State is not necessary for post-tensioning box culverts or transversely post-tensioning adjacent box beam bridges.

**(c) Shop Drawings.** Section 105.02 and as follows:

Show the proposed method, material, and equipment including any changes to reinforcing steel. Show the method and sequence of stressing including complete specifications and details of the prestressing steel and anchoring devices, bearing devices, location of splices or couplings, working stresses, anchoring stresses, type of ducts, steel corrosion protection, proposed arrangement of the prestressing steel in the members, pressure-grouting material and equipment, and vent details including size, type, spacing, and location and direction of grouting.

Provide a detailed stressing force diagram showing the following:

- deviations from design forces;
- sequence of loading stages;
- friction coefficients for the duct and tendon combinations;
- friction and jacking forces;
- jacking techniques, e.g., overjacking;
- friction loss diagram, superimposed on the force diagram; and
- elongation computations.

Provide shop drawings that are signed, dated, and sealed by a Professional Engineer registered in the State.

Unless indicated, or specified, do not use a working stress greater than 0.6 $f_u$, a temporary stress greater than 0.75 $f_u$, or an anchoring stress greater than 0.7 $f_u$. ($f_u$ = specified minimum ultimate tensile strength of prestressing steel.)

Working force and working stress are the force and stress remaining in the prestressing steel after losses, including concrete creep and shrinkage, elastic concrete compression, steel losses due to stressing sequence, steel relaxation, friction and take up at anchorages, and other losses peculiar to the prestressing system.

## 1108.02 MATERIAL—

**(a) Prestressing Steel.** Use wire, strand, or bar, conforming to the requirements specified in Section 1107.02(n).

**(b) Corrosion Inhibitor.** Obtain from a manufacturer listed in Bulletin 15. Submit the grout mixture to the District Materials Engineer/District Materials Manager for review and approval before use.

Certify as specified in Section 106.03(b)3.

**(c) Anchorages, Bearing Devices, Fittings, and Couplings.** Design anchorages to develop 0.95 $f_u$. Design couplings to develop 1.0 $f_u$. Use bearing devices designed to transmit the anchor force to the concrete, at bearing stress no greater than 21 MPa (3,000 pounds per square inch). Limit bearing device stress to 80% of its yield strength when the prestressing steel is stressed to 0.95 $f_u$.

Certify as specified in Section 106.03(b)3.

**(d) Duct Sheathing.** Unless otherwise indicated, use corrugated, rigid or semi-rigid type, galvanized steel sheathing.

Certify as specified in Section 106.03(b)3.

Minimum duct thickness for metal ducts shall be as follows:

- Strand tendons—0.4 mm (26 gauge) diameter for ducts less than or equal to 66.7 mm (2.625 inches) in diameter and 0.5 mm (24 gauge) diameter for ducts greater than 66.7 mm (2.625 inches) in diameter

- Bar tendons—0.2 mm (31 gauge) diameter

**(e) Epoxy Resin.** Section 1019.2(b)

**(f) Water.** Section 720.1

**(g) Unbonded Prestressing Steel for Precast Box Culverts and Adjacent Box Beams.** Encased, corrosion protected, prestressing strand for unbonded post-tensioning, comprised of the following components:

**1. Special Grade, 7-Wire, Uncoated, Low-Relaxation Strand.** Section 1107.02(n)3.d

**2. Polymer Sheathing.**

**2.a Material.** Polypropylene, cell classification PP 210 B55542, conforming to ASTM D 4101, or polyethylene, High Density Type II, conforming to ASTM D 3350 and ASTM D 1248.

**2.b Thickness and Diameter.** Provide a minimum sheathing wall thickness of 1.25 mm (0.05 inch) and an inside diameter of 0.75 mm (0.03 inch) greater than the maximum diameter of the strand.

**2.c Application.** Apply around prestressing strand in a seamless hot-melt extrusion process. Provide a smooth, circular outside with no visible reveal of the lay of the strand.

**3. Corrosion Inhibitor Compound.**

**3.a Material Properties.** Provides corrosion protection to the strand; lubrication between the strand and sheathing; continuous non-brittle coating if exposed to a temperature of -23 °C (-10F); resists flow within temperature range of -23 °C to 43 °C (-10F to 110F); and chemically stable and nonreactive with prestressing strand, reinforcing steel, sheathing material, and concrete.

**3.b Quantity.** Not less than 1.14 kg (2.5 pounds) per 30.5 m (100 feet) for 12.7 mm (0.5-inch) diameter strand and 1.36 kg (3.0 pounds) per 30.5 m (100 feet) for 15.25 mm (0.6-inch) diameter strand. Completely fill the annular space between the strand and sheathing along the entire length of strand.

**3.c Performance Criteria.** Table A.

**TABLE A**
**Performance Specification for Corrosion Inhibitor Compound**

| Test Description | Test Method | Acceptance Criteria |
|---|---|---|
| Dropping Point | ASTM D 566 or ASTM D 2265 | Minimum 149 °C (300F) |
| Oil Separation at 71 °C (160F) | FTMS (Federal Test Method Standard) 791B Method 321.2 | 0.5% max by weight (mass) |
| Water Content | ASTM D 95 | 0.1% maximum |
| Flash Point (refers to oil content) | ASTM D 92 | Minimum 149 °C (300F) |
| Corrosion test (5% salt fog at 38 °C (100F) 127 µm (5 mils)) | ASTM B 117 | Rest Grade 7 or better after 1000 hours of exposure according to ASTM D 610 |
| Water-soluble ions *<br>a. Chlorides<br>b. Nitrates<br>c. Sulfides | <br>ASTM D 512<br>ASTM D 3867<br>APHA (American Public Health Association) 4500-$S^2E$ | <br>10 ppm maximum<br>10 ppm maximum<br>10 ppm maximum |
| Soak test (5% salt fog at 38 °C (100F) 127 µm (5 mils) coating, Q Panel Type S. Immerse panels 50% in a 5% salt solution and expose to salt fog) | ASTM B 117 (modified) | No emulsification of the coating after 720 hours of exposure. |
| Compatibility with sheathing<br>a. Hardness and volume after exposure of polymer to grease, 40 days at 66 °C (150F)<br>b. Tensile strength change of polymer after exposure to grease, 40 days at 66 °C (150F) | <br>ASTM D 4289 (ASTM D 792 for density)<br><br>ASTM D 638 | <br>Permissible change in hardness 15%, volume 10%.<br><br>Permissible change in tensile strength 30%. |

* Procedure: The inside (bottom and sides) of a 1 L Pyrex beaker (approximate outside diameter 105 mm, 145 mm height) is thoroughly coated with 100 ± 10 g of corrosion inhibitor compound. The coated beaker is filled with approximately 900 cc of distilled water and heated in an oven at a controlled temperature of 38 °C ± 1° for 4 hours. The water extraction is tested by the noted test procedures for the appropriate water-soluble ions. Results are reported as ppm in the extracted water.

## 1108.03 CONSTRUCTION—

**(a) Post-Tensioning Systems.** Include anchorages, fittings, sheathing, tendons, and grout.

**(b) Corrosion Protection.** Protect prestressing steel against physical damage, rust, and corrosion. Do not use prestressing steel that has sustained physical damage, pitting, or that has rust that cannot be removed by wiping with a dry cloth. Do not retain prestressing steel in an ungrouted duct for more than 10 days without special acceptable corrosion protection. Pack prestressing steel in containers or other shipping forms for protection against physical damage and corrosion during shipping and storage. Place a corrosion inhibitor that prevents rust or other corrosion in the package or form or, when allowed, apply it directly to the steel or to the tendon.

Mark on the shipping package or form that the package contains high-strength, prestressing steel and the care to be used in handling. State the type, kind, and amount of corrosion inhibitor used, including placement date, safety orders, and instructions for use.

When stressing and grouting are completed within 10 calendar days after the prestressing steel installation, rust that may form will not be cause for rejection. In this case, use of a corrosion inhibitor is not necessary.

Before use submit the coating system for tendon corrosion protection in a bonded system for approval.

Protect bar tendons from corrosion at the job site by spraying with a rust preventative and by use of an approved protective covering over the bars.

**(c) Anchorages and Bearing Devices.** Use permanent-type anchorages to secure prestressing steel at the ends. Steel distribution plates or assemblies may be omitted if large enough anchorages are used in conjunction with a steel grill embedded in the concrete to effectively distribute the compressive stresses to the concrete.

For all systems of post-tensioning, set each anchorage device in all directions perpendicular to the prestressing steel axis. At both tendon ends, make accurate measurements of anchorage loss, due to slippage or other causes. Compare these losses with the assumed losses shown in the post-tensioning schedule on the shop drawings. When necessary, make adjustments or corrections in the operation.

For special anchorage devices, test according to AASHTO Standard Specification Division II, Section 10.3.2.3.

**(d) Installation of Sheathing Ducts.** Form and place sheathing and secure it to prevent movement when concrete is placed. Make splices grout-tight.

After installation, blow the ducts clear using oil-free compressed air, for at least 5 seconds each. Plug the duct ends to prevent the entry of water or debris.

Furnish sheathing ducts with interlocked seams. Make joints with positive metallic connections, which do not result in angle changes at the joints. Use waterproof tape at the connections to seal seams.

Provide ducts or anchorage assemblies with pipes or connections for grout injection. Install pipe vents that are 13 mm (1/2 inch) or larger in size near the high points of each duct. Use metallic structural fasteners to make connections to ducts. Make vents grout-tight, tape as necessary, and provide means for grout injection. Remove vent ends 25 mm (1 inch) below the member surface, after grouting has been completed.

For tendons made up of single prestressing bar or strand, make the inside diameter at least 6 mm (1/4 inch) greater than the diameter of the prestressing bar or strand. For tendons made up of a number of prestressing bars or strands, make the duct's cross-sectional area at least twice the net area of prestressing steel.

Locate ducts within the specified tolerances. For curved members, place the ducts on, or symmetrically about, the member axis parallel to the curvature direction.

Provide concrete cover a minimum of 38 mm (1 1/2 inches) for sheathing up to 51 mm (2 inches) O.D., and a minimum of 51 mm (2 inches) of cover for larger sheathing. Provide a minimum of 38 mm (1 ½-inch) clear spacing between the sheathing at the beam ends, or provide 1 1/2 times the maximum aggregate size, whichever is greater.

After the prestressing steel has been installed, do not weld or ground for welding equipment on steel in the member. Do not flame cut, unless the ducts and tendons are effectively shielded.

**(e) Prestressing.** Tension prestressing steel, using hydraulic jacks, so the force in the prestressing steel is not less than the value indicated or on the accepted shop drawings with appropriate allowance for all losses.

Within 20 days before stressing, calibrate all jacks and pressure gauge system and furnish certified copies of the load calibration curves to the Engineer except jack calibration for post tensioning of box culverts and adjacent box beams. For post tensioning of box culverts and adjacent box beams accompany jack gages with a current, certified calibration chart, not older than 6 months. Equip each jack with a pressure gage having an accurate reading dial at least 150 mm (6 inches) in diameter. Calibrate each jack and its gage as a unit, with the cylinder extension in the approximate position it will be in at final jacking force. Recalibrate stressing equipment at 6-month intervals and at other times when required. Do not interchange jacks and gauges without recalibration. Check the certified calibration chart for hydraulic jacks and pressure gages used for tensioning prestressing steel, both before and during tensioning operations.

Do not stress tendons until the concrete has attained its 28-day strength, unless partial stressing is allowed at a lower strength.

Apply to the tendon, an initial load of 10% of the full load to take up slack and to provide a starting point for measurement of elongations. Apply the final load, including any overload. Apply the load at a rate consistent with procedures recommended by the manufacturer of the system.

Unless otherwise indicated, in simple span members, stress by jacking from one end only, with one-half of the prestressing steel in each member tensioned from one end and the other one-half tensioned from the opposite end.

When the same tendons are jacked from two ends, both jacking operations may be done simultaneously, provided uniform tensioning forces are applied at each end. The stressing forces, measured by jacking pressures and elongation, are required to agree within 5%. If the measurements cannot be reconciled within this range, halt the stressing, examine the procedure, and determine the sources of error so the measured force can be verified within this limit. If sources of error cannot be determined or verified by the Professional Engineer in charge of post-tensioning operations, to the satisfaction of the Engineer, the post-tensioning of the member will be stopped and the member rejected.

In continuous members, tension by jacking at each tendon end, unless otherwise indicated. Jacking of both ends need not be done simultaneously, unless otherwise indicated.

**(f) Bonding and Grouting.** Start grouting promptly after tensioning.

**1. Grout.** Use grout consisting of Portland cement, water, and admixtures. Use Type I, II, or III Portland cement. Use nonshrink admixture and anti-bleed admixture of the type recommended by the manufacturer of an accepted tendon. Do not use admixtures containing chlorides or nitrates, or that release free hydrogen.

Use enough grout plastic to pump and completely fill the ducts. No grout shrinkage is allowed while in the plastic state. Before post-tensioning, design the mix and verify that it has a strength of 17 MPa (2,500 pounds per square inch) at 7 days and has 4% to 10% expansion. Verify strength by testing according to ASTM C 109. Limit the water content of the grout to the minimum volume necessary to produce a mix that can be pumped, with a maximum of 19 L (5 gallons) per bag of cement.

Prepare test cylinders from each day's grouting.

Visually determine the grout's ability to be pumped.

Place water in the mixer, then add cement and admixture.

Strength testing of grout for precast box culverts is not required.

**2. Grouting Equipment.** Use equipment capable of grouting at a pressure of at least 700 kPa (100 pounds per square inch). Furnish equipment with a pressure gage that has a full-scale reading of not more than 2 MPa (300 pounds per square inch). Provide standby flushing equipment and compressed air equipment capable of developing a pumping pressure at 1.7 MPa (250 pounds per square inch) and large enough to flush out partially grouted ducts. Provide working pressure meters on the group pumps, meters that show the grout pressure at the injector nozzle discharge end.

**3. Grouting.** Clear ducts of deleterious materials that would impair grout bonding or interfere with grouting procedures.

After curing, blow ducts free of water and keep them dry until grouting. Immediately before grouting, flush the ducts with clean water, then remove excess water by blowing out with oil-free compressed air.

Mix the grout in mechanical mixing equipment that produces uniform and thoroughly mixed grout. Do not retemper grout. Agitate the grout continuously until it is pumped. Before entry into the pump, screen grout through 2 mm (0.07-inch) maximum, clear opening screen.

Grout the ducts on the day of completion of the tensioning operation of each unit, unless otherwise directed.

Equip grout injection pipes with positive, mechanical shutoff valves. Fit vents and ejection pipes with valves, caps, or other devices capable of withstanding the pumping pressures. Do not remove or open valves and caps until directed, generally after the grout has set.

Apply grout by pumping toward open vents. Pump continuously, using moderate pressure at the entry point in the duct, until entrapped air is forced out the open vent or vents and until visible slugs of water or air are ejected. Close the outlet pipe. With the entire duct filled and discharge vents closed, raise the pressure to a minimum of 345 kPa (50 pounds per square inch) and hold for a minimum of 1 minute, then plug the injection point to prevent any grout loss. Close the valve at the inlet while maintaining this pressure.

Using an abrasive, blast clean the concrete surfaces at anchorage assemblies, until clean aggregate is exposed, to ensure concrete bonding or grout encasement of assemblies.

Where the end of a post-tensioned assembly is not embedded in concrete, recess the anchorages so the prestressing steel ends and parts of the anchorages will be at least 50 mm (2 inches) inside of the member end surface, unless a greater embedment is indicated. Following post-tensioning, clean the recesses, fill with nonshrinking mortar, and finish flush. After curing, paint surfaces with two coats of epoxy resin.

# SECTION 1109—GUIDE RAIL AND METAL MEDIAN BARRIER

**1109.01 RAILS**—As shown on the Standard Drawings and as follows:

**(a) Rail Elements.** AASHTO M 180, Class A, Type II; mark to show the approximate radius of curved rails.

**(b) Rubbing Rails.** Fabricate from steel, ASTM A 1011/A 1011M, with mechanical properties conforming to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).

Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

Shop form, when required, on curves having a radius of less than 45 m (150 feet), as follows:

- Notch flanges to form a curve with a series of chords of equal lengths not exceeding 450 mm (18 inches) (for radii from 0 to 6 m (0 to 20 feet)), 900 mm (3 feet) for radii from 6 m (20 feet) to 30 m (100 feet), and 1.9 m (6 1/4 feet) for radii from 30 m (100 feet) to 45 m (150 feet); cut notches to the proper angle and weld.
- Form so the midpoint of the chord is tangent to the curve.
- Mark to show the approximate radius of curvature.

**1109.02 TERMINAL SECTIONS**—As shown on the Standard Drawings and as follows:

**(a) Alternate Terminal Sections.** AASHTO M 180, Class A, Type II.

**(b) Terminal Section Bridge Connection.** AASHTO M 180, Class B, Type II.

**(c) Flared Terminal Section.** AASHTO M 180, Class A, Type II.

**1109.03 POSTS**—

**(a) Steel I-Beam Posts.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36) or ASTM A 769/A 769M.

Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

**(b) Steel C-Posts and Channel Posts.** Fabricate from steel, ASTM A 570/A 570M, with mechanical properties conforming to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).

Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

**(c) Wood Guide Rail Posts.** AASHTO M 168. As shown on the Standard Drawings and as follows:

Label each wood item with lot or batch number, plant, place, and date of manufacture.

Manufacture from timber having a minimum grade of 8.2 MPa (1,200 pounds per square inch) according to the current standard grading and dressing rules of the West Coast Lumber Inspection Bureau, the Southern Pine Inspection Bureau or other acceptable timber associations. Timber to be either rough sawn (unplanned) or surfaced four sides (s4s) to the dimensions indicated. Size in the direction parallel to the axis of bolt holes to be within a tolerance of ± 6 mm (± 1/4 inch). Use one type of surface finish for posts and offset blocks in a continuous run of guide rail.

Treat timber with a preservative according to AASHTO M 133, after end cuts are made and holes are drilled. AASHTO M 133 designates AWPA C14 and AWPA C2 as the respective specifications. In cases of conflict, AWPA C14 will govern.

Certify as specified in Section 106.03(b)3.

**(d) Breakaway Terminal Wood Posts.** Section 1109.03(c)

**(e) Breakaway Terminal Foundation Wood Posts.** Section 1109.03(c)

**1109.04 OFFSET BRACKETS—**

**(a) General Requirements.** Provide offset brackets from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

**(b) Wood Offset Brackets.** As shown on the Standard Drawings and/or the approved Shop Drawings manufactured from timber having a minimum grade of 8.2 MPa (1,200 pounds per square inch) according to the standard grading and dressing rules of the West Coast Lumber Inspection Bureau, the Southern Pine Inspection Bureau, or other acceptable timber associations. Treat timber with a preservative according to AASHTO M 133, after cutting ends, drilling bolt holes and, if applicable, routing. Provide brackets with a ± 6 mm (±1/4-inch) dimension tolerance in the direction of the bolt hole.

1. **Non-Routed.** Use with wood posts.

2. **Routed.** Use with steel posts.

**(c) Plastic Offset Brackets.** As shown on the Standard Drawings and/or the approved Shop Drawings and manufactured from greater than 95% virgin and/or recycled plastic material. Provide brackets with a ± 6 mm (±1/4-inch) dimension tolerance in the direction of the bolt hole.

1. **Non-Routed.** Use with wood posts.

2. **Routed.** Use with steel posts.

**(d) Composite Offset Brackets.** As shown on the Standard Drawings and/or the approved Shop Drawings and manufactured from a combination of either virgin or recycled wood, plastic, rubber, or other materials. Provide brackets with a ± 6 mm (±1/4-inch) dimension tolerance in the direction of the bolt hole.

1. **Non-Routed.** Use with wood posts.

2. **Routed.** Use with steel posts.

**1109.05 MISCELLANEOUS MATERIAL**—As shown on the Standard Drawings and as follows:

**(a) Nuts, Bolts, and Washers.** Section 1105.02(c)1.
Galvanize as specified in Section 1105.02(s) (ASTM A 153, or ASTM B 695 and B 696).

**(b) Base Plates, Post Plates, End Post Support Angles, and Hardware.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).
Galvanize base plates and hardware after fabrication, as specified in Section 1105.02(s) (AASHTO M 111). Do not punch, drill, grind, cut, or weld after galvanizing. Repair minor abrasions of galvanized surfaces with two coats of galvanizing paint.

**(c) Rotating Bracket.** Fabricate from malleable cast iron, ASTM A 47 or structural steel, AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).
Galvanize as specified in Section 1105.02(s) (AASHTO M 111).

**(d) Steel Spacer Tube.** ASTM A 53, Type S, Grade B, plain end, Schedule 40 steel pipe.
Galvanize as specified in Section 1105.02(s).

**1109.06 GALVANIZING**—Galvanize metal parts as specified in Section 1105.02(s) (ASTM A 153 unless otherwise specified) and conform to the requirements of AASHTO M 180, Section 9.

**1109.07 GALVANIZING PAINT**—Bulletin 26

**1109.08 WELDING MATERIAL**—Section 1105.02(t)

**1109.09 CERTIFICATION**—Section 106.03(b)3

# SECTION 1110—RIGHT-OF-WAY FENCE

**1110.01 WIRE FABRIC AND COMPONENTS**—As shown on the Standard Drawings and as follows:

**(a) Type 1 Right-of-Way Fence.**

**1. Fabric.** AASHTO M 181, Type I, II, or IV, 3.76 mm (No. 9 gage) coated wire size with the same type of coating throughout the project. Galvanize Type I fabric with a Class D coating.

**2. Fasteners.**

- For attaching the fabric to line posts: 4.87 mm (No. 6 gage) aluminum wire or 3.76 mm (No. 9 gage) galvanized preformed clips.
- For attaching the fabric to tension wires: 3.43 mm (No. 10 gage) galvanized steel wire or aluminum hog rings of comparable size.

Galvanize at a minimum of 488 g/m$^2$ (1.6 ounces per square foot) of actual surface area.

**3. Tension Wire.** AASHTO M 181

**(b) Type 2 and Type 5 Right-of-Way Fence.**

**1. Fabric.** Galvanized, 3.76 mm (No. 9 gage) steel wire, 3.06 mm (No. 11 gage) aluminum coated steel wire conforming to ASTM A 491, or galvanized 3.76 mm (No. 9 gage) steel wire top and bottom with galvanized 3.06 mm (No. 11 gage) steel intermediate wires.

Join vertical stays at each horizontal wire by electric arc welding or by a hinge-type method, consisting of not less than 1 1/4 tightly wrapped twists.

Galvanize at a minimum of 180 g/m$^2$ (0.6 ounce per square foot) of actual surface area, as specified in Section 1110.04.

**2. Fasteners.** For attaching the fabric to posts; aluminum or galvanized steel bands or clamps, galvanized staples set in the post flanges, or another acceptable method.

**1110.02 END POSTS, CORNER AND PULL POSTS, LINE POSTS, BRACES, STRETCHER BARS, TRUSS RODS, FITTINGS, AND HARDWARE**—As shown on the Standard Drawings and as follows:

- Straight posts true to section.
- Braces, fittings, and hardware of commercial-quality steel or malleable iron.
- Posts of commercial quality steel or malleable iron, or Aluminum Alloys 6063-T6, 6005-T5, or 6061-T6, according to ASTM B 221/B 221M; tubular and open type sections.
- Moisture-excluding caps, firmly and rigidly secured to the post top.

Galvanize or coat both the inside and outside of tubular and open-type sections, according to AASHTO M 111. Either of two alternate coating systems may be used, as follows:

- **Outside.** Hot-dipped zinc coating, according to ASTM B 6, at a minimum of 305 g/m$^2$ ± 30 g/m$^2$ (1.0 ± 0.1 ounce per square foot) of actual surface area; chromate conversion coating at 50 mg/m$^2$ ± 25 mg/m$^2$ (30 micrograms per square inch ± 15 micrograms per square inch) of actual surface area; thermoplastic electrostatically applied acrylic coating, 0.01 mm ± 0.005 mm (0.5 mil ± 0.2 mil) in thickness.

and

- **Inside.** Zinc base coating, 0.01 mm ± 0.005 mm (0.5 mil ± 0.2 mil) thickness (92 g/m$^2$ ± 15 g/m$^2$) (0.3 ounce per square foot ± 0.05 ounce per square foot) with a minimum of 80% zinc powder by mass (weight).

or

- **Outside and Inside.** Hot-dipped, pure, aluminum coating, commonly identified as Type 2, with a minimum mass (weight) of coating of 230 g/m$^2$ (0.75 ounce per square foot) of actual surface area, triple spot test, and 215 g/m$^2$ (0.70 ounce per square foot) of actual surface area, single spot test, as measured according to AASHTO T 213; a chromate conversion coating; and a thin acrylic resin film.

**(a) Type 1 Right-of-Way Fence.**

**1. End Posts.** Round, rectangular, or square tubular sections, conforming to the requirements of Table A; if acceptable, other posts sections, conforming to the requirements of Table A.

**TABLE A (Metric)**
**Minimum Section Modulus About Major & Minor Axis (mm$^3$)**

| Fabric Height (mm) | Minimum Yield Point Stress (MPa) | | | | | |
|---|---|---|---|---|---|---|
| | 310 or greater | | 310 to 241 | | 241 to 172 | |
| | Major | Minor | Major | Minor | Major | Minor |
| 1220 | 5000 | 1800 | 6400 | 2300 | 9000 | 3200 |
| 1520 | 6300 | 2800 | 8000 | 3600 | 11 200 | 5100 |
| 1830 | 7500 | 4100 | 9600 | 5200 | 13 500 | 7300 |
| 2130 | 8700 | 5500 | 11 200 | 7100 | 15 700 | 9900 |
| 2440 | 10 000 | 7200 | 12 800 | 9300 | 18 000 | 13 000 |

**TABLE A (English)**
**Minimum Section Modulus About Major & Minor Axis (inch$^3$)**

| Fabric Height (feet) | Minimum Yield Point Stress (ksi) | | | | | |
|---|---|---|---|---|---|---|
| | 45 or greater | | 45 to 35 | | 35 to 25 | |
| | Major | Minor | Major | Minor | Major | Minor |
| 4 | 0.304 | 0.110 | 0.392 | 0.141 | 0.548 | 0.197 |
| 5 | 0.381 | 0.171 | 0.489 | 0.220 | 0.686 | 0.308 |
| 6 | 0.457 | 0.247 | 0.588 | 0.317 | 0.823 | 0.444 |
| 7 | 0.533 | 0.336 | 0.685 | 0.432 | 0.960 | 0.605 |
| 8 | 0.609 | 0.439 | 0.784 | 0.564 | 1.097 | 0.790 |

**2. Corner and Pull Posts.** Section 1110.02(a)1., except finish brace clamps or attaching devices, adjustable to various horizontal and vertical angles.

**3. Line Posts.** Tubular, H-column, or I-beam sections, conforming to the requirements of Table B; if acceptable, other post sections, conforming to the requirements of Table B.

**TABLE B (Metric)**
**Minimum Section Modulus About Major Axis ($mm^3$)**

| Fabric Height (mm) | Minimum Yield Point Stress (MPa) | | | Test Force* (kN) |
|---|---|---|---|---|
| | 310 or greater | 310 to 241 | 241 to 172 | |
| 1220 | 4400 | 5600 | 7900 | 7.2 |
| 1520 | 5500 | 7000 | 9800 | 8.9 |
| 1830 | 6600 | 8400 | 11 800 | 10.7 |
| 2130 | 7600 | 9800 | 13 800 | 12.5 |
| 2440 | 8700 | 11 200 | 15 700 | 14.2 |

* Test load a 914 mm section of line post for bending capacity about the major axis of its cross section. Apply a concentrated force at span center with supports spaced at 610 mm. Ensure that the test section supports the minimum force as indicated in Table B, within the elastic limit of the material.

**TABLE B (English)**
**Minimum Section Modulus About Major Axis ($inch^3$)**

| Fabric Height (feet) | Minimum Yield Point Stress (ksi) | | | Test Load* (kips) |
|---|---|---|---|---|
| | 45 or greater | 45 to 35 | 35 to 25 | |
| 4 | 0.267 | 0.343 | 0.480 | 1.6 |
| 5 | 0.333 | 0.429 | 0.600 | 2.0 |
| 6 | 0.400 | 0.514 | 0.720 | 2.4 |
| 7 | 0.466 | 0.600 | 0.840 | 2.8 |
| 8 | 0.533 | 0.686 | 0.960 | 3.2 |

* Test load a 36-inch section of line post for bending capacity about the major axis of its cross section. Apply a concentrated load at span center with supports spaced at 24 inches. Ensure that the test section supports the minimum load as indicated in Table B, within the elastic limit of the material.

**4. Braces, Stretcher Bars, and Truss Rods.**

- Braces, 42.2 mm (1.66-inch) O.D., tubular steel section at nominal 3.4 kg/m (2.27 pounds per linear foot), 41.3 mm x 31.8 mm (1 5/8 inches by 1 1/4 inches) roll formed, U-shaped steel section, at nominal 2 kg/m (1.35 pounds per linear foot), or equal.

- Stretcher Bars (for attaching the fabric), at least 5 mm x 19 mm (3/16-inch by 3/4-inch) flat steel, or equal.

- Truss Rods, 10 mm (3/8-inch) nominal diameter, good quality steel, or equal, with a turnbuckle or other provision for adjustment.

**(b) Type 2 and Type 5 Right-of-Way Fence.**

**1. End, Corner, and Pull Posts.** Tubular, angle, or other acceptable section, conforming to the requirements of Table A.

**2. Line Posts.** Tubular, ribbed tee, U-shaped, angle, or other acceptable section, conforming to the requirements of Table B.

Attach an acceptable plate or other device to the posts to hold plumb and to keep properly aligned. Fasten the plate or device by welding or riveting (not less than two rivets), or by another acceptable method.

**3. Braces.** 42.2 mm (1.66-inch) O.D. tubular steel section at nominal 3.4 kg/m (2.27 pounds per linear foot); 51 mm x 51 mm x 6.4 mm (2-inch by 2-inch by 1/4-inch) angle or equal.

**1110.03 GATES**—As shown on the Standard Drawings and as follows:

- Swing-type gates, with latches, stops, keepers, hinges, and locks.
- Steel wire fabric of same type material as the fence.
- Hinges of adequate strength to support the gate, and that do not twist or turn under the gate's action.
- Plungebar-type latches that can be locked, full gate height, and located in a manner that engages the gate stop.

  Forked latches may be allowed, for single gates less than 3 m (10 feet) wide.
- Stops are to consist of a flush plate, anchored in concrete, to engage the plungebar of the latch.
- Other types of stops may be allowed , for single gates less than 3 m (10 feet) wide.
- Substantial devices are necessary for securing and supporting the free end of the gate in an open position.

**1110.04 GALVANIZING**—Galvanize fabric, posts, post caps, braces, fittings, and hardware, by electrolytic, hop-dip, mechanical, or other acceptable methods as specified in Section 1105.02(s) and as follows:

For electrolytic method: ASTM B 633

For hot-dip method:

- Posts, braces, and fittings—ASTM A 123 or ASTM A 53
- Fabric—ASTM A 392
- Hardware—ASTM A 153

For mechanical method (hardware only): ASTM B 695

Test galvanizing by mass (weight), according to ASTM A 90.

**1110.05 INSPECTION**—Material will be inspected, if considered necessary, at the place of manufacture, before shipment. Provide facilities for the Department inspector to determine that the material is being furnished as indicated.

**1110.06 CERTIFICATION**—Section 106.03(b)3

**1110.07 DRIVE ANCHOR**—Anchors from a manufacturer listed in Bulletin 15.

# SECTION 1111—HIGH LOAD MULTI-ROTATIONAL BEARINGS

**1111.01 DESCRIPTION**—This work is the fabrication of high load multi-rotational bearings, as indicated.

**1111.02 MATERIAL**—Use new material at all times, with no reclaimed material incorporated in the finished bearing.

**(a) Steel.** Conform to AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250, 345, or 345W (Grade 36, 50, or 50W), except for steel for guide bars and shear restriction pins and sleeves. Furnish guide bars and shear restriction mechanisms as specified by the manufacturer and that are approved.

**(b) Elastomeric Disc.**

**1. Pot Bearings.** Provide Shore A 50 Durometer and conform to the following requirements:

Furnish only virgin, crystallization-resistant polychloroprene (neoprene) or virgin, natural polyisoprene (natural rubber) as the raw polymer for the elastomeric rotational element used in the construction of pot bearings. Use individually molded and one-piece elastomers. Provide neoprene and natural rubber used in these bearings with physical properties, which conform to the following ASTM or AASHTO requirements, with the modification noted:

| Compound | ASTM Requirement | AASHTO Requirement |
|---|---|---|
| Neoprene | ASTM D 2000, Line Call Out M2BC520A14B14 | AASHTO M 251 |
| Natural Rubber | ASTM D 2000, Line Call Out M4AA520A13B33 | AASHTO M 251 |

Modification: 1) Samples for compression set tests shall be prepared using a type 2 die.
2) Shore A durometer hardness = 50 ± 10 Points

**2. Disc Bearings.** Provide polyether urethane conforming to the following requirements:

| Physical Property | ASTM Test Method | Requirements | | | |
|---|---|---|---|---|---|
| | | Compound A | | Compound B | |
| | | Min. | Max. | Min. | Max. |
| Hardness, Type D Durometer | D 2240 | 46 | 50 | 60 | 64 |
| Tensile Stress, MPa (psi) | D 412 | | | | |
| At 100% elongation | | 10 (1,500) | — | 14 (2,000) | — |
| At 200% elongation | | 19 (2,800) | — | 26 (3,700) | — |
| Tensile Strength, MPa (psi) | D 412 | 28 (4,000) | — | 35 (5,000) | — |
| Ultimate Elongation, % | D 412 | 350 | — | 220 | — |
| Compression Set, 22 h @ 70 °C (158F), % | D 395 | — | 40 | — | 40 |

**(c) Sliding Surfaces.**

**1. General.** Provide polytetrafluoroethylene (PTFE) resin sheets, PTFE fabric, interlocked bronze and PTFE structures, PTFE-perforated metal composite, back-up materials and all other parts of fixed or expansion bearings containing PTFE materials having the friction, mechanical, physical, and weathering properties specified in 1111.02(c) or indicated.

**2. PTFE Resin.** Furnish virgin PTFE resin (not reprocessed) conforming to the requirements of ASTM D 1457. Provide resin with specific gravity of 2.13 to 2.19 and melting point of 328 °C ± 1 °C (623F ± 2F).

**3. Filler Material.** When filler material is used, furnish milled glass fibers (15% maximum filler percent by mass (weight)), carbon (25% maximum filler percent by mass (weight)) or fabric containing PTFE fibers, or other approved inert filler materials.

**4. Adhesive Material.** Use heat cured, high temperature epoxy capable of withstanding temperatures of 196 °C to 260 °C (385F to 500F) when bonding the PTFE to its steel substrate. Provide adhesive material in epoxy resin conforming to the requirements of Federal Specification MMM-A-134 FEP film or approved equal.

**5. Unfilled PTFE Sheet.** Make finished unfilled PTFE sheet from virgin PTFE resin and ensure that it conforms to the following requirements:

| | | |
|---|---|---|
| Tensile Strength (minimum) | ASTM D 1457 | 19 MPa (2,800 psi) |
| Elongation (minimum) | ASTM D 1457 | 200% |

**6. Filled PTFE Sheet.** Make filled PTFE sheet from virgin PTFE resin uniformly blended with inert material.

Ensure that finished filled PTFE sheets containing glass fiber or carbon conform to the following requirements:

| Requirement | ASTM Method | 15% Glass Fibers | 25% Carbon |
|---|---|---|---|
| Mechanical | | | |
| Tensile Strength (minimum) | D 1457 | 14 MPa (2,000 psi) | 9 MPa (1,300 psi) |
| Elongation (minimum) | D 1457 | 150% | 75% |
| Physical | | | |
| Specific Gravity (minimum) | D 792 | 2.20 | 2.10 |
| Melting Point | D 1457 | 327 °C ± 10 °C (620F ± 18F) | 327 °C ± 10 °C (620F ± 18F) |

**7. Fabric Containing PTFE Fibers.** Use manufactured fabric produced from oriented, multifilament, PTFE, fluorocarbon fibers and other fibers as required by proprietary designs. Use PTFE fibers with the following typical physical properties:

| Physical Requirement | ASTM Method | PTFE Fibers |
|---|---|---|
| Tensile Strength (minimum) | D 2256 | 165 MPa (24,000 psi) |
| Elongation (minimum) | D 2256 | 75% |

**8. Interlocked Bronze and Filled PTFE Structures.** Supply interlocking bronze and filled PTFE structures consisting of a phosphor bronze plate with a 0.25 mm (0.010-inch) thick porous bronze surface layer into which is impregnated a lead/PTFE compound. Provide an overlay of compounded PTFE not less than 0.025 mm (0.001 inch) thick. Ensure that the phosphor bronze back plate conforms to ASTM B 100 and the porous bronze layer conforms to ASTM B 103/B 103M.

**9. PTFE Metal Composite.** Supply PTFE metal composite consisting of virgin PTFE molded on each side and completely through a 35 mm (1.32-inch) perforated stainless steel ASTM A 240, Type 304 sheet.

**10. Surface Treatment.** Where PTFE sheets are to be epoxy bonded, have an approved manufacturer factory treat one side of the PTFE sheet using the sodium napthalene or sodium ammonia process.

**11. Stainless Steel Mating Surface.** Furnish stainless steel sliding surfaces conforming to ASTM A 167 or A 240, Type 304 with an ANSI 0.4 µm (0.02 mil) surface finish or less. Attach a stainless steel sheet by an approved welding procedure, which keeps the sheet in contact with the substrate, or weld a stainless steel overlay using Type 309L electrodes. Use 1.25 mm (0.05-inch) minimum thickness stainless steel.

**12. Manufacturing Requirements.** Manufacture the expansion bearing to the dimensions of and to conform to the requirements of the method of fastening to the structure as indicated.

**12.a Attachment of PTFE Material.** Factory-bond, mechanically connect, or recess into the back-up material PTFE material as indicated.

**12.a.1 Bonding.** Perform the bonding at the factory of the manufacturer of the fixed or expansion bearings under controlled conditions and according to the written instructions of the manufacturer of the approved adhesive system. Ensure that after completion of the bonding operation, the PTFE surface is smooth and free from bubbles. Then polish filled PTFE surfaces.

**12.a.2 Mechanically Fastened.** If mechanically fastened, fasten PTFE sheet as indicated with the size, type, and number of fasteners required, taking care to have full bearing of the fastener used in the PTFE sheet and back-up material.

**12.a.3 Fabric Containing PTFE Fibers.** Bond or mechanically attach the fabric to a rigid substrate. Supply fabric capable of carrying unit loads of 69 MPa (10,000 pounds per square inch) without cold flow. Provide a fabric-substrate bond capable of withstanding a shear force equal to 10% of the perpendicular or normal application loading without delamination in addition to the shear force developed as a result of the natural bearing friction shear force.

**(d) Sealing Rings.**

**1. Rings with Rectangular Cross Sections.** Furnish brass sealing rings conforming to ASTM B 36/B 36M.

**2. Rings with Circular Cross Sections.** Furnish round cross section metal sealing rings conforming to Federal Specifications QQ-B-626, composition 22, half hard.

**(e) Bronze Elements.** Ensure that bronze bearing and expansion plates conform to the specification for Bronze Castings for Bridges and Turntables, AASHTO M 107 (ASTM B 22). Furnish alloy C91100 unless otherwise specified.

Cast bronze plates according to the indicated details. Plane sliding surfaces parallel to the movement of the spans and polish them unless otherwise indicated.

**(f) Lubricant.** Furnish solid lubricant consisting of a combination of solids having non-deteriorating characteristics as well as lubricating qualities and capable of withstanding long term atmospheric exposure, de-icing materials, and water. Do not use molybdenum disulfide and other ingredients, which promote electolytic or chemical action between the bearing elements. Do not use shellac, tars and asphalts, or petroleum solvents as binders.

## 1111.03 FABRICATION—

**(a) Rotational Elements.** Furnish elements conforming to the following requirements:

**1. Pot and Disc Bearings.** Manufacture from a solid plate by machining or fabricate by welding a flame-cut shape to a plate. Test all welded areas by the magnetic particle method meeting AWS D1.5, Section 6 requirements. Welding is as specified in Section 1105.03(m).

Machine inside diameter (ID) of pots to a tolerance of ±0.125 mm (±0.005 inch) up to 500 mm (20 inches) ID and ±0.175 mm (±0.007 inch) over 500 mm (20 inches) ID.

Pots machined parallel to the inside to Class "A" tolerance.

Machined surfaces to an ANSI 3 µm (125 micro-inch rms) finish or better.

Elastomeric discs with tolerances as follows:

- Diameters up to 500 mm (20 inches), ±1.5 mm (±1/16 inch)
- Diameters greater than 500 mm (20 inches), ±2.3 mm (±3/32 inch)
- Total thickness of all pieces, -0 mm (-0 inch), +3 mm (+1/8 inch)
- Mold discs in one piece, do not layer elastomer.

Pistons with tolerances as follows:

- Diameters up to 500 mm (20 inches), ±0.125 mm (±0.005 inch).
- Diameters greater than 500 mm (20 inches), ±0.175 mm (±0.007 inch).
- Upper side, Class "A" tolerance. Lower side, Class "B" tolerance.

**2. Disc Bearings.** Provide discs with tolerances as follows:

- Diameters up to 500 mm (20 inches), ±1.5 mm (±1/16 inch).
- Diameters greater than 500 mm (20 inches), ±2.3 mm (±3/32 inch).
- Thickness, -0 mm (-0 inch), +3 mm (+1/8 inch).
- Mold discs in one piece, do not layer elastomer.

Furnish bearing plates for discs with tolerances as follows:

- Diameters up to 500 mm (20 inches), ±0.125 mm (±0.005 inch).
- Diameters greater than 500 mm (20 inches), ±0.175 mm (±0.007 inch).
- Inside surfaces facing disc Class "A" tolerance and minimum ANSI 3 µm (125 micro-inch rms) finish.
- Outside surfaces, Class "A" tolerance and minimum ANSI 3 µm (125 micro-inch rms) finish.

**3. Spherical Bearings.** Provide spherical bearings with tolerances as follows:

- Machined diameters, ±380 µm (±0.015 inch).
- Convex radius dimensions, +0 µm (+0.000 inch), -250 µm (-0.010 inch).
- Concave radius dimensions, +250 µm (+0.010 inch), -0 µm (-0.000 inch).
- Mating surfaces to be as indicated, external edges may be "as cast" or flame-cut.
- Lower surface of convex element Class "C" tolerance.

**(b) Non-Rotational Elements (All Bearings).** Furnish elements conforming to the following requirements:

Furnish masonry and distribution plates with tolerances as follows:

- Plan dimensions up to 750 mm (30 inches), -0 mm (-0 inch), +5 mm (+3/16 inch)
- Plan dimensions over 750 mm (30 inches), -0 mm (-0 inch), +6 mm (+1/4 inch)
- Thickness tolerance, -0.75 mm (-0.030 inch), +1.50 mm (+0.060 inch)
- Masonry plates used with pot, disc, or spherical bearings, Class "C" tolerance for the underside and Class "A" tolerance for the upper side.

Provide PTFE sliding surfaces with tolerances as follows:

- Plan dimensions "total design area," +5%, -0%
- Substrate flatness: Class "A" tolerance for pot and disc bearings, Class "B" tolerance for spherical bearings.

Seal weld the stainless steel sheet around the entire perimeter using techniques, which ensure it will remain in contact with the backing plate.

Provide an ANSI 0.4 µm (20 micro-inch rms) finish or better. Flatness to Class "A" tolerance. Furnish sole plates with tolerances as follows:

- Plan dimensions up to 750 mm (30 inches), -0 mm (-0 inch), +5 mm (+3/16 inch)
- Plan dimensions over 750 mm (30 inches), -0 mm (-0 inch), +6 mm (+1/4 inch)
- Center line thickness, -0.75 mm (-1/32 inch), +3.0 mm (+1/8 inch)
- Flatness of surface in contact with steel beams, Class "B" tolerance; in contact with fresh concrete, none; in contact with stainless steel sliding surface, Class "A" tolerance; in contact with another steel plate, Class "B" tolerance.
- Minimum edge thickness, 20 mm (3/4 inch)
- Machined bevels to an angular tolerance of ±0.002 rad
- Flatness of bevelled surfaces, Class "A" tolerance

Provide guide bar with tolerances as follows:

- Length, unless integral with plate, ±3 mm (±1/8 inch)
- Section dimensions, ±1.5 mm (±1/16 inch)
- Flatness where it bears on another plate, Class "A" tolerance
- Bar-to-bar, nominal dimension ±0.75 mm (±1/32 inch)
- Not more than 0.75 mm (1/32 inch) out of parallel

Overall bearing height not more than 3 mm (1/8 inch) or less than 0 mm (0 inch) from nominal dimension. Chamfer all edges.

**(c) Determination of Flatness and Tolerances.** Furnish bearings with flatness determined by the following method:

Place a precision straightedge, longer than the nominal dimension to be measured, in contact with the surface to be measured or as parallel to it as possible.

Select a feeler gage having a tolerance of ±0.025 mm (±0.001 inch) and attempt to insert it under the straightedge using the least number of blades.

Flatness is acceptable if the feeler gage does not pass under the straightedge.

Flatness tolerances are arranged in the following classes:

Class "A" = 0.0005 mm (0.0005 inch) x "Nominal Dimension"
Class "B" = 0.001 mm (0.001 inch) x "Nominal Dimension"
Class "C" = 0.002 mm (0.002 inch) x "Nominal Dimension"

"Nominal Dimension" is defined as the actual dimension of the plate, in millimeters (inches), under the straightedge.

In determining flatness, the straightedge may be located in any position on the surface being evaluated and not necessarily at 90 degrees to the edges.

Ignore a 25 mm (1-inch) wide border around the plate in determining flatness.

**(d) Painting.** Do not paint before completion of welding.

If the time of exposure before welding is to exceed 90 calendar days, provide metal surfaces with a protective coating of clear lacquer or other approved coating.

Paint all steel surfaces as indicated and according to recommendations of the coating manufacturer.

**(e) Testing.** Conduct the following tests before installation of the bearings, and in the presence of the Representative.

**1. Sampling.** Select one sample, for testing purposes, at random from each "lot" of completed bearings at the manufacturer's plant.

A "lot" consists of one of the following:

- No more than 25 fixed bearings of one "load category"
- No more than 25 expansion bearings of one "load category"

One "load category" may consist of bearings of differing vertical force capacity but the bearings may not exceed a range of capacity differing by more than 1300 kN (300 kips).

**2. Friction Test.** Test only those bearings actually fabricated for the project.

Test a sample from each lot of expansion bearings. For all guided and nonguided expansion type bearings, measure the sliding coefficient of friction at the bearing's design capacity as specified in Section 1111.03(e)2.a, and on the fifth and fiftieth cycles, at a sliding speed of 25 mm (1 inch) per minute.

Calculate the sliding coefficient of friction as the horizontal force necessary to maintain continuous sliding of one bearing, divided by the bearing's vertical design capacity.

The test results will be evaluated as follows:

- Measured sliding coefficients of friction not to exceed 3%.
- Visually examine the bearing both during and after the test. Any resultant visual defects, such as bond failure, physical destruction, cold flow of TFE to the point of debonding, or damaged components will cause rejection of the lot.

**2.a Test Method.** Obtain approval of the test method and equipment and comply with the following requirements:

- Arrange the test so that the coefficient of friction on the first movement of the manufactured bearing can be determined.
- Clean the bearing surface before testing.
- Conduct the test at maximum working stress for the TFE surface with the test load applied continuously for 12 hours before measuring friction.
- Determine the first movement static and dynamic coefficient of friction of the test bearing at a sliding speed of less than 25 mm (1 inch) per minute, which is not to exceed the coefficient of friction for design in Article 14.7.25 of the LRFD specification.

- Subject the bearing specimen to 100 movements of at least 25 mm (1 inch) of relative movement and, if the test facility allows, the full design movement at a speed of less than 300 mm (1 foot) per minute. Following this test, determine the static and kinetic coefficient of friction again, which is not to exceed the values specified in Section 1111.03(e)2.a, fourth bullet. Verify that the bearing or specimen shows no appreciable sign of bond failure or other defects.

Bearings represented by test specimens passing the above requirements will be approved for use in the structure subject to on-site inspection for visible defects.

Bearings not damaged during the testing of performance characteristics may be used in the work.

**3. Proof Load Test.** Test one bearing from each production "lot" of fixed and expansion bearings. Load a test bearing to 150% of the bearing's rated design capacity and simultaneously subject it to a rotational range of 0.02 radians (1.146 degrees) or design rotation, whichever is greater, for a period of 1 hour.

Visually examine the bearing both during the test and upon disassembly after the test. Any resultant visual defects, such as extruded or deformed elastomer, polyether urethane or TFE, damaged seals or limited or cracked steel, will cause rejection of the lot.

During the test, for pot bearings maintain continuous and uniform contact between the steel bearing plate and steel piston for the duration of the test. For disc bearings maintain continuous and uniform contact between the polyether urethane element and the bearing plates and between the sliding steel top plate and the upper bearing plate for the duration of the test. Any observed lift-off will cause rejection of the lot.

**4. Material Tests.** Submit one sample of elastomer and one sample of PTFE from each "lot of material" to MTD for material testing to ensure compliance with appropriate material specifications.

**(f) Packing and Shipping.**

**1. Packaging and Handling.** Ensure that the bearings are securely banded together as units by fabricator, shipped to the job site, and stored without relative movement of the bearing parts or disassembly at any time. Wrap bearings in moisture resistant and dust resistant material to protect against shipping and job site conditions. Match mark the bearings to indicate normal position of each bearing.

Take care to ensure that bearings are stored at the job site in a dry sheltered area free from dirt or dust until installation.

Inspect bearings within one week after arriving on the project. Do not disassemble unless the fabricator's representative is present. Following inspection, rewrap the bearings to keep them clean until installation.

Do not remove the sole and top plates of bearings for separate attachment to the structure except under the direct supervision of the fabricator.

With each shipment, enclose a copy of the materials, fabrication, and testing compliance certifications.

**(g) Shop Drawings.** Submit as specified in Section 105.02(d) and include the following information:

- The total quantity of each kind of bearing required (fixed, guided-expansion, or non-guided expansion), grouped first according to type (load range) and then by actual design capacity.
- Plan view and section elevation including all relative dimensions.
- Details of all components and sections showing all materials incorporated into the bearing.
- All ASTM, AASHTO, and other material designations.
- The maximum design coefficient of friction as indicated.
- Clearly describe and detail any welding process used in the bearing manufacture that does not conform to the approved processes of the AWS code.
- Vertical, horizontal, rotation, movement, and load capacity.

- A schedule of all bearing offsets, if required by the project.
- Alignment plans.
- Paint or coating requirements.
- Installation scheme.
- Complete design calculations verifying conformance with the provisions of this specification. Stress analysis and the mechanics of standard bearing details are not required.
- Anchorage details.
- Bearing pre-set details.
- Location of the fabrication plant.
- The manufacturer's name and the name of its representative responsible for coordinating production, sampling, and testing.

**(h) Certification.** Ensure that the fabricator provides a certification package as specified in Section 106.03(b)3 and containing the following:

- Material test reports for all steels used except AISI C1018 and C1020 for which a mill conformance certificate is acceptable.
- Certificate of Compliance for all non-ferrous metals.
- Material test reports for any elastomeric components.
- Certificate of Compliance for PTFE and any adhesive used.
- A Certificate of Compliance for the bearings, executed by an officer of the manufacturing company.
- Certificate of Compliance for any dowels or bolts supplied.
- Test reports for the performance tests.

# SECTION 1112—GLUED LAMINATED HARDWOOD TIMBER MEMBERS

## 1112.01 GENERAL REQUIREMENTS—

**(a) Description.** This work is the fabrication, treatment, delivery, and storage of hardwood glued laminated timber for structural members.

**(b) Definitions.**

**1. Glued Laminated Hardwood Timber.** An engineered, stress-rated product of a timber laminating plant, comprising assemblies of suitably selected and prepared laminations bonded together with adhesives.

**2. Lamination.** The separate lamination thickness shall not exceed 50 mm (2 inches) or be less than 20 mm (3/4 inch). They may be comprised of pieces jointed to form any specific lamination length.

Laminations formed in combination using narrower pieces are not acceptable for bridge stringers.

Laminations bent and glued to curve form are accepted for use.

**3. Exterior Use Adhesives.** Use adhesives that perform satisfactorily for all moisture conditions, including exposure to weather, marine use, and where approved preservative pressure treatments are used after gluing. Accepted exterior use adhesives conform to current ANSI/AITC A190.1 requirements.

**(c) Prequalification.** Unless otherwise specified, timber fabricators will be required to prequalify to perform work for the Department by establishing proof of their competency in fabricating members conforming to the current ANSI/AITC A190.1.

Certification of the plant/shop will be performed by the MTD, and submission of a valid certificate to the Structural Materials Engineer, MTD, 1118 State Street, Harrisburg, PA 17120, is required by the Department. An annual endorsed copy is required for continued qualification.

**(d) Shop Drawings.** Section 105.02 and as follows:

Design bridge members in lengths, depths, and widths that can be transported from fabrication source to the project.

Provide design computations prepared by a Professional Engineer registered in the State for Department approval.

It is the Department's prerogative to accept or reject the changes by the Contractor.

**(e) Inspection.**

**1. General.** The MTD will supervise fabrication and treatment inspection. Provide at least 14 calendar days notice of the beginning of work to the Department so that arrangements can be made for inspection.

The Department may waive fabrication or treatment shop inspection and make a complete inspection at a later stage of the construction sequence.

Provide material certification, in duplicate, ensuring that the components used in fabrication were in conformance with material specifications.

**2. Facilities for Inspection.** Furnish necessary supplies for the inspection of materials and workmanship. Allow Inspectors unrestricted access to the premises during plant working hours. Necessary facilities for inspection include a Type C field office as specified in Section 609.

**3. Plant Inspector's Authority.** Plant inspectors have the authority to reject any material or work that does not conform to the requirements of these Specifications.

In case of dispute, the Contractor may appeal to the Representative, whose decision will be final.

**4. Rejections.** Material, workmanship, or finished members accepted by the inspector at the fabricator's plant and treatment plant may be rejected later if they do not conform to the specifications.

**5. Testing.** Perform all certification tests when required according to the provisions of the current AITC 200 Inspection Manual or another trade association that certifies glued laminated timber under ANSI/AITC A190.1. Perform all preservative testing according to AWPA Standards.

**6. Mill Orders and Shipping Statements.** Furnish copies of mill orders and shipping statements, as directed. Ensure that the fabricator presents a copy of the shipping invoice to be stamped for verification of inspection and approval of timber items before shipment to the Department's shop inspector. Forward the stamped copy with the shipment for the project file.

**(f) Storage of Materials.** Section 106.05 and as follows:

Store fabricated glued laminated materials above ground upon suitable platforms, skids, or other supports.

Keep material free from dirt or other foreign materials and properly protected from moisture. Store glued laminated materials to avoid water or high humidity exposure.

**1112.02 MATERIAL—**

**(a) Lumber.**

**1. General.** Ensure that lumber conforms to the manufacturer's requirements under the American Softwood Lumber Standard PS 20-70. Use only Red Maple, Northern Red Oak, or Yellow Poplar.

**2. Grading.** Grade the lumber according to appropriate grading agency or inspection bureau rules. Grade red maple and northern red oak according to Northeast Lumber Manufacturer's Association (NELMA) rules.

Grade yellow poplar according to Northern Softwood Lumber Bureau (NSLB) rules.

Certify as specified in Section 106.03(b)3.

**3. Moisture Content.** Maintain average moisture content of hardwood lumber at 12% to 15%.

Any deviations from these lumber moisture content conditions must be approved.

**(b) Adhesives.**

**1. General.** Use any fully exterior adhesive for face joint bonding of laminations provided that adhesives have been qualified under appropriate sections of ANSI/AITC A190.1.

Acceptable face bonding includes either a 100% resorcinolic adhesive or in formulation with phenolic base adhesives.

End-joint connections must be bonded with a similar fully exterior adhesive or a 100% melamine base adhesive.

**2. Exterior Adhesives.** Examples of adhesive formulations shown acceptable for face lamination are:

Cascophen RS-254 (Resorcinol Adhesive)
Penacolite G1131 (Resorcinol Adhesive)
Cascophen LT-75 (Phenol with Resorcinol Adhesive)
Cascophen LT-5210 (Phenol with Resorcinol Adhesive)
Penacolite G1260 (Phenol with Resorcinol Adhesive)

Acceptable performance with use of these exterior adhesives is species dependent and is maintained through strict lamination procedures to achieve optimum bond development.

**(c) Marking.**

**1.** Mark all glued laminated hardwood timber bending members for orientation of end-use application. Mark straight or slightly cambered members with identification to denote proper top versus bottom beam orientation.

**2.** Include the word "TOP" by permanently labelling with routed letters approximately 50 mm (2 inches) high with identifications.

Members intended for axial load application or of symmetric construction suited for either up or down installation need not be labelled.

Appropriately stamp members with a quality mark or other documentation indicating conformance with ANSI/AITC A190.1. Certify as specified in Section 106.03(b)3.

**(d) Treatment Chemicals.** Treat northern Red Oak, Red Maple, and Yellow Poplar glued laminated members with an AWPA accepted oil base preservative. For creosote or creosote solution treat to a minimum 185 $kg/m^3$ (11.5 pounds per cubic foot) assay retention. Other oil base treatments must meet minimum retentions conforming to AWPA C14.

Conduct retention and penetration assay according to AWPA C28.

Sample Northern Red Oak and Red Maple for soil contact as required for Southern Pine (refer to AWPA C28, Table 1).

Sample Yellow Poplar for soil contact as required for Pacific Coast Douglas-Fir (refer to AWPA C28, Table 1).

## 1112.03 FABRICATION—

**(a) Required Standards.** Fabricate structural glued laminated hardwood timber according to the requirements put forth in the current ANSI/AITC A190.1 and AITC 119.

Treat all structural glued laminated bridge members to minimum retention and penetration requirements.

**(b) Lumber Preparation.**

**1. Moisture Content.** Maintain moisture content for lumber received, at the Laminator's shop/plant, between 12% and 15%.

**2. Surfacing Tolerances.** Current ANSI/AITC A190.1.

**3. End Joints.** Current ANSI/AITC A190.1.

**(c) Laminating Requirements.** Current ANSI/AITC A190.1. Conduct red maple and yellow poplar lamination fabrication according to the general requirements for a 24F-E4 or 24F-E1 southern pine glued laminated timber (refer to AITC 117, Table 1) with special lumber stiffness and edge knot restrictions as follows:

| | |
|---|---|
| Outer Tension Zone | 10% 2.0-1/6 E-rated |
| Inner Tension Zone | 15% 1.8-1/3 E-rated |
| Core | 50% No. 2 VSR (NELMA, NSLB) |
| Inner Compression Zone | 15% 1.8-1/3 E-rated |
| Outer Compression Zone | 10% 2.0-1/3 E-rated |

Conduct Northern Red Oak lamination according to the AITC 119 for the fabrication of Combination A glued-laminated timbers.

For applications other than girders no special laminating requirements apply other than minimum No. 2 lumber grade.

Provide hardwood glued laminated timbers at the treatment facility conforming to these requirements with a minimum 12% and maximum 19% moisture content.

Accept only hardwood glued laminated timbers that conform to these requirements. Certify as specified in Section 106.03(b)3.

**(d) Surfacing of Laminated Members.** Surface according to AITC 110. Provide industrial appearance hardwood glued-laminated members.

**(e) Holes and Countersinks for Bolts, Dowels, Rods, Nails, and Screws.**

**1. Preservative Treatment.** Section 1031.3(b)1

**2. Location Tolerances.** Section 1031.3(b)1 and 1031.3(b)2

**3. Temporary Attachments.** Section 1031.3(e)

**4. Diameter.** Size holes for driftpins, machine bolts, rods, and lag screws to allow in-service shrinkage and swelling of the wood. For dowels, drifts, pins and rods, match the hole diameter with the connection shank. For lag screws, refer to National Design Specifications (NDS), NDS Section 9.1.2. For machine bolts, refer to NDS Section 8.1.2 for size.

**(f) Shop Assembly.** Ensure that all fabricated members assemble together according to the shop and design drawings before shipping components to the job site.

## 1112.04 TREATMENT—

**(a) General.** Treat all glued laminated hardwood timber surfaces with an approved oil-borne preservative conforming to AWPA C1.

**(b) Treatment Facilities.** All treatment facilities must be prequalified by the Department by establishing proof of their competency and efficacy of their treating operation with the MTD.

**(c) Creosote Treating Cycle.** An empty cell cycle shall be used for creosote treatment of northern red oak, red maple and yellow poplar glued laminated timber bridge members. Provide initial air pressure between 140 kPa and 210 kPa (20 pounds per square inch and 30 pounds per square inch). Creosote solutions shall be introduced into the chamber and pressurized to 1035 kPa to 1380 kPa (150 pounds per square inch to 200 pounds per square inch). The actual pressure will depend upon hardwood species being treated. Treatment temperature shall be between 88 °C and 99 °C (190F and 210F). Continue treatment pressure and temperature until 190 kg/m$^3$ (12 pounds per cubic foot) gauge retention is achieved. Gauge retention is confirmed by assay measurement to ensure a minimum 185 kg/m$^3$ (11.5 pounds per cubic foot) creosote retention.

Following the pressure cycle, the pressure shall be released in a slow step down manner over a 1-hour period. An expansion bath during the "slow pressure release" shall be used with an increase in temperature in the treating chamber of 6 °C (43F) following the pressure release. The creosote solution is removed from the cylinder and a minimum vacuum of 74 kPa (11 pounds per square inch) shall be applied for 2 hours. At this time the vacuum is released to atmospheric pressure and, if possible, the surface is steamed for 1 hour. A final minimum vacuum of 74 kPa (11 pounds per square inch) is applied to the treated members for 2 hours.

This treating cycle will ensure a minimum amount of exudate during the service life of the member. It is the Department's prerogative to accept or reject treated hardwood glued laminated members, after pressure treatment that do not minimize exudate.

**(d) Field Treatment.** Field treat any preservative treated hardwood according to AWPA M4.

**(e) Finish.** Oil-borne preservative treated hardwood glued laminated members do not require a finish or sealer treatment. Do not use treated hardwood glued laminated railings where prolonged exposure to direct human contact is likely without application of a finish sealer.

Provide a two-coat sealer application for finish treatment for treated railings where prolonged exposure is likely. Acceptable sealers include latex epoxy, urethane, shellac, or other finishes that are effective coating agents that adhere to treated rails.

**(f) Shipping, Field Storage, and Field Handling.**

1. **Storage and Handling.** Section 1031.3(a)

2. **Cuts and Abrasions.** Section 1031.3(e)

3. **Temporary Attachments.** Section 1031.3(e)

# SECTION 1113—PLAIN AND LAMINATED NEOPRENE BEARING PADS

## 1113.01 GENERAL REQUIREMENTS—

**(a) Description.** This work is the fabrication, furnishing, transportation, and delivery of plain and laminated neoprene bearing pads.

**(b) General Requirements.** Furnish bearings with the dimensions, material properties, elastomer grades, and laminate types indicated.

**(c) Definition of Terms.**

1. **Unreinforced Pads.** Elastomeric bearing pads consisting of elastomer only.

2. **Reinforced Pads.** Elastomeric bearing pads reinforced with steel or fabric laminates.

## 1113.02 MATERIAL—

**(a) Elastomer.** Furnish virgin Neoprene (polychlororprene) elastomer. Provide low temperature grade 0, 2, 3, 4, or 5 elastomer compound. Elastomer compound grades are defined by the testing requirements in Table A. Substitution of a higher grade of elastomer for a lower one is permissible.

Provide elastomer compound conforming to Table A unless otherwise directed. Interpolate test requirements for intermediate hardnesses. If the material is specified by its shear modulus, furnish material with a measured shear modulus that is within 15% of the specified value. For the purpose of defining limits for the tests in Table A, supply material with a consistent value of hardness. If the material is specified by its hardness, furnish material with a measured shear modulus that conforms to Table 14.7.5.2-1 of the LRFD Specification. When test specimens are cut from the finished product, the physical properties are allowed to vary from those specified in Table A by 10%. Conduct all material tests at 23 °C ± 2 °C (73F ± 4F) unless otherwise noted. Conduct shear modulus tests according to Annex A of ASTM D 4014.

**(b) Steel Laminates.** Fabricate steel laminates used for reinforcement from rolled mild steel conforming to ASTM A 36/A 36M, ASTM A 1011, or equivalent, unless otherwise directed. Furnish laminates with a minimum nominal thickness of 3 mm (16 gage). Do not make holes in plates for manufacturing purposes unless indicated.

**(c) Fabric Reinforcement.** Weave fabric reinforcement from 100% glass fibers of "E" type yarn with continuous fibers. Provide a minimum thread count in either direction of ten threads per 100 mm (25 threads per inch). Furnish fabric having either a crowfoot or an 8 Hardness Satin weave. Ensure each ply of fabric has a minimum breaking strength of 140 N/mm (800 pounds per inch) in each thread direction. Holes in the fabric are not allowed.

**(d) Bond.** Provide a vulcanized bond between the fabric reinforcement and elastomer with a minimum peel strength of 5.2 N/mm (30 pounds per inch). Supply steel laminated bearings that develop a minimum peel strength of 6.9 N/mm (40 pounds per inch). Perform peel strength tests according to ASTM D 429, Method B.

## 1113.03 FABRICATION—

**(a) General.** Ensure that the bearings conform to the requirements for flash tolerance, finish, and appearance of the latest edition of the Rubber Handbook, published by the Rubber Manufacturers Association, Inc.; RMA F3 AND T.063 for molded bearings and RMA F2 for extruded bearings.

**(b) Laminated Pads with Steel Reinforcement.** Cast laminated bearings pads with steel reinforcement as a unit in a mold. Bond and vulcanize bearings under heat and pressure. Ensure that the mold finish conforms to standard shop practice. Sand blast and clean the internal steel laminates to remove all surface coatings, rust, mill scale, and dirt before bonding, and ensure that the internal steel laminates are free of sharp edges and burrs. For bearings that are designed to act as a single unit with a given shape factor, manufacture the bearings as single units. Repair all cavities left in the edges of the pad from the manufacturing process by in-plant vulcanizing with neoprene material from the same lot as the bearing pad.

**(c) Laminated Pads with Fabric Reinforcement.** Vulcanize fabric-reinforced bearings in large sheets and cut to size. Perform cutting in such a way to avoid heating the materials and to produce a smooth finish with no separation of the fabric from the elastomer. Furnish at least single ply fabric reinforcement for the top and bottom reinforcement layers and double ply for internal reinforcement layers. Place fabric parallel to the top and bottom surfaces. Ensure that the fabric is free of folds and ripples.

**(d) Plain Pads.** Mold, extrude, or vulcanize plain pads in large sheets and cut to size. Ensure that cutting does not heat the material, but produces a smooth finish.

**(e) Marking and Certification.** Provide the manufacturer's certification that each bearing satisfies the requirements of the plans and these Specifications. Provide a certified copy of the material test results. Mark each reinforced bearing in indelible ink or flexible paint. Include the orientation, the order number, lot number, bearing identification number, and elastomer type and grade number in the marking. Unless otherwise specified in the contract documents, place the marking on the face that is visible after erection of the bridge.

**(f) Testing.** Sample the completed pads according to PTM No. 312.

**1. Scope.** Test materials for elastomeric bearings and finished bearings according to Table A and as specified below.

**TABLE A**
**Neoprene Quality Control Tests**

| Property | | Test Method | Minimum Requirements | | |
|---|---|---|---|---|---|
| | | | Type 50 | Type 60 | Type 70 |
| **Physical Properties** | • Hardness (Shore A Durometer)<br>• Tensile Strength, Min. MPa (psi)<br>• Ultimate Elongation, min. % | ASTM D 2240<br>ASTM D 412 | 50 ± 5<br>16 (2,250)<br>400 | 60 ± 5<br>16 (2,250)<br>350 | 70 ± 5<br>16 (2,250)<br>300 |
| **Heat Resistance** | • Change in Durometer Hardness, max. points<br>• Change in Tensile Strength, max. %<br>• Change in Ultimate Elongation, max. % | ASTM D 573<br>70 h @ 100 °C (212F) | 15<br>-15<br>-40 | 15<br>-15<br>-40 | 15<br>-15<br>-40 |
| **Compression Set** | • 22 h @ 100 °C (212 F), max. % | ASTM D 395<br>Method B | 35 | 35 | 35 |
| **Ozone** | • 100 pphm Ozone in Air by Volume, 20% Strain 38 °C ±1 °C (100F ± 2F) 100 h Mounting Procedure<br>ASTM D 518, Procedure A | ASTM D 1149 | No Cracks | No Cracks | No Cracks |
| **Low Temperature Brittleness** | • Grades 0 & 2<br>• Grade 3 Tested @ -40 °C (-40F)<br>• Grade 4 Tested @ -49 °C (-55F)<br>• Grade 5 Tested @ -57 °C (-70F) | No test required<br>ASTM D 746<br>Procedure B | <br>No Failure<br>No Failure<br>No Failure | <br>No Failure<br>No Failure<br>No Failure | <br>No Failure<br>No Failure<br>No Failure |
| **Instantaneous Thermal Stiffening** | • Grades 0 & 2 @ -32 °C (-25F)<br>• Grade 3 Tested @ -40 °C (-40F)<br>• Grade 4 Tested @ -46 °C (-50F)<br>• Grade 5 Tested @ -54 °C (-65F) | ASTM D 1043 | Stiffness(1) at test temperature not to exceed 4 times the stiffness measured at 23 °C (73F). | | |
| **Low Temperature Crystallation** | • Grade 0<br>• Grade 2, 7 days @ -18 °C (0F)<br>• Grade 3, 14 days @ -27 °C (-15F)<br>• Grade 4, 21 days @ -38 °C (-35F)<br>• Grade 5, 28 days @ -38 °C (-35F) | No test required<br>Quad Shear Test as described(2) | Stiffness(1) at test time and temperature not to exceed 4 times the stiffness at 23 °C (73F) with no time delay. | | |

(1) Note in Table A that ASTM D 1043 refers to "modulus of rigidity", while ASTM D 4014, referenced in the text, refers to "shear modulus stiffness". The word "stiffness" is used in Table A to cover both terms.

(2) Measure the stiffness with a quad shear rig in an enclosed freezer unit. Take test specimens from a randomly selected bearing. Use a 25% strain cycle and apply a complete cycle of strain with a period of 100 seconds. Discard the first 3/4 cycle of strain and determine the stiffness by the slope of the force deflection curve for the next 1/2 cycle of loading.

**2. Frequency of Testing.** Conduct ambient temperature tests as specified in Section 1113.03(f)3 for each lot of bearings. Provide test certificates from the supplier for each lot of reinforcement.

Conduct low temperature tests as specified in Section 1113.03(f)4 for each lot of bearings.

Visually inspect every finished bearing as specified in Section 1113.03(f)5.

Conduct short-duration compression tests as specified in Section 1113.03(f)6 on every steel reinforced bearing.

If required, conduct shear stiffness tests on material from a random sample of the finished bearings as specified in Section 1113.03(f)8.

**3. Ambient Temperature Tests on the Elastomer.** Use elastomer conforming to Table A for durometer hardness, tensile strength, ultimate elongation, heat resistance, compression set, and ozone resistance. Ensure that the bond to the reinforcement conforms to the requirements specified in Section 1113.02(d).

Test the shear modulus of the material at 23 $^{o}$C (73F) according to Annex A of ASTM D 4014. Ensure that the measured shear modulus is within 15% of the specified value. If no shear modulus is specified, ensure that the hardness falls within the range given in Article 14.7.5.2 of the LRFD Specification. Instead of performing a shear modulus test for each batch of material, the manufacturer may, if permitted, provide certificates from tests performed on identical formulations within the preceding year.

**4. Low Temperature Tests on the Elastomer.** Conduct low temperature brittleness tests (ASTM D 746), instantaneous low temperature stiffness tests (ASTM D 1043), and low temperature crystallization tests (ASTM D 4014) on grades 3, 4, and 5 elastomers. For grade 3 elastomers, instead of conducting low temperature crystallization tests, the manufacturer may provide certificates from low temperature crystallization tests performed on identical material within the last year, unless the tests are required.

Conduct instantaneous low temperature stiffness tests (ASTM D 1043) on grades 0 and 2 elastomers. If required, conduct low temperature brittleness tests (ASTM D 746) and low temperature crystallization tests (ASTM D 4014) on grades 0 and 2 elastomers.

Perform all tests according to Table A and ensure the compound satisfies all limits for its grade.

**5. Visual Inspection of the Finished Bearing.** Inspect every finished bearing for compliance with dimensional tolerances and for overall quality of manufacture. In steel reinforced bearings, protect the edges of the steel everywhere from corrosion.

**6. Short-Duration Compression Tests on Bearings.** Load the bearing in compression to 1.5 times its maximum design load. Hold the load constant for 5 minutes, remove, and reapply for another 5 minutes. Visually examine the bearing while under the second loading. If the bulging pattern suggests laminate parallelism or a layer thickness that is outside the specified tolerances, or poor laminate bond, reject the bearing. If there are three or more separate surface cracks that are greater than 2 mm (0.08 inch) wide and 2 mm (0.08 inch) deep, reject the bearing.

**7. Long-Duration Compression Tests on Bearings.** Load the bearing in compression to 1.5 times its maximum design load for a minimum period of 15 hours. If during the test the load falls below 1.3 times the maximum design load, increase the test duration by the period of time for which the load is below this limit. Visually examine the bearing at the end of the test while it is still under load. If the bulging pattern suggests laminate parallelism or a layer thickness that is outside the specified tolerances, or poor laminate bond, reject the bearing. If there are three or more separate surface cracks that are greater than 2 mm (0.08 inch) wide and 2 mm (0.08 inch) deep, reject the bearing.

**8. Shear Modulus Tests on Material from Bearings.** Cut a specimen from the finished bearing and test the shear modulus of the material according to Annex A of ASTM D 4014, or, if acceptable, conduct a comparable nondestructive stiffness test on a pair of finished bearings. Ensure that the measured shear modulus is within 15% of the specified value. If no shear modulus is specified, ensure that the hardness falls within the range given in Article 14.7.5.2 of the LRFD Specification. If the test is conducted on finished bearings, compute the material shear modulus from the measured shear stiffness of the bearings, taking due account of the influence on shear stiffness of bearing geometry and compressive load.

**(g) Tolerances.** Provide finished pads within the following tolerances:

| | |
|---|---|
| • Overall Height<br>Design Thickness 32 mm (1 1/4 inches) or less<br>Design Thickness over 32 mm (1 1/4 inches) | <br>-0, +3 mm (+1/8 inch)<br>-0, +6 mm (+1/4 inch) |
| • Overall Horizontal Dimensions<br>900 mm (3 feet) or less<br>Over 900 mm (3 feet) | <br>-0, +6 mm (+1/4 inch)<br>-0, +12 mm (+1/2 inch) |
| • Thickness of Individual Layers of Elastomer (Laminated Bearings Only)<br>At any point within the bearings | <br>±20% of design value but no more than ±3 mm (±1/8 inch) |
| • Parallelism with Opposite Face<br>Top and bottom<br>Sides | <br>0.005 rad<br>0.02 rad |
| • Position of Exposed Connection Members<br>Hole, slots or inserts | ±3 mm (±1/8 inch) |
| • Edge Cover<br>Embedded laminates or connection members | -0, +3 mm (+1/8 inch) |
| • Thickness<br>Top and bottom cover layer (if required) | -0, the smaller of 1.5 mm (1/16 inch) and +20% of the nominal cover layer thickness |
| • Size<br>Holes, slots, or inserts | ±3 mm (±1/8 inch) |

**(h) Bedding Material for Bridge Shoes.** Manufacture material from elastomeric material reinforced with organic fiber as filler material. The fiber may be oriented or random (Type I), or in the form of fabric (single or multiple laminations, Type II). Certify as specified in Section 106.03(b)3. Furnish finished pads conforming to the following requirements:

| | | | Type I | Type II |
|---|---|---|---|---|
| 1. | **Tensile Strength.** ASTM D 378, Die A, min. | | 3.5 MPa (500 psi) | 10.4 MPa (1,500 psi) |
| 2. | **Oven Aging.** 7 days at 70 °C (158F), change in actual tensile strength not to exceed | | ±40% | ±40% |
| 3. | **Compressibility.** ASTM F 36, Procedure H., without high temperature preconditioning | min.<br>max. | 10%<br>20% | 0%<br>20% |
| 4. | **Compressive Strength.** 100 mm x 100 mm (4-inch by 4-inch) specimen, compressed to rupture between flat plates | min. | 34.5 MPa (5,000 psi) | 55.0 MPa (8,000 psi) |
| 5. | **Water Absorption.** 24-hour immersion | max. | 3.5% | 0% |

# SECTION 1119—THRIE BEAM GUIDE RAIL

**1119.01 RAILS**— As shown on the Standard Drawings and as follows:

**(a) Rail Elements.** AASHTO M 180, Class A, Type II; mark to show the approximate radius of curved rails.

**(b) Transition Section.** AASHTO M 180, Class B, Type II; mark to show the approximate radius of curved rails.

**1119.02 TERMINAL SECTIONS**— As shown on the Standard Drawings and as follows:

**(a) Terminal Section Bridge Connection.** AASHTO M 180, Class B, Type II

**1119.03 POSTS—** As shown on the Standard Drawings and as follows:

**(a) Steel I-Beam Posts.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36) or ASTM A 769/A 769M

**(b)** Galvanize as specified in Section 1105.02(s) (AASHTO M 111)

**1119.04 OFFSET BRACKETS—** Section 1109.04

**1119.05 MISCELLANEOUS MATERIAL—** As shown on the Standard Drawings and as follows:

**(a) Nuts, Bolts, and Washers.** Section 1105.02(c)1. Galvanize as specified in Section 1105.02(s) (ASTM A 153 or ASTM B 695 and B 696).

**(b) Miscellaneous Hardware.** AASHTO M 270/M 270M (ASTM A 709/A 709M), Grade 250 (Grade 36).

Galvanize hardware after fabrication, as specified in Section 1105.02(s) (AASHTO M 111). Do not punch, drill, grind, cut, or weld after galvanizing. Repair minor abrasions of galvanized surfaces with two coats of galvanizing paint.

**1119.06 GALVANIZING—** Galvanize metal parts as specified in Section 1105.02(s) (ASTM A 153 unless otherwise specified) and conform to the requirements of AASHTO M 180, Section 9.

**1119.07 GALVANIZING PAINT—** Bulletin 26

**1119.08 WELDING MATERIAL—** Section 1105.02(t)

**1119.09 CERTIFICATION—** Section 106.03(b)3

# APPENDIX A
# METRIC (SI) INFORMATION

**General:** This Appendix provides guidance on the selection of metric (SI) units and how they relate to their counterparts in English or I-P units. Topics include definitions, dual units, conversion rules, basic units of measure, commonly used SI prefixes, SI measurements, and conversion tables. The conversion tables show multiplication values to change I-P units to SI units.

Several additional tables in this Appendix provide specific I-P / SI relationships. These tables include:

- **Table A-1.** $mm^2$ Equivalents of American Wire Gage
- **Table A-2.** NEMA Metric Non Metallic and Metallic Conduit and Fittings
- **Table A-3.** Reinforcing Bar Information
- **Table A-4.** Standard Test Sieves (U.S.A. Standard Sieves)

**Definitions:** Important terms include the following:

- **SI Units**—Units belonging to the International System of Units, which is abbreviated SI, as interpreted or modified for use in the United States by the Secretary of Commerce.
- **English or I-P Units**—Units based upon the yard and the pound, commonly used in the United States, and defined by the National Institute of Standards and Technology.
- **Soft Conversion**—An I-P measurement that is mathematically converted to its exact SI equivalent. (Example: Lane Width = 12 feet (I-P) = 3.658 m (SI).)
- **Hard Conversion**—A close approximation of the I-P unit but is rounded logically in the SI system. (Example: Lane Width = 12 feet (I-P) or 3.6 m (SI).)
- **SI Base Units**—The SI system consists of seven base units of measurement, six of which are used in design and construction. (The seventh, mole, is the amount of molecular substance and is used in physics.)

| Quantity | Unit | Symbol |
|---|---|---|
| length | meter | m |
| mass | kilogram | kg |
| time | second | s |
| electric current | ampere | A |
| temperature | kelvin | K |
| luminous intensity | candela | cd |

- **SI Derived Units**—Derived units are formed by combining base units, supplementary units, and other derived units according to the algebraic relations linking the corresponding quantities. The symbols for derived units are obtained by means of the mathematical signs for multiplication, division, and use of exponents. See the list entitled "Basic Units of Measure" for examples of SI derived units.

**Dual Units:** Wherever possible, measurements in these Specifications are stated in dual units—SI units followed by I-P units in parentheses. Dual units may be found in references to SI or dual unit codes and standards (e.g., ASTM, AASHTO, etc.). In other situations, where references to other sources are not available, logical "Conversion Rules" are applied.

Many SI measurements in these Specifications are soft conversions of the I-P measurements. Over time, these SI measurements will be changed, through the consensus process, into hard conversions—rationalized, rounded SI dimensions of the I-P measurements.

Certain situations do occur where specifications are stated in SI units only or in I-P units only. These situations may occur when:

- Existing specifications have not been fully converted.

- The specification was developed exclusively using I-P units only or SI units only.
  (i.e., Specified products may be available exclusively in SI sizes or I-P sizes.)

**Conversion Rules:** The *Metric Guide for Federal Construction*, published by the National Institute of Building Sciences, provides further direction about developing specifications. The publication presents "Conversion Rules" which aids in developing construction specifications. The "Conversion Rules" include the following:

- Use ASTM E 621, *Standard Practice for the Use of Metric (SI) Units in Building Design and Construction*, as a basic reference.

- Follow the rules for usage, conversion, and rounding in IEEE/ASTM SI 10-1997, *Standard for Use of International System of Units (SI): The Modern Metric System*, Annex B, or ANSI/IEEE 268, *American National Standard Metric Practice*, Sections 3.5 and 4.

- Wherever possible, convert measurements to rounded, rationalized, "hard" SI numbers. For instance, if anchor bolts are to be imbedded to a depth of 10 inches, the exact converted length (i.e., soft conversion) of 254 mm might be rounded to either 250 mm (9.84 inches) or 260 mm (10.24 inches). The less critical the number, the "rounder" it can be, but ensure that allowable tolerances or safety factors are not exceeded. When in doubt, stick with the exact "soft" conversion.

- Round to "preferred" SI numbers (i.e., hard conversion). While the preferred numbers for the "1 foot = 12 inches" system are, in order of preference, those divisible by 12, 6, 4, 3, 2, and 1, preferred SI numbers are, in order of preference, those divisible by 10, 5, 2, and 1 or decimal multiples thereof.

- Use hand calculators or software conversion programs that convert I-Ps to SI. They are readily available and are indispensable to the conversion process. Simply check with any store or catalogue source that sells calculators or software.

- Be careful with the decimal marker when converting areas and volumes; SI numbers can be significantly larger than I-P numbers (a cubic meter, for instance, is one billion cubic millimeters).

**Basic Units of Measure**

| | |
|---|---|
| micrometer | (µm) |
| millimeter | (mm) |
| meter | (m) |
| square meter | ($m^2$) |
| cubic meter | ($m^3$) |
| hectare | (ha) |
| liter | (L) |
| pascal | (Pa) |
| kilopascal | (kPa) |
| megapascal | (MPa) |
| newton | (N) |
| kilonewton | (kN) |
| day | (d) |
| second | (s) |
| hour | (h) |
| degree Celsius | (°C) |
| kelvin | (K) |
| gram | (g) |
| kilogram | (kg) |
| megagram | (Mg) or tonne (t) |
| tonne | (t) |
| kilogram per square meter | ($kg/m^2$) |
| radian | (rad) |
| ampere | (A) |
| farad | (F) |
| henry | (H) |
| joule | (J) |
| lumen | (lm) |
| lux | (lx) |
| volt | (V) |
| watt | (W) |

**SI Prefixes**

| | | |
|---|---|---|
| deci (d)* | $10^{-1}$ | one tenth |
| centi (c)* | $10^{-2}$ | one hundredth |
| milli (m) | $10^{-3}$ | one thousandth |
| micro (µ) | $10^{-6}$ | one millionth |
| nano (n) | $10^{-9}$ | one billionth |
| deca (da) | $10^{1}$ | ten |
| hecto (h) | $10^{2}$ | one hundred |
| kilo (k) | $10^{3}$ | one thousand |
| mega (M) | $10^{6}$ | one million |
| giga (G) | $10^{9}$ | one billion |

*Not in SI system

**SI Measurements**

Apparent Power = volt-amperes (V×A)
Length = millimeters, meters, kilometers
Area = square meters or hectares (10,000 square meters)
Volume = Liters or cubic meters
Mass = kilograms, tonnes
Force = newton ($N = (kg \times m)/s^2$)
Pressure, Stress = Pascal ($Pa = N/m^2$)
Energy, Work = Joule ($J = N \times m$)
Torque = Newton meter ($N \times m$)
Speed, Velocity = meter/second, kilometers/hour
Acceleration = meters/second squared, kilometers/hours squared
Density = kilograms/cubic meter
Temperature = degrees Celsius
Power = Watt ($W = (N \times m)/s$)
Viscosity (Dynamic) = Pascal second (Pa×s)
Viscosity (Kinematic) = square meter per second ($m^2/s$)
Luminous Flux = lumen
Illuminance = lux
Luminous Intensity = candela

| Conversions | From English | To SI | Multiply By |
|---|---|---|---|
| ANGLE | degree | rad | 0.017 453 29 |
| AREA | square inch | $mm^2$ | 645.16 |
| | square foot | $m^2$ | 0.092 903 04 |
| | square yard | $m^2$ | 0.836 127 4 |
| | acre | $m^2$ | 4 046.873 |
| | acre | ha | 0.404 685 |
| | square mile | $km^2$ | 2.59 |
| ENERGY | foot pound | J | 1.355 818 |
| FORCE | pound-force | N | 4.448 222 |
| | kip | kN | 4.448 222 |
| FORCE/UNIT LENGTH | lb./in. | N/mm | 0.175 127 |
| | lb./ft. | N/m | 14.593 39 |
| LENGTH | inch | mm | 25.4 |
| | foot | mm | 304.8 |
| | foot | m | 0.3048 |
| | yard | m | 0.9144 |
| | mile | km | 1.609 344 |
| | mile | m | 1 609.344 |
| | inches/mile | mm/km | 15.7828 |
| LIGHT | candlepower | cd | 1 |
| | footcandle | lx | 10.763 91 |

| **Conversions** | **From English** | **To SI** | **Multiply By** |
|---|---|---|---|
| MASS | ounce | g | 28.349 523 |
| | pound | kg | 0.453 592 |
| | kip (1000 lbs.) | tonne | 0.453 592 |
| | ton | tonne | 0.907 185 |
| MASS/UNIT AREA | ounces/sq. yd. | $kg/m^2$ | 0.033 905 75 |
| | lbs./sq. ft. | $kg/m^2$ | 4.882 428 |
| | lbs./sq. yd. | $kg/m^2$ | 0.542 5 |
| | lbs./cu. ft. | $kg/m^3$ | 16.018 46 |
| | lbs./cu. yd. | $kg/m^3$ | 0.593 276 4 |
| | lbs./acre | kg/ha | 1.1208 |
| | ton/acre | tonne/ha | 2.2417 |
| PRESSURE, STRESS | lbs./sq. ft. | Pa | 47.880 26 |
| | kips/sq. ft. | kPa | 47.880 26 |
| | lbs./sq. in. | kPa | 6.894 757 |
| | lbs./sq. in. | MPa | 0.006 895 |
| | kips/sq. in. | MPa | 6.894 757 |
| TEMPERATURE | (F - 32)/1.8 = °C | | |
| VOLUME | cubic inch | $mm^3$ | 16 387.064 |
| | cubic foot | $m^3$ | 0.028 316 85 |
| | cubic yard | $m^3$ | 0.764 554 9 |
| | gallon | L | 3.785 41 |
| | gal./yd. | L/m | 4.1398 |
| | gal./sq. yd. | $L/m^2$ | 4.5273 |
| | gal./cu. yd. | $L/m^3$ | 4.9511 |
| | gal./acre | L/ha | 9.3539 |
| | gal./ton | L/tonne | 4.1726 |

**TABLE A-1**
**$mm^2$ Equivalents of American Wire Gage**

| AWG American Wire Gage | ASTM B 3 Soft or Annealed Copper Wire | ASTM B 8 Concentric-Lay-Stranded Copper Conductors Hard, Medium-Hard, or Soft | | | | | ASTM B 258 Solid Round Wires |
|---|---|---|---|---|---|---|---|
| | | 3 Wires | 7 Wires | 19 Wires | 37 Wires | 61 Wires | |
| 0000 | 107.0 | — | 107.3 | 107.2 | 107 | 107 | 107.2 |
| 000 | 85.0 | — | 85.00 | 85.1 | 84.9 | 84.9 | 85.03 |
| 00 | 67.4 | — | 67.45 | 67.4 | 67.5 | 67.4 | 67.42 |
| 0 | 53.5 | — | 53.49 | 53.4 | 53.5 | 53.5 | 53.49 |
| 1 | 42.4 | 42.39 | 42.37 | 42.4 | 42.5 | 42.3 | 42.41 |
| 2 | 33.6 | 33.61 | 33.6 | 33.6 | 33.7 | — | 33.62 |
| 3 | 26.7 | 26.69 | 26.7 | 26.6 | 26.6 | — | 26.67 |
| 4 | 21.2 | 21.17 | 21.1 | 21.2 | 21.2 | — | 21.15 |
| 5 | 16.8 | — | 16.8 | 16.7 | 16.8 | — | 16.77 |
| 6 | 13.3 | — | 13.3 | 13.3 | 13.3 | — | 13.30 |
| 7 | 10.5 | — | 10.5 | 10.5 | 10.5 | — | 10.55 |
| 8 | 8.37 | — | 8.38 | 8.38 | 8.35 | — | 8.367 |
| 9 | 6.63 | — | 6.62 | 6.61 | 6.63 | — | 6.631 |
| 10 | 5.26 | — | 5.26 | 5.27 | 5.23 | — | 5.261 |
| 11 | 4.17 | — | — | — | — | — | 4.17 |
| 12 | 3.31 | — | 3.30 | 3.30 | 3.32 | — | 3.30 |
| 13 | 2.63 | — | — | — | — | — | 2.63 |
| 14 | 2.08 | — | 2.08 | 2.08 | 2.07 | — | 2.08 |
| 15 | 1.65 | — | — | — | — | — | 1.65 |
| 16 | 1.31 | — | 1.31 | 1.32 | — | — | 1.31 |
| 17 | 1.04 | — | — | — | — | — | 1.04 |
| 18 | 0.823 | — | 0.819 | 0.81 | — | — | 0.823 |
| 19 | 0.654 | — | — | — | — | — | 0.653 |
| 20 | 0.517 | — | 0.519 | 0.51 | — | — | 0.519 |
| 21 | 0.411 | — | — | — | — | — | 0.412 |
| 22 | 0.324 | — | 0.33 | 0.32 | — | — | 0.324 |
| 23 | 0.259 | — | — | — | — | — | 0.259 |
| 24 | 0.205 | — | 0.20 | 0.20 | — | — | 0.205 |
| 25 | 0.162 | — | — | — | — | — | 0.162 |
| 26 | 0.128 | — | — | — | — | — | 0.128 |
| 27 | 0.102 | — | — | — | — | — | 0.102 |
| 28 | 0.081 | — | — | — | — | — | 0.081 |
| 29 | 0.065 | — | — | — | — | — | 0.0645 |
| 30 | 0.051 | — | — | — | — | — | 0.0506 |
| 31 | 0.040 | — | — | — | — | — | 0.0401 |
| 32 | 0.032 | — | — | — | — | — | 0.0325 |
| 33 | 0.026 | — | — | — | — | — | 0.0255 |
| 34 | 0.020 | — | — | — | — | — | 0.0201 |
| 35 | 0.016 | — | — | — | — | — | 0.0159 |

**TABLE A-1 (Continued)**
**$mm^2$ Equivalents of American Wire Gage**

| AWG American Wire Gage | ASTM B 3 Soft or Annealed Copper Wire | ASTM B 8 Concentric-Lay-Stranded Copper Conductors Hard, Medium-Hard, or Soft | | | | | ASTM B 258 Solid Round Wires |
|---|---|---|---|---|---|---|---|
| | | 3 Wires | 7 Wires | 19 Wires | 37 Wires | 61 Wires | |
| 36 | 0.013 | — | — | — | — | — | 0.0126 |
| 37 | 0.010 | — | — | — | — | — | 0.0103 |
| 38 | 0.0081 | — | — | — | — | — | 0.00813 |
| 39 | 0.0062 | — | — | — | — | — | 0.00621 |
| 40 | 0.0049 | — | — | — | — | — | 0.00487 |
| 41 | — | — | — | — | — | — | 0.00397 |
| 42 | — | — | — | — | — | — | 0.00317 |
| 43 | — | — | — | — | — | — | 0.00245 |
| 44 | — | — | — | — | — | — | 0.00203 |
| 45 | — | — | — | — | — | — | 0.00157 |

**TABLE A-2**
**NEMA Metric Non-Metallic and Metallic Conduit and Fittings**

| Table Size (Inches) | Metric Size Designations |
|---|---|
| 1/2 | 16 |
| 3/4 | 21 |
| 1 | 27 |
| 1 1/4 | 35 |
| 1 1/2 | 41 |
| 2 | 53 |
| 2 1/2 | 63 |
| 3 | 78 |
| 3 1/2 | 91 |
| 4 | 103 |
| 5 | 129 |
| 6 | 155 |

**TABLE A-3**
**Reinforcing Bar Information**

| SI Bar Information | | | | | I-P Bar Information | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SI Bar No.[1]** | **SI Diam. (mm)** | **SI Area ($mm^2$)** | **SI Mass (kg/m)** | **SI Grades [2] (MPa)** | **I-P Bar No.** | **I-P Bar Diam. (in)** | **I-P Area ($in^2$)** | **I-P Weight (lbs/ft)** | **I-P Grades [2],[7] (ksi)** |
| 10 | 9.5 | 71 | 0.560 | 300[3],[5], 350[4], 400[3],[4],[5],[6] | 3 | 0.375 | 0.11 | 0.376 | 40[3][5], 50[4], 60[3],[4],[5],[6] |
| 13 | 12.7 | 129 | 0.994 | 300[3],[5], 350[4], 400[3],[4],[5],[6] | 4 | 0.500 | 0.20 | 0.668 | 40[3][5], 50[4], 60[3],[4],[5],[6] |
| 16 | 15.9 | 200 | 1.552 | 300[3],[5], 350[4], 400[3],[4],[5],[6] | 5 | 0.625 | 0.31 | 1.043 | 40[3][5], 50[4], 60[3],[4],[5],[6] |
| 19 | 19.1 | 284 | 2.235 | 300[3],[5], 350[4], 400[3],[4],[5],[6] | 6 | 0.750 | 0.44 | 1.502 | 40[3],[5], 50[4], 60[3],[4],[5],[6], 75[3] |
| 22 | 22.2 | 387 | 3.042 | 300[5], 350[4], 400[3],[4],[5],[6], 500[3] | 7 | 0.875 | 0.60 | 2.044 | 40[5], 50[4], 60[3],[4],[5],[6], 75[3] |
| 25 | 25.4 | 510 | 3.973 | 300[5], 350[4], 400[3],[4],[5],[6], 500[3] | 8 | 1.000 | 0.79 | 2.670 | 40[5], 50[4], 60[3],[4],[5],[6], 75[3] |
| 29 | 28.7 | 645 | 5.060 | 300[5], 350[4], 400[3],[4],[5],[6], 500[3] | 9 | 1.128 | 1.00 | 3.400 | 40[5], 50[4], 60[3],[4],[5],[6], 75[3] |
| 32 | 32.3 | 819 | 6.404 | 300[5], 350[4], 400[3],[4],[5],[6], 500[3] | 10 | 1.270 | 1.27 | 4.303 | 40[5], 50[4], 60[3],[4],[5],[6], 75[3] |
| 36 | 35.8 | 1006 | 7.907 | 300[5], 350[4], 400[3],[4],[5],[6], 500[3] | 11 | 1.410 | 1.56 | 5.313 | 40[5], 50[4], 60[3],[4],[5],[6], 75[3] |
| 43 | 43.0 | 1452 | 11.38 | 400[3],[6], 500[3] | 14 | 1.693 | 2.25 | 7.650 | 60[3],[6], 75[3] |
| 57 | 57.3 | 2581 | 20.24 | 400[3],[6], 500[3] | 18 | 2.257 | 4.00 | 13.600 | 60[3],[6], 75[3] |

(1) PennDOT has not added the "M" suffix appearing in some standard literature to SI bar numbers.
(2) Grade is equivalent to Min. Yield Designation, $f_y$.
(3) ASTM A 615/A 615 M billet-steel.
(4) ASTM A 616/A 616 M rail-steel.
(5) ASTM A 617/A 617 M axle-steel.
(6) ASTM A 706/A 706 M low-alloy steel.
(7) Equivalent MPa values for I-P grades follow: 40 ksi = 276 MPa, 50 ksi = 345 MPa, 60 ksi = 414 MPa, and 75 ksi = 517 MPa.

**TABLE A-4**
**Standard Test Sieves**
**(U.S.A. Standard Series)**

| Standard Sieve Designation | Alternative Sieve Designation | Standard Sieve Designation | Alternative Sieve Designation |
|---|---|---|---|
| 125 mm | 5 in. | 2.36 mm | No. 8 |
| 106 mm | 4.24 in. | 2.00 mm | No. 10 |
| 100 mm(1) | 4 in.(1) | 1.70 mm | No. 12 |
| 90 mm | 3 1/2 in. | 1.40 mm | No. 14 |
| 75 mm | 3 in. | 1.18 mm | No. 16 |
| 63 mm | 2 1/2 in. | 1.00 mm | No. 18 |
| 53 mm | 2.12 in. | 850 µm | No. 20 |
| 50 mm(1) | 2 in.(1) | 710 µm | No. 25 |
| 45 mm | 1 3/4 in. | 600 µm | No. 30 |
| 37.5 mm | 1 1/2 in. | 500 µm | No. 35 |
| 31.5 mm | 1 1/4 in. | 425 µm | No. 40 |
| 26.5 mm | 1.06 in. | 355 µm | No. 45 |
| 25.0 mm(1) | 1 in.(1) | 300 µm | No. 50 |
| 22.4 mm | 7/8 in. | 250 µm | No. 60 |
| 19.0 mm | 3/4 in. | 212 µm | No. 70 |
| 16.0 mm | 5/8 in. | 180 µm | No. 80 |
| 13.2 mm | 0.530 in. | 150 µm | No. 100 |
| 12.5 mm(1) | 1/2 in.(1) | 125 µm | No. 120 |
| 11.2 mm | 7/16 in. | 106 µm | No. 140 |
| 9.5 mm | 3/8 in. | 90 µm | No. 170 |
| 8.0 mm | 5/16 in. | 75 µm | No. 200 |
| 6.7 mm | 0.265 in. | 63 µm | No. 230 |
| 6.3 mm(1) | 1/4 in.(1) | 53 µm | No. 270 |
| 5.6 mm | No. 3½ | 45 µm | No. 325 |
| 4.75 mm | No. 4 | 38 µm | No. 400 |
| 4.00 mm | No. 5 | 32 µm | No. 450 |
| 3.35 mm | No. 6 | 25 µm(1) | No. 500(1) |
| 2.80 mm | No. 7 | 20 µm(1) | No. 635(1) |

(1) These sieves are not in the standard series but they have been included because they are in common usage.

# APPENDIX B
# STANDARD SPECIAL PROVISIONS TO PUBLICATION 408

**General:** This Appendix contains an explanation of the five Standard Special Provision (SSP) Indices (G, I, N, P, and S) relating to Publication 408. These indices and the full text of their SSP can be found on the ECMS Website. SSPs contain instructions, standards, requirements or directions applying to a project, as set forth in the bid proposal, but not contained within Publication 408. In many applications they must be further tailored by designers and reviewers for use on specific projects using heading documents and merge-lines.

**Internet Access:** Internet access to all SSPs and their contents may be obtained on the ECMS website at www.dot2.state.pa.us. Once at the ECMS homepage select "Design Admin", then "Std Special Provisions".

**Revisions:** Revisions will occur to the indices and their associated contents. Changes and updates to SSPs may be identified by new versions (example: A to B) or by their "From" dates. As SSP entries are revised they will be retained in their original format with an appropriate notation to indicate documents that might have replaced them or their effective "To" dates. Thus entries will not be deleted, only annotated and added. Therefore, it will always be possible to determine what SSPs were in effect at a certain point in time.

**SSP Indices.** Following is an explanation of the five indices relating to the series of SSPs to Publication 408, found in ECMS:

- **G INDEX.** This index includes ***General Provision Related*** SSPs. The index associated with this series addresses issues that apply to Publication 408 General Provisions, contract terms and conditions. General Provision related issues that apply to numbered sections within Publication 408 are found in the S Index.

- **I INDEX.** This index includes standard and non-standard Construction ***Item Related*** SSPs. All Non-Standard "9000" Construction Items and many Standard Master Construction Items can not be included in bid proposals without reference to SSPs found in this index.

- **N INDEX.** This index includes ***Non-pay Item Related*** SSPs relating to those issues not paid for separately.

- **P INDEX.** This index addresses ***Provisional Specification Related*** SSPs that are to be used on a case-by-case or trial basis, and require close monitoring when used in conjunction with construction projects. They may be removed at any time, but they also have the potential for being incorporated into the text of Publication 408. An appropriate Strike-Off Letter further addresses each provision within this index.

- **S INDEX.** This index includes ***Section Related*** SSPs. This particular index addresses issues and conditions that apply to current Publication 408/2003 numbered sections and also those numbered, but considered "Seldom Used (SU)" and, therefore, not currently found in the current edition of Publication 408.

# APPENDIX C
# DESIGNATED SPECIAL PROVISIONS

**General:** This appendix to Publication 408 contains standard documents previously included in PENNDOT Bid Proposals. Effective with the publication of Publication 408 they will be maintained within this Appendix in all versions (Hardcopy, CD, and Internet) and be referenced in bid proposals. Governing Specifications, the applicable Designated Special Provisions, and other details will be specified in a single Standard Special Provision to each bid proposal. This Standard Special Provision is entitled: "GOVERNING SPECIFICATIONS AND APPLICABLE DESIGNATED SPECIAL PROVISIONS."

**Standard Documents:** Designated Special Provisions (DSPs) that are referenced to this Appendix in PENNDOT Bid Proposals are:

DSP1. Offset Provision for State Contracts. See page C1-1.

DSP2. Contractor Responsibility Provisions. See page C2-1.

DSP3. Provisions for State Contracts Concerning the Americans with Disabilities Act. See page C3-1.

DSP4. Minority Business and Women Business Enterprise Participation Requirements. This is used on all 100% State projects requiring Prequalification. See page C4-1.

DSP5. Minority Business and Women Business Enterprise Program. Use only on 100% State funded projects over $100,000 requiring Prequalification and do not have Designated Special Provision DSP4. See page C5-1.

DSP6. Minority Business and Women Business Enterprise Utilization Requirements. Use is on all 100% State funded projects without Prequalification requirements. Minimum participation levels of 5% for MBE and 3% for WBE of the dollar amount of the bid have been established for this project. See page C6-1.

DSP7. Disadvantaged Business Enterprise Requirements. See page C7-1.

DSP8. F. A. R.—Required Contract Provisions Federal-Aid Construction Contracts – March 10, 1994. See page C8-1.

DSP9. Special Supplement—Anti-Pollution Measures – August 26, 1999. See page C9-1.

DSP10. Nondiscrimination/Sexual Harassment Clause – June 30, 1999. See page C10-1.

DSP11. Contractor Integrity Provisions – June 30, 1999. See page C11-1.

DSP12. Executive Order 11246, with Appendices A and B. See page C12-1.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 1 (DSP1)

## OFFSET PROVISION FOR STATE CONTRACTS

The Contractor agrees that the State may offset the amount of any state tax or State liability of the Contractor or its affiliates and subsidiaries that is owed to the State against any payments due the Contractor under this or any other contract with the State.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 2 (DSP2)

## CONTRACTOR RESPONSIBILITY PROVISIONS

For the purpose of these provisions, the term contractor is defined as any person, including, but not limited to, a bidder, offeror, loan recipient, grantee, or subgrantee who has furnished or seeks to furnish goods, supplies, services, or leased space, or who has performed or seeks to perform construction activity under contract, subcontract, grant, or subgrant with the State, or with a person under contract, subcontract, grant or subgrant with the State or its state-affiliated entities and state-related institutions. The term contractor may include a permittee licensee, or any agency, political subdivision, instrumentality, public authority or other entity of the State.

**(a)** The Contractor must certify, in writing, for itself and all its subcontractors, that as of the date of its execution of any State contract, that neither the Contractor, nor any subcontractors, nor any suppliers are under suspension or debarment by the State or any governmental entity, instrumentality, or authority and, if the Contractor cannot so certify, then it agrees to submit, along with the bid/proposal, a written explanation of why such certification cannot be made.

**(b)** The Contractor must also certify, in writing, that as of the date of its execution, of any State contract it has no tax liabilities or other State obligations.

**(c)** The Contractor's obligations pursuant to these provisions are ongoing from and after the effective date of the contract through the termination date thereof. Accordingly, the Contractor shall have an obligation to inform the contracting agency if, at any time during the term of the contract, it becomes delinquent in the payment of taxes, or other State obligations, or if it or any of its subcontractors are suspended or debarred by the State, the federal government, or any other state or governmental entity. Such notification shall be made within 15 days of the date of suspension or debarment.

**(d)** The failure of the Contractor to notify the contracting agency of its suspension or debarment by the State, any other state, or the federal government shall constitute an event of default of the contract with the State.

**(e)** The Contractor agrees to reimburse the State for the reasonable costs of investigation incurred by the Office of State Inspector General for investigations of the Contractor's compliance with the terms of this or any other agreement between the Contractor and the State, which results in the suspension or debarment of the Contractor. Such costs shall include, but shall not be limited to, salaries of investigators, including overtime; travel and lodging expenses; and expert witness and documentary fees. The Contractor shall not be responsible for investigative costs for investigations that do not result in the Contractor's suspension or debarment.

**(f)** The Contractor may obtain a current list of suspended and debarred State contractors by either searching the internet at http://www.dgs.state.pa.us/debarment.htm or contacting the:

Department of General Services
Office of Chief Counsel
603 North Office Building
Harrisburg, PA 17125
Telephone: (717) 783-6472
FAX: (717) 787-9138

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 3 (DSP3)

## PROVISIONS FOR STATE CONTRACTS CONCERNING THE AMERICANS WITH DISABILITIES ACT

During the term of this contract, the Contractor agrees as follows:

Pursuant to federal regulations promulgated under the authority of the Americans With Disabilities Act, 28 CFR, 35.101 et seq., the Contractor understands and agrees that no individual with a disability is to be excluded from participation in this contract or from activities provided for under this contract on the basis of the disability. As a condition of accepting and executing this contract, the Contractor agrees to comply with the "General Prohibitions Against Discrimination," 28 CFR, 35.130, and all other regulations promulgated under Title II of The Americans With Disabilities Act which are applicable to the benefits, services, programs, and activities provided by the State through contracts with outside contractors.

The Contractor is to be responsible for and agrees to indemnify and hold harmless the State from all losses, damages, expenses, claims, demands, suits, and actions brought by any party against the State as a result of the Contractor's failure to comply with the above provisions.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 4 (DSP4)

## MINORITY BUSINESS AND WOMEN BUSINESS ENTERPRISE PARTICIPATION REQUIREMENTS

NOTE: Use on all 100% State-funded projects requiring Prequalification. Requires special provision for participation goal percentage. Minority Business Enterprise and Women Business Enterprise Participation of 100% State funded Projects is accessed by logging on to the Department's ECMS website.

**I. PARTICIPATION LEVEL—**

**(a)** Under the authority of Executive Order 1996-8, PENNDOT has established the following Minority Business Enterprise (MBE) and Women Business Enterprise (WBE) minimum participation levels (MPLs) for this project:

| MBE | WBE |
|---|---|
| (*add percentage*)% | (*add percentage*)% |

These minimum levels of participation serve exclusively as a guide in determining bidder responsibility. Attainment of the levels is not a measure of bidder responsiveness.

All predetermined amounts shown in the Schedule of Prices are to be excluded from the original total contract price for the determination of MBE/WBE MPLs.

**(b)** MBE/WBE subcontractors and manufacturers will be credited toward the minimum level at 100%. Regular dealers are credited at 100%. Others providing a BONA FIDE service are credited at 100%.

1. **Certified MBE/WBE**. A certified MBE/WBE means a entity certified by any of the following agencies: Allegheny County, Office of Minority, Women and Disadvantaged Business Enterprises; City of Philadelphia, Minority Business Enterprise Council; Pennsylvania Department of Transportation, Bureau of Equal Opportunity; Port Authority of Allegheny County, Office of Equal Opportunity; or Southeastern Pennsylvania Authority, Small & Disadvantage Business Utilization Department.

2. **MBE/WBE Manufacturer.** A MBE/WBE manufacturer is a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract and of the general character described by the specifications.

3. **Regular Dealer.** A regular dealer is a firm that owns, operates or maintains a store, warehouse, or other establishment in which the materials, supplies, articles, or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business.

   To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question.

   A person may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating, or maintaining a place of business as provided above if the person both owns and operates distribution equipment for the products. Any supplementing of regular dealers' own distribution equipment shall be by a long-term lease agreement and not on an ad hoc or contract-by-contract basis. Packagers, brokers, manufacturers' representatives, or other persons who arrange or expedite transactions are not regular dealers.

4. **Services.** With respect to materials or supplies purchased from a MBE/WBE, which is neither a manufacturer nor a regular dealer, count the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the

delivery of materials or supplies required on a job site, toward MBE/WBE MPLs, provided you determine the fees to be reasonable and not excessive as compared with fees customarily allowed for similar services. Do not count any portion of the cost of the materials and supplies themselves toward MBE/WBE MPLs.

**5. Trucking Firms.** The following factors are used in determining MBE/WBE credit:

**5.a** The MBE/WBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting MBE/WBE MPLs.

**5.b** The MBE/WBE must itself own and operate at least one fully licensed, insured, and operational truck used on the contract.

**5.c** The MBE/WBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.

**5.d** The MBE/WBE may lease trucks from another MBE/WBE firm, including an owner-operator who is certified as a MBE/WBE. The MBE/WBE who leases trucks from another MBE/WBE receives credit for the total value of the transportation services the lessee MBE/WBE provides on the contract.

**5.e** The MBE/WBE may also lease trucks from a non-MBE/WBE firm, including an owner-operator. The MBE/WBE who leases trucks from a non-MBE/WBE is entitled to credit only for the fee or commission it receives as a result of the lease arrangement. The MBE/WBE does not receive credit for the total value of the transportation services provided by the lessee, since these services are not provided by a MBE/WBE.

**5.f** For purposes above, a lease must indicate that the MBE/WBE has exclusive use of and control over the truck. This does not preclude the leased truck from working for others during the term of the lease with the consent of the MBE/WBE, so long as the lease gives the MBE/WBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the MBE/WBE.

Any services to be performed by a MBE/WBE agency are required to be readily identifiable to the project.

**(c)** A firm, which is both a MBE and a WBE will only receive credit toward the minimum participation level as either a MBE or WBE in any single supply or work area. The firm will not receive credit in each category, MBE and WBE. Bidders will note with the submission which status, MBE or WBE, is submitted for credit.

**(d)** A MBE/WBE firm which is the prime bidder, will receive no credit toward meeting the MPLs for its own work effort on this project.

**(e)** MBE/WBE subcontractors must perform at least 50% of the cost of the subcontract with its own employees.

## II. RESPONSIVENESS -

**(a)** The apparent low bidder is required to electronically submit evidence of certified MBE and WBE firms who have been contacted. The reviewed bidder is responsible for verifying that a given MBE and WBE firm is currently certified and a registered business partner. The bidder is also required to electronically submit evidence of certified MBE and WBE firms to which commitments have been made. Electronically submit evidence of such solicitations and commitments, by accessing the Department's ECMS web page and selecting the MBE/WBE Participation for State Projects, by 3:00 P.M. prevailing local time within 7 calendar days after the bid opening. Failure to fill out and electronically submit the required information

on MBE/WBE Solicitation and Participation Screens in ECMS will result in rejection of the bid, regardless of whether the minimum levels of MBE/WBE participation have been attained. MBE/WBE Solicitation and Participation Screens completed in ECMS regarding solicitation of and commitments to certified MBE and WBE firms become part of the contract.

Mailings to large numbers of PENNDOT registered business partners and certified MBEs and WBEs, which are intended to provide notice of a contractor's interest in bidding a Department 100% state funded highway construction contract, will not be deemed solicitations but rather will be treated as informational notifications only.

A bidder should only make actual solicitation of PENNDOT registered business partners and certified MBE/WBE subcontractors, manufacturers, regular dealers and/or providers of bona fide services whose work, material supplies, equipment, and/or services are within the project scope and related to project line items or portions thereof, and which the bidder reasonably believes it will choose to subcontract, purchase, or lease.

**(b)** Bidders failing to meet the minimum levels of participation are required to submit sufficient evidence that demonstrates to the State that the reviewed bidder has not engaged in discriminatory practices in the solicitation and commitment of subcontracts and supply contracts by 3:00 P.M. prevailing local time within 7 calendar days after the bid opening.

**1.** Evidence submitted on this point should:

**1.a** Indicate whether certified minority and women businesses were solicited for each type of work the bidder intends or expects to subcontract or for all materials which the bidder intends or expects to procure and, if not, the reason(s) why solicitation was not made;

**1.b** In any instance where a certified minority or women business has not been committed to for a type of subcontract work or materials contract in any area where a quote was received from a certified minority or women business the reason should be expressly indicated, and;

**1.c** In any case where quotations are not received nor commitments made to certified and registered business partner MBE or WBE firms, the lack of quotations and/or commitments must be shown and explained on the MBE/WBE Commitment Screen. MBE/WBE leaving the Commitment Screen blank is not sufficient.

**2.** Any evidence submitted should meet the following standards for review:

**2.a** The bidder, whose actions resulted in a limited or no commitment to minority and/or women businesses, was not motivated by considerations of race or gender.

**2.b** PENNDOT registered and certified minority and women businesses were not treated less favorably than other businesses in the contract solicitation and commitment process.

**2.c** Solicitation and commitment decisions were not based upon policies which disparately affect certified minority and women businesses.

**(c)** In cases where specialty items and WBE/MBE involvement overlap, follow the requirements specified in Section 108.01(d).

**(d)** If there is a deficiency in the MBE/WBE information submitted, the bidder will be notified and will be given 2 business days from the date of the notification to correct the deficiency. If the deficiency is not corrected within the 2 business-day period, the bid will be rejected. The 2 business-day period will be strictly enforced. No extensions or waivers will be granted.

Upon notice from PENNDOT, Bureau of Equal Opportunity, Project Management and Business Assistance Division of the need to remedy a deficiency in the MBE/WBE submission requirements, the bidder should fully review the requirements as well as its submission and the subsequently provided

information to ensure that the submission and the subsequently provided information fully comply with the requirements of Section II. (a) and (b) above, MBE/WBE Solicitation Screen, and MBE/WBE Commitment Screen. While the Bureau of Equal Opportunity, Project Management and Business Assistance Division will carefully review the bidder's submission before sending a notice of deficiency, it is the responsibility of the reviewed bidder to fully comply with the requirements of Section II (a) and (b) above, MBE/WBE Solicitation Screen, and MBE/WBE Commitment Screen.

If the Bureau of Equal Opportunity, Project Management and Business Assistance Division notifies the reviewed bidder of a deficiency and the bidder provides information/documentation to meet the deficiency, but later it is discovered that there are other deficiencies, the reviewed bidder will not be given another 2 business-day period to correct the deficiency. The Bureau of Equal Opportunity, Project Management and Business Assistance Division disclaims any and all responsibility for notifying the bidder of all deficiencies.

If the reviewed bidder fails to submit such evidence as required, the bid submission will be rejected. Additional solicitations or commitments made after the bid will not be considered.

**(e)** Failure to electronically submit MBE/WBE Solicitation and Participation Screens completed in ECMS or the submission of blank MBE/WBE Solicitation and Participation Screens within 7 days of the bid opening by the 3:00 P.M. deadline will result in the bid being rejected.

**(f)** Only MBE/WBE firms certified at the time of bid submission will be approved.

## III. RESPONSIBILITY -

**(a)** Upon receipt of the ECMS screens, the submittals of the apparent low bidder will be subject to review by the Bureau of Equal Opportunity, Project Management and Business Assistance Division to determine whether the bidder has discriminated in the selection of subcontractors, manufacturers, regular dealers and other providers of BONA FIDE services. If a bidder has met the certified MBE/WBE MPL, the bidder will be presumed not to have discriminated in its selections. Where the minimum levels are not met, the Bureau of Equal Opportunity, Project Management and Business Assistance Division will determine whether discrimination has occurred. After review of the MBE/WBE Solicitation Screen, the MBE/WBE Commitment Screen, and other relevant information submitted, the Bureau of Equal Opportunity, Project Management and Business Assistance Division will make a recommendation. If PENNDOT, after review of the recommendation and supporting documentation, concurs that discrimination has occurred, the bid will be rejected.

**(b)** MBE/WBE commitments made at the time of submission are to be maintained throughout the term of the contract. Any change in commitment must be preapproved by the Bureau of Equal Opportunity, Project Management and Business Assistance Division.

## IV. ACCESS TO INFORMATION -

**(a)** PENNDOT, the Department of General Services (DGS), and the Office of Inspector General (OIG) have the right to obtain documents and information from any contractor, subcontractor, manufacturer, regular dealer or other provider of a BONA FIDE service that may be required in order to ascertain bidder or contractor responsibility. Except as otherwise provided by law and/or for use by PENNDOT, DGS, OIG, and/or the Attorney General for investigations and proceedings following therefrom, the documents submitted will be confidential.

**V. MBE/WBE CERTIFICATION -**

**(a)** Credit will be given for PENNDOT registered business partners and certified MBE/WBE subcontractors, manufacturers, regular dealers or other providers of a BONA FIDE service who are PENNDOT registered business partners and certified and, where necessary because of the nature or quantity of work, prequalified by PENNDOT. Credit may be given for firms whose prequalification applications are pending by PENNDOT with the condition that they become prequalified prior to performing any work must be registered as a business partner prior to submittal. Certified also means those MBE/WBE firms who are United States citizens and who are African Americans, Hispanic Americans, Native Americans, Asian Americans, Alaskans, Pacific Islanders, or women that are certified.

**(b)** Under the Act of December 21, 1984, No. 230, P.L. 210, 18 PA C.S.A. Section 4107.2, a person commits a felony of the third degree if, in the course of business, that person engages in deception relating to MBE/WBE certification.

**VI. RESOURCES -**

**(a)** The Bureau of Equal Opportunity, Project Management and Business Assistance Division is available for technical assistance to all bidders/contractors seeking to meet the State's MBE/WBE MPLs. A listing of certified MBE/WBEs is maintained by PENNDOT and is available to bidders upon request through the Publication Sales Store (717-787-6746) or PENNDOT's home page address, www.dot.state.pa.us. A database of registered business partners is available on the ECMS website.

**(b)** Contact the Project Management and Business Assistance Division, Bureau of Equal Opportunity, PENNDOT, at 1-800-468-4201 or 717-787-5891 or address correspondence to the Project Management and Business Assistance Division, Bureau of Equal Opportunity, PENNDOT, 5th Floor, Commonwealth Keystone Building, 400 North Street, Harrisburg, PA 17120.

**VII. RECORDS AND REPORTS -**

**(a)** Keep such projects records as are necessary to determine compliance with MBE/WBE commitments. Design these records to indicate:

**1.** The number of MBE/WBE and non-MBE/WBE subcontractors, manufacturers, regular dealers, and other providers of a BONA FIDE service, and the type of work, materials, or services performed on or incorporated in this project.

**2.** The progress and efforts made in seeking out individual MBE/WBE contractors for work on this project, to increase the amount of MBE/WBE participation and/or to maintain the commitments made, and approved, to MBEs and WBEs. Do this, as a minimum, anytime a contract with a subcontractor, manufacturer, regular dealer, or other provider of a BONA FIDE service is contemplated during the life of this contract.

**3.** Documentation of all correspondence, contacts, telephone calls, etc., to obtain the services of MBE/WBEs for this project.

**(b)** Submit reports, as required by PENNDOT or, at the least, on a monthly basis, on contracts and other business executed with MBE/WBEs, with respect to the records referred to in Section VII. (a) above, in the form and manner prescribed by PENNDOT. Submit monthly reports, Form EO-402, to the Inspector-in-Charge, within 5 working days following the end of the month, containing:

**1.** The number of contracts awarded to MBE/WBEs, noting the type of work and amount of each contract executed with each firm, including the execution date of each contract.

**2.** The amount paid to each MBE/WBE during the month and the date of payment.

**3.** Upon completion of the individual MBE/WBE firm's work, submit paid invoices or a certification attesting to the actual amount paid to each firm. In the event the actual amount paid is less than the award amount, a complete explanation of the difference is required.

**(c)** Maintain all such records for a period of 3 years following acceptance of final payment. If any litigation, claim, or audit is started before expiration of the 3-year period, retain the records until all litigations, claims, or audits involving the records have been resolved. Make these records available for inspection by PENNDOT and/or the Bureau of Contract Administration and Business Development (BCABD).

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 5 (DSP5)

## MINORITY BUSINESS AND WOMEN BUSINESS ENTERPRISE PROGRAM

NOTE: Use ONLY on 100% State-funded projects over $100,000 requiring Prequalification and DO NOT require the MBE/WBE Designated Special Provision, DSP4.

To effectively implement a Minority Business Enterprise (MBE) and Women Business Enterprise (WBE) program, prospective bidders (prime contractors), who intend to subcontract portions of this project are required to:

**(a)** Designate a liaison officer authorized to administer this program.

**(b)** Make contact with, and document results of such contact with, potential MBEs and WBEs, to affirmatively solicit their interest, capability, and price for subcontracting, supplying, or to perform services on portions of this project.

**(c)** No subcontracting will be approved without evidence of compliance with affirmative action steps listed above.

**(d)** Requests for approval of subcontracting, after the bid opening, will require documentation that appropriate action has been taken, as previously stated.

Records and Reports:

**(a)** Keep such records as are necessary to determine compliance with Minority and Women Business Enterprise Utilization obligations. Design these records to indicate:

**1.** The number of minority women and non-minority subcontractors, suppliers, and service agencies and the type of work or materials or services performed on or incorporated in this project.

**2.** The progress and efforts made in seeking out individual minority and women contractors for work on this project anytime a subcontractor, supplier, or service contract is contemplated during the life of this contract.

**3.** Documentation of all correspondence, contacts, telephone calls, etc. to obtain the services of MBEs and WBEs on this project.

**(b)** Submit reports as required by the Department but at least on a monthly basis, of those contracts and other business executed with MBEs and WBEs with respect to the records referred to in (a) under Records and Reports above in such form and manner as prescribed by the Department.

**(c)** Maintain all such records for a period of 3 years following acceptance of final payment. Make these records available for inspection by the Department.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 6 (DSP 6)

## MINORITY BUSINESS AND WOMEN BUSINESS ENTERPRISE UTILIZATION REQUIREMENTS

NOTE: Use on all 100% State-funded projects without Prequalification requirements.

### I. PARTICIPATION LEVEL—

The Department of General Services, Bureau of Contract Administration and Business Development (DGS, BCABD) has established Minority Business Enterprise (MBE) and Women Business Enterprise (WBE) minimum participation levels (MPLs) of 5% for MBE and 3% for WBE of the dollar amount of the bid for this contract.

These MPLs serve exclusively as a threshold in determining bidder responsibility. A bidder will not be rejected as being not responsible solely because the bidder fails to reach the MPLs. To determine the participation level that has been reached, divide the total dollar amount of the commitments by the total dollar amount of the bid.

A firm that is both an MBE and a WBE will only receive credit toward the MPLs as either an MBE or a WBE, but not both. The bidder is to indicate on Form STD-168, MBE/WBE Contact/Solicitation and Commitment Statement, whether the firm is being listed as an MBE or a WBE.

An MBE/WBE firm that is bidding as the prime contractor on a project will receive no MPL credit for its own work effort for services provided. An MBE/WBE bidding as a prime contractor must solicit the participation of other certified MBEs/WBEs for material and/or supplies. MBE/WBE subcontractors must perform at least 75% of the cost of the subcontract, not including the cost of materials, with its own employees.

### II. RESPONSIVENESS—

Complete and submit Form STD-168 with the bid. Failure to submit this form with the bid will result in the bid being rejected as nonresponsive. Solicit only MBE/WBE subcontractors, vendors, manufacturers, or suppliers whose services, material, or supplies are within the scope of work and which the bidder reasonably believes it will choose to subcontract with or purchase from.

Bidders failing to meet the MPLs must submit, concurrently with the bid, an explanation of why the MPLs have not been met. This explanation must demonstrate that the bidder has not engaged in discriminatory practices in solicitation for and utilization of DGS, BCABD-certified MBEs/WBEs to perform as subcontractors or suppliers of goods and services related to the performance of the contract. The evidence submitted by the bidder must:

- Indicate whether MBEs/WBEs were solicited for each type of work the bidder expects to subcontract for and for all materials which the bidder expects to procure and, if not, the reason(s) why no such solicitation was made;

- Indicate the reason why an MBE/WBE has not been committed to for a type of subcontract work or materials in any area where a quote was received from an MBE/WBE; and

- In cases where no quotations are received nor commitments made to MBE or WBE firms, indicate on Form STD-168 that no quotes were received, and, if there is any other reason for no commitments being made, the reason for the lack of commitments.

If the bidder fails to submit such evidence, the bid submission will be considered nonresponsive and the bid will be rejected.

Submit information related to the above on Form STD-168 or on additional paper.

**III. RESPONSIBILITY—**

The submittals of each bidder are subject to review to determine whether the bidder has discriminated in the selection of manufacturers, subcontractors, and suppliers. If a bidder has met the prescribed MPLs for MBE/WBE participation, the bidder will be presumed not to have discriminated in the selections. Where the MPLs are not met, DGS, BCABD-procuring agency will determine whether discrimination has occurred. If, after investigation including a review of Form STD-168, it is found that discrimination has occurred, the reviewed bidder will be deemed to be not responsible and the bid will be rejected.

Documentation submitted by the bidder is to meet the following standards for review:

- The bidder whose actions resulted in a limited or no commitment to MBEs/WBEs was not motivated by consideration of race or gender;
- MBEs and WBEs were not treated less favorably than other businesses in the contact solicitation and commitment process; and
- Solicitation and commitment decisions were not based upon policies that disparately affect MBEs and WBEs.

Commitments to MBE and WBE firms made at the time of bidding must be maintained throughout the term of the contract, unless a change in commitment to these firms is preapproved by DGS, BCABD or the Department.

**IV. ACCESS TO INFORMATION—**

The DGS, BCABD and the Office of the Inspector General (OIG) may obtain documents and information from any bidder, contractor, subcontractor, supplier, or manufacturer that may be required in order to ascertain bidder or contractor responsibility. Failure to provide requested information may result in the bidder being declared not responsible.

**V. MBE/WBE CERTIFICATION—**

Bidders will not be given credit for MBEs/WBEs not certified by DGS, BCABD or by PENNDOT.

State certification of an entity as an MBE/WBE means only that the applicant for certification has submitted information that qualified it as an MBE/WBE in terms of its ownership and control. State certification does not address the ability of the MBE/WBE to perform required services.

Under the Act of December 21, 1984, No. 230, P.L. 1210, 18 PA C.S.A., Section 4107.2, a person commits a felony of the third degree if, in the course of business, that person engages in deception relating to MBE/WBE certification.

**VI. BID AS PART OF THE CONTRACT—**

The bid of the successful bidder, including the completed MBE/WBE Form STD-168 and accompanying documentation regarding solicitation and commitments to MBE and WBE firms, become part of the contract.

**VII. RESOURCES—**

DGS, BCABD is available for technical assistance to all bidders/contractors submitting bids to the State. A listing of certified MBEs/WBEs is maintained by DGS, BCABD and made available to bidders upon request.

Contact the DGS, BCABD at:

Department of General Services
Bureau of Contract Administration and Business Development
Room 502 North Office Building
Harrisburg, PA 17125
Telephone: (717) 787-7380
FAX: (717) 787-7052

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 7 (DSP7)

## DISADVANTAGED BUSINESS ENTERPRISE REQUIREMENTS

NOTE: Use on Federal-aid projects only. Requires special provision for participation goal percentage. Disadvantaged Business Enterprise Participation of Federal Projects is accessed by logging on to the Department's ECMS website.

### I. DBE GOAL—

To create a level playing field that Disadvantage Business Enterprises (DBEs) can compete fairly for U.S. Department of Transportation assisted contracts, PENNDOT has established, in connection with this contract, a goal as specified in the proposal of the original contract amount for the utilization of firms owned and controlled by socially and economically disadvantaged individuals certified as DBEs at the time submission of DBE Participation of Federal Projects documents are due. This goal remains in effect throughout the life of the contract. When the award of the contract is made with a DBE participation less than the contract goal, continue Good Faith Effort throughout the life of the contract to increase the DBE participation to meet the contract goal.

Include the following provisions in every subcontract, so that such provisions will be binding upon each subcontractor, regular dealer, manufacturer, consultant, or service agency.

**(a)** **Policy.** It is the policy of the U.S. Department of Transportation and PENNDOT that DBEs, as defined in 49 CFR Part 26, as amended, and this Designated Special Provision, be given the opportunity to participate in the performance of contracts financed in whole or in part with Federal funds under this contract. Consequently, the DBE requirements of 49 CFR Part 26, as amended, apply to this contract. The term DBE as used throughout also applies to Women Business Enterprises and all requirements herein are applicable.

**(b)** **DBE Obligation.** Take all necessary and reasonable steps, according to 49 CFR Part 26, as amended, to ensure that DBEs have the opportunity to compete for and perform contracts. Do not discriminate on the basis of race, color, national origin, or sex in the award and performance of PENNDOT and U.S. Department of Transportation assisted contracts.

**(c)** **Failure to Submit DBE Requirements.** Failure to comply with DBE requirements includes, but is not limited to, failure to submit DBE Participation for Federal Projects within the time period specified, failure to exert a reasonable Good Faith Effort to meet the established goal, or failure to realize the approved DBE participation level set forth may result in the bidder being declared ineligible for the contract.

**(d)** **Failure to Comply with DBE Requirements.** All contractors and subcontractors are hereby advised that failure to carry out the requirements specified hereinabove constitutes a breach of contract and, after notification to the U.S. Department of Transportation, may result in termination of the contract, being barred from bidding on Department contracts for up to 3 years, or any other remedy that PENNDOT deems appropriate.

### II. DEFINITIONS—

Consistent with the federal regulations, the following definitions apply for terms used in this specification:

**(a)** Certified DBE means a for-profit small business concern:

**1.** **Certified DBE**. A certified DBE means a entity certified by any of the following agencies: Allegheny County, Office of Minority, Women and Disadvantaged Business Enterprises; City of

Philadelphia, Minority Business Enterprise Council; Pennsylvania Department of Transportation, Bureau of Equal Opportunity; Port Authority of Allegheny County, Office of Equal Opportunity; or Southeastern Pennsylvania Authority, Small & Disadvantage Business Utilization Department.

**2.** That is a least 51% owned by one or more individuals who are both socially and economically disadvantaged or, in the case of a corporation, in which 51% of the stock is owned by one or more such individuals; and

**3.** Whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.

**(b)** Small business concern means, with respect to firms seeking to participate as DBE's in DOT-assisted contracts, a small business concern as defined pursuant to section 3 of the Small Business Act and Small Business Administration regulations implementing it (13 CFR Part 121) that also does not exceed the cap on average annual gross receipts specified in subsection 26.65(b).

**(c)** Socially and economically disadvantaged individual means any individual who is a citizen (or lawfully admitted permanent resident) of the United States and who is:

**1.** Any individual who the Department finds to be a socially and economically disadvantaged individual on a case-by-case basis.

**2.** Any individual in the following groups, members of which are rebuttably presumed to be socially and economically disadvantaged:

- "Black Americans," which includes persons having origins in any of the Black racial groups of Africa;
- "Hispanic Americans," which includes persons of Mexican, Puerto Rican, Cuban, Dominican, Central or South American, or other Spanish or Portuguese culture or origin, regardless of race;
- "Native Americans," which includes persons who are American Indians, Eskimos, Aleuts, or Native Hawaiians.
- "Asian-Pacific Americans," which includes persons whose origins are from Japan, China, Taiwan, Korea, Burma (Myanmar), Vietnam, Laos, Cambodia (Kampuchea), Thailand, Malaysia, Indonesia, the Philippines, Brunei, Samoa, Guam, the U.S. Trust Territories of the Pacific Islands (Republic of Palau), the Commonwealth of the Northern Marianas Islands, Macao, Fiji, Tonga, Kirbati, Juvalu, Nauru, Federated States of Micronesia, or Hong Kong;
- "Subcontinent Asian Americans," which includes persons whose origins are from India, Pakistan, and Bangladesh, Bhutan, the Maldives Islands, Nepal or Sri Lanka;
- Women;
- Any additional groups whose members are designated as socially and economically disadvantaged by the Small Business Administration, at such time as the Small Business Act designation becomes effective.

**(d)** Committee. The Good Faith Effort Review Committee.

**(e)** Director. Director, Bureau of Equal Opportunity.

**(f)** DBE Participation for Federal Projects. PENNDOT Schedule of DBE Participation that is accessed by the Department's ECMS website.

**(g)** Revised DBE Participation for Federal Projects. DBE Participation for Federal Projects, Schedule of DBE Participation, which includes new DBE firm(s) as well as those not affected by the revision.

## III. COUNTING DBE PARTICIPATION TOWARD THE DBE GOAL -

Utilization of certified DBEs is in addition to all other equal opportunity requirements of the contract.

Count DBE participation toward meeting the DBE goal as follows:

**(a)** **DBE Firms.** If a firm is a certified DBE and registered as a business partner at the time submission of DBE Participation for Federal Projects documents are due, the total dollar value of the contract awarded to the certified DBE is counted toward the applicable DBE goal except as provided below.

When a DBE participates in a contract, count only the value of the work actually performed by the DBE toward DBE goals.

The Department requires that all prime contractors including DBE prime contractors perform at least 50% of the work on a Department project. A DBE bidder on a prime contract will receive credit toward any DBE goal for all work performed with its own forces. The Department strongly encourages DBE prime contractors to make additional outreach efforts to solicit DBEs to perform subcontracting work on the project.

Count the entire amount of that portion of a construction contract that is performed by the DBE's own forces. Include the cost of supplies and materials obtained by the DBE for the work of the contract, including supplies purchased or equipment leased by the DBE.

Count the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a DOT-assisted contract, toward DBE goals, provided the fee to be reasonable and not excessive as compared with fees customarily allowed for similar services.

When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the DBE's subcontractor is itself a DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward DBE goals.

Count expenditures to a DBE contractor toward DBE goals only if the DBE is performing a commercially useful function on that contract.

A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself.

**(b)** **Materials and Supplies.**

1. **DBE Manufacturer.** If the materials or supplies are obtained from a DBE manufacturer, count 100% of the cost of the materials or supplies toward DBE goals.

   A manufacturer is a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract and of the general character described by the specifications.

2. **DBE Regular Dealer.** If the materials or supplies are purchased from a DBE regular dealer, count 60% of the cost of the materials or supplies toward DBE goals.

A regular dealer is a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business.

To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question.

A person may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating, or maintaining a place of business as provided above if the person both owns and operates distribution equipment for the products. Any supplementing of regular dealers' own distribution equipment shall be by a long-term lease agreement and not on an ad hoc or contract-by-contract basis.

Packagers, brokers, manufacturers' representatives, or other persons who arrange or expedite transactions are not regular dealers.

**(c)** **Services.** With respect to materials or supplies purchased from a DBE, which is neither a manufacturer nor a regular dealer, count the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site, toward DBE goals, provided you determine the fees to be reasonable and not excessive as compared with fees customarily allowed for similar services. Do not count any portion of the cost of the materials and supplies themselves toward DBE goals.

**(d)** **Trucking Firms.** The following factors are used in determining DBE credit:

**1.** The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE goals.

**2.** The DBE must itself own and operate at least one fully licensed, insured, and operational truck used on the contract.

**3.** The DBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.

**4.** The DBE may lease trucks from another DBE firm, including an owner-operator who is a certified DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the contract.

**5.** The DBE may also lease trucks from a non-DBE firm, including an owner-operator. The DBE who leases trucks from a non-DBE is entitled to credit only for the fee or commission it receives as a result of the lease arrangement. The DBE does not receive credit for the total value of the transportation services provided by the lessee, since these services are not provided by a DBE.

**6.** For purposes above, a lease must indicate that the DBE has exclusive use of and control over the truck. This does not preclude the leased truck from working for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.

Any services to be performed by a DBE agency are required to be readily identifiable to the project.

**(e)** **Specialty Items.** In cases where specialty items and DBE involvement overlap, follow the requirements specified in Section 108.01(c).

## IV. ACTIONS REQUIRED BY THE BIDDER AT THE BIDDING STAGE AND PRIOR TO AWARD -

**Responsive.** When the goal established by the Department is met or exceeded, the apparent low bidder is required to electronically submit evidence of such solicitations and commitments, by accessing the Department's ECMS web page by selecting and submitting DBE Participation for Federal Projects by 3:00 P.M. prevailing local time within 7 calendar days after the bid opening. When the seventh calendar day after the bid opening falls on a day the PENNDOT offices are closed, submit the DBE Participation for Federal Projects by 3:00 P.M. prevailing local time on the next business day.

When the goal established by the Department is not met, demonstrate a Good Faith Effort to meet the DBE contract goal. Demonstrate that the efforts made were those that a bidder seeking to meet the goal established by the Department would make, given all relevant circumstances. Fax the Good Faith Effort documentation to (717) 705-1504 so that they are received by the time specified above. Also, indicate on the DBE Participation of Federal Projects screen that the Good Faith Efforts are being submitted.

When the above required documentation is not provided by the apparent low bidder within the time specified, the bid will be rejected and the apparent next lowest bidder will be notified by telephone to electronically submit evidence of such solicitations and commitments, by accessing the Department's ECMS web page by selecting DBE Participation for Federal Projects by 3:00 P.M. prevailing local time within 7 calendar days notification.

The demonstration of Good Faith Effort is accomplished by seeking out DBE participation in the project given all relevant circumstances. The following are the kinds of efforts that may be taken, but they are not deemed to be exclusive or exhaustive. The Director and/or Committee will consider other factors and types of efforts that may be relevant:

- Efforts made to solicit through all reasonable and available means (e.g., use of the DBE Directory, attendance at pre-bid meetings, advertising and/or written notices) the interest of all certified DBEs who have the capability to perform the work of the contract. The bidder must provide written notification, at least 15 calendar days prior to the bid opening, to allow the DBEs to respond to the solicitation. The bidder must determine with certainty if the DBEs are interested by taking appropriate steps to follow up initial solicitations.

- Efforts made to select portions of the work to be performed by DBEs in order to increase the likelihood that the DBE goal will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DBE participation, even when the prime contractor might otherwise prefer to perform these work items with its own forces.

- Efforts made to provide interested DBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

- Efforts made to negotiate in good faith with interested DBEs. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBEs to perform the work. A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBEs is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a bidder to perform the work of a contract with its own work force does not relieve the bidder of the responsibility to make Good Faith Effort. Bidders are not, however, required to accept higher quotes from DBEs if the price difference is excessive or unreasonable.

- Failure to accept a DBE as being unqualified without sound reasons based on a thorough investigation of their capabilities. The contractor's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the contractor's efforts to meet the DBE contract goal.

- Efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance.

- Efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.

- Efforts to effectively use the Department's DBE Supportive Services Contractors, services of available minority/women community organizations; minority/women contractors' groups; local, State, and Federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBEs.

If the goal has not been met at the time of bid submission, the Bidder is expected to make a concerted effort between that time and the time that DBE Participation of Federal Projects documents are due.

## V. ACTIONS TO BE TAKEN BY THE DEPARTMENT BEFORE AWARD -

If the apparent low bidder meets the DBE contract goal and all other contract requirements, the Department will approve the submission.

NOTE: If any DBE listed on the DBE Participation of Federal Projects is not prequalified, if required, at the time the Department desires to award the contract, the Department will issue a conditional approval of the DBE Participation of Federal Projects to the apparent low bidder.

If the apparent low bidder fails to meet the DBE contract goal, the Director and/or Committee will review the apparent low bidder's DBE data and Good Faith Effort to meet the DBE contract goal. If the Good Faith Effort is deemed satisfactory, the Director and/or Committee will recommend award.

If the Committee determines that the apparent low bidder has failed to make a Good Faith Effort, the bid will be rejected and the apparent low bidder will be notified of the rejection. The Department will then notify, by telephone, the apparent next lowest bidder on the project to electronically submit evidence of such solicitations and commitments, by accessing the Department's ECMS web page by selecting DBE Participation for Federal Projects by 3:00 P.M. prevailing local time within 7 calendar days after notification.

The bidder's proposal and all appropriate DBE data will be submitted to the Director and/or Committee for evaluation. If, during the review of the bidder's DBE data and Good Faith Effort information, the Director and/or Committee has questions, the bidder may be contacted for clarification.

## VI. ACTION TO BE TAKEN BY THE DEPARTMENT AFTER AWARD -

To ensure that all obligations awarded to DBEs under this contract are met, the Department will review the Contractor's DBE involvement efforts during the performance of the contract.

**(a) Sanctions.** Upon completion of the work the Department will review the actual DBE participation and make a determination regarding the Contractor's compliance with the applicable requirements specified herein.

In the event the Contractor is found to be in noncompliance, the Prequalification Officer, acting under the direction of the Committee, may impose sanctions that the Committee deems appropriate.

Sanctions may be imposed for unwarranted shortfalls in the approved goal.

## VII. ACTION REQUIRED BY THE CONTRACTOR AFTER AWARD -

**(a) DBE Participation Goal.** When DBE Participation of Federal Projects is approved with a DBE participation less than the contract goal, continue efforts toward meeting the contract goal.

**(b) Prequalification or Approval.** Firms listed on DBE Participation of Federal Projects are not to commence work until they are prequalified or approved, if required.

When submitting Form 4339R, Request for Subcontractor Approval, to the District for approval of a DBE named on DBE Participation of Federal Projects, according to this Designated Special Provision, attach the following when electing not to attach a copy of the DBE subcontract or agreement:

- A copy of the executed signature page,
- A copy of the description of the scope of work, and
- A copy of the unit prices as they appear in the DBE's subcontract or agreement.

**(c) Substitution.** The Contractor shall immediately notify the District Executive and the Bureau of Equal Opportunity, in writing, before substituting a DBE or making any change to the DBE participation listed on the approved DBE Participation of Federal Projects. The notification from the Contractor must include documentation supporting the substitution. Requests to substitute DBEs will be scrutinized closely. Contractors should demonstrate that a DBE is unwilling or unable to successfully perform and that every effort has been made to allow the DBE to perform.

**1.** If the arrangement to be replaced is agreeable between the Contractor and the DBE, the following procedures are required:

- The Contractor must make a Good Faith Effort to recontract the work with another DBE, or subcontract other work items to DBE firms, to make up the DBE shortfall.
- Contact available qualified DBEs and DBE referral sources in an effort to recontract the work or subcontract other work items with DBEs, if a DBE contract shortfall exists.
- Provide the District Executive with a Revised DBE Participation of Federal Projects and additional Good Faith Effort information, when the approved DBE Participation of Federal Projects amount is not met, within 7 calendar days after written notification to the District Executive. If the DBE performed on the project, the Revised DBE Participation of Federal Projects should include the total amount paid to the DBE prior to the DBE substitution.

The Contractor's Good Faith Effort information will be forwarded to the Director and/or Committee for evaluation. If, during the review of the Contractor's Good Faith Effort information, the Director and/or Committee has questions, the Contractor may be contacted for clarification.

During the 7 calendar day period specified above and the additional period required for Department processing of the Revised DBE Participation of Federal Projects, the Contractor may continue the substituted work with their own forces to maintain the scheduled progress of the work, with the written approval of the District Executive.

If the projected DBE participation on an approved DBE Participation of Federal Projects exceeds the goal amount for the contract without counting the amount committed to a substituted DBE, then no contract shortfall exists and the Contractor is not required to replace the DBE. A Revised DBE Participation of Federal Projects must be submitted to reflect the decreased dollar amount.

**2.** If the arrangement to be replaced is not agreeable between the Contractor and the DBE, the following procedures are required:

- The Contractor or the affected DBE must immediately request a mediation meeting with the Department by contacting the District Office.

- The Contractor or any other subcontractor may not perform the DBE work until the completion of the mediation meeting.

- Upon completion of the mediation meeting, if a Revised DBE Participation of Federal Projects is required, the Contractor must submit a Revised DBE Participation of Federal Projects according to VII.(c)1. above.

Failure to make Good Faith Effort as determined by the Committee, or failure to comply with the provisions of this Section for substitution of a DBE, will constitute a breach of contract and, after notification to the U.S. Department of Transportation, may result in termination of the contract, being barred from bidding on Department contracts for up to 3 years, or any other remedy that PENNDOT deems appropriate.

**(d)** **Additional Work.** When additional work is required for any classification of work which is identified on the DBE Participation of Federal Projects to be performed by the DBE, at least 50% of this additional work will be performed by the same DBE unless the DBE submits, in writing, that he/she cannot perform the work due to his/her own limitations. If the DBE cannot perform this additional work, the prime may take necessary measures to complete the work.

**(e)** **Progress Payments.** Bring to the attention of the Department, in writing, any situation in which regularly scheduled progress payments are not made to DBE subcontractors, regular dealers, manufacturers, consultants, or service agencies.

**(f)** **Records and Reports.** Keep such project records as are necessary to determine compliance with Disadvantaged Business Enterprise Utilization obligations. Design these records to indicate:

- The number of disadvantaged and nondisadvantaged subcontractors, regular dealers, manufacturers, consultants, and service agencies, and the type of work or services performed on or materials incorporated in this project.

- The progress and efforts made in seeking out DBE contractor organizations and individual DBEs for work on this project to maintain the level of DBE participation outlined on DBE Participation of Federal Projects.

- Documentation of all correspondence, personal contacts, telephone calls, etc., to obtain the services of DBEs for this project. Submit reports, as required by PENNDOT, but at least on a monthly basis, on those contracts and other business executed with DBEs, with respect to the records referred to above, in such form and manner as prescribed by PENNDOT. Submit monthly reports, Form EO-402 (Monthly DBE/MBE/WBE Status Report), to the Inspector-in-Charge within 5 working days following the end of the month and have them contain:

  - The number of contracts awarded to DBEs, noting the type of work and amount of each contract executed with each firm and including the execution date of each contract.

  - The amount paid to each DBE during the month and the amount paid to date.

  - Paid invoices or a certification attesting to the actual amount paid to each firm, upon completion of the individual DBE's work. In the event the actual amount paid is less than the award amount, provide a complete explanation of the difference.

Maintain all such records for a period of 3 years following acceptance of final payment. Make these records available for inspection by PENNDOT and FHWA.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 8 (DSP8)

## F. A. R. – REQUIRED CONTRACT PROVISIONS
## FEDERAL-AID CONSTRUCTION CONTRACTS

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## I. GENERAL—

**(a)** These contract provisions shall apply to all work performed on the contract by the Contractor's own organization and with the assistance of workers under the Contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or subcontract.

**(b)** Except as otherwise provided for in each section, the Contractor shall insert in each subcontract all of the stipulations contained in these Required Contract Provisions, and further require their inclusion in any lower tier subcontract or purchase order that may in turn be made. The Required Contract Provisions shall not be incorporated by reference in any case. The prime Contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with these Required Contract Provisions.

**(c)** A breach of any of the stipulations contained in these Required Contract Provisions shall be sufficient grounds for termination of the contract.

**(d)** A breach of the following clauses of the Required Contract Provisions may also be grounds for debarment as provided in 29 CFR 5.12:

Section I, (b);

Section IV, (a), (b), (c), (d), and (g);

Section V, (a) and (b)1 through (b)7.

**(e)** Disputes arising out of the labor standards provisions of Section IV (except (e)) and Section V of these Required Contract Provisions shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved according to the procedures of the U.S. Department of Labor (DOL) as set forth in 29 CFR 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the DOL, or the Contractor's employees or their representatives.

**(f)** Selection of Labor: During the performance of this contract, the Contractor shall not:

**1.** discriminate against labor from any other State, possession, or territory of the United States (except for employment preference for Appalachian contracts, when applicable, as specified in Attachment A), or

**2.** employ convict labor for any purpose within the limits of the project unless it is labor performed by convicts who are on parole, supervised release, or probation.

## II. NONDISCRIMINATION—

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $10,000 or more.)

**(a)** **Equal Employment Opportunity (EEO).** EEO requirements not to discriminate and to take affirmative action to ensure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, and 41 CFR 60) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140, shall constitute the EEO and specific affirmative action standards for the Contractor's project activities under this contract. The Equal Opportunity Construction Contract Specifications set forth under 41 CFR 60-4.3 and the provisions of the American Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the Contractor agrees to comply with the following minimum specific requirement activities of EEO:

**1.** The Contractor will work with the Department and the Federal Government in carrying out EEO obligations and in their review of his/her activities under the contract.

**2.** The Contractor will accept as his/her operating policy the following statement:

"It is the policy of this Company to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age, or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, preapprenticeship, and/or on-the-job training."

**(b) EEO Officer.** The Contractor will designate and make known to the Department's contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of EEO and who must be assigned adequate authority and responsibility to do so.

**(c) Dissemination of Policy.** All members of the Contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the Contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

**1.** Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every 6 months, at which time the Contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

**2.** All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the Contractor's EEO obligations within 30 days following their reporting for duty with the Contractor.

**3.** All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the Contractor's procedures for locating and hiring minority group employees.

**4.** Notices and posters setting forth the Contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

**5.** The Contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

**(d) Recruitment.** When advertising for employees, the Contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minority groups in the area from which the project work force would normally be derived.

**1.** The Contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants. To meet this requirement, the Contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to the Contractor for employment consideration.

**2.** In the event the Contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, he/she is expected to observe the provisions of that agreement to the extent that the system permits the Contractor's compliance with EEO contract provisions. (The DOL has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Executive Order 11246, as amended.)

**3.** The Contractor will encourage his/her present employees to refer minority group applicants for employment. Information and procedures with regard to referring minority group applicants will be discussed with employees.

**(e) Personnel Actions.** Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age, or disability. The following procedures shall be followed:

**1.** The Contractor will conduct periodic inspections of project sites to ensure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

**2.** The Contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

**3.** The Contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the Contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

**4.** The Contractor will promptly investigate all complaints of alleged discrimination made to the Contractor in connection with his/her obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the Contractor will inform every complainant of all of his/her avenues of appeal.

**(f) Training and Promotion.**

**1.** The Contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

**2.** Consistent with the Contractor's work force requirements and as permissible under Federal and State regulations, the Contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, 25% of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision.

**3.** The Contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

**4.** The Contractor will periodically review the training and promotion potential of minority group and women employees and will encourage eligible employees to apply for such training and promotion.

**(g) Unions.** If the Contractor relies in whole or in part upon unions as a source of employees, the Contractor will use his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. Actions by the Contractor either directly or through a Contractor's association acting as agent will include the procedures set forth below:

**1.** The Contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

**2.** The Contractor will use best efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age, or disability.

**3.** The Contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the Contractor, the Contractor shall so certify to the Department and shall set forth what efforts have been made to obtain such information.

**4.** In the event the union is unable to provide the Contractor with a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, the Contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age, or disability; making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The DOL has held that it shall be no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents the Contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such Contractor shall immediately notify the Department.

**(h) Selection of Subcontractors, Procurement of Materials and Leasing of Equipment.** The Contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age, or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment.

**1.** The Contractor shall notify all potential subcontractors and suppliers of his/her EEO obligations under this contract.

**2.** Disadvantaged business enterprises (DBE), as defined in 49 CFR 23, shall have equal opportunity to compete for and perform subcontracts that the Contractor enters into pursuant to this contract. The Contractor will use his/her best efforts to solicit bids from and to utilize DBE subcontractors or subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of DBE construction firms from Department personnel.

**3.** The Contractor will use his/her best efforts to ensure subcontractor compliance with their EEO obligations.

**(i) Records and Reports.** The Contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of 3 years following completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the Department and the FHWA.

**1.** The records kept by the Contractor shall document the following:

**1.a** The number of minority and non-minority group members and women employed in each work classification on the project;

**1.b** The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women;

**1.c** The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees; and

**1.d** The progress and efforts being made in securing the services of DBE subcontractors or subcontractors with meaningful minority and female representation among their employees.

**2.** The Contractor will submit an annual report to the Department each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. If on-the-job training is being required by special provision, the Contractor will be required to collect and report training data.

## III. NONSEGREGATED FACILITIES—

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $10,000 or more.)

**(a)** By submission of this bid, the execution of this contract or subcontract, or the consummation of this material supply agreement or purchase order, as appropriate, the bidder, Federal-aid construction contractor, subcontractor, material supplier, or vendor, as appropriate, certifies that the firm does not maintain or provide for its employees any segregated facilities at any of its establishments, and that the firm does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The firm agrees that a breach of this certification is a violation of the EEO provisions of this contract. The firm further certifies that no employee will be denied access to adequate facilities on the basis of sex or disability.

**(b)** As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, timeclocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive, or are, in fact, segregated on the basis of race, color, religion, national origin, age or disability, because of habit, local custom, or otherwise. The only exception will be for the disabled when the demands for accessibility override (e.g., disabled parking).

**(c)** The Contractor agrees that it has obtained or will obtain identical certification from proposed subcontractors or material suppliers prior to award of subcontracts or consummation of material supply agreements of $10,000 or more and that it will retain such certifications in its files.

## IV. PAYMENT OF PREDETERMINED MINIMUM WAGE—

(Applicable to all Federal-aid construction contracts exceeding $2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural minor collectors, which are exempt.)

**(a) General.**

**1.** All mechanics and laborers employed or working upon the site of the work will be paid unconditionally and not less often than once a week and without subsequent deduction or rebate on any account [except such payroll deductions as are permitted by regulations (29 CFR 3) issued by the Secretary of Labor under the Copeland Act (40 U.S.C. 276c)] the full amounts of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment. The payment shall be computed at wage rates not less than those contained in the wage determination of the Secretary of Labor (hereinafter "the wage determination"), which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor or its subcontractors and such laborers and mechanics. The wage determination (including any additional classifications and wage rates conformed under (b) of this Section IV and the DOL poster (WH-1321) or Form FHWA-1495) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers. For the purpose of this Section, contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act (40 U.S.C. 276a) on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section IV, (c)2, hereof. Also, for the purpose of this Section, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs, which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in (d) and (e) of this Section IV.

**2.** Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein, provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed.

**3.** All rulings and interpretations of the Davis-Bacon Act and related acts contained in 29 CFR 1, 3, and 5 are herein incorporated by reference in this contract.

**(b) Classification.**

**1.** The Department's contracting officer shall require that any class of laborers or mechanics employed under the contract, which is not listed in the wage determination, shall be classified in conformance with the wage determination.

**2.** The contracting officer shall approve an additional classification, wage rate and fringe benefits only when the following criteria have been met:

- the work to be performed by the additional classification requested is not performed by a classification in the wage determination;
- the additional classification is utilized in the area by the construction industry;
- the proposed wage rate, including any BONA FIDE fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination; and
- with respect to helpers, when such a classification prevails in the area in which the work is performed.

**3.** If the Contractor or subcontractors, as appropriate, the laborers and mechanics (if known) to be employed in the additional classification or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the DOL, Administrator of the Wage and Hour Division, Employment Standards Administration, Washington, D.C. 20210. The Wage and Hour Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

**4.** In the event the Contractor or subcontractors, as appropriate, the laborers or mechanics to be employed in the additional classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. Said Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

**5.** The wage rate (including fringe benefits where appropriate) determined pursuant to (b)3 or (b)4 of this Section IV shall be paid to all workers performing work in the additional classification from the first day on which work is performed in the classification.

**(c) Payment of Fringe Benefits.**

**1.** Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor or subcontractors, as appropriate, shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly case equivalent thereof.

**2.** If the Contractor or subcontractor, as appropriate, does not make payments to a trustee or other third person, he/she may consider as a part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

**(d) Apprentices, Trainees (Programs of the U.S. DOL), and Helpers.**

**1. Apprentices.**

**1.a** Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the DOL, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau, or if a person is employed in his/her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State apprenticeship agency (where appropriate) to be eligible for probationary employment as an apprentice.

**1.b** The allowable ratio of apprentices to journeyman-level employees on the job site in any craft classification shall not be greater than the ratio permitted to the Contractor as to the entire work force under the registered program. Any employee listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate listed in the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a Contractor or subcontractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman-level hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed.

**1.c** Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyman-level hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits according to the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator for the Wage and Hour Division determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid according to that determination.

**1.d** In the event the Bureau of Apprenticeship and Training, or a State apprenticeship agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor or subcontractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the comparable work performed by regular employees until an acceptable program is approved.

**2. Trainees.**

**2.a** Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the DOL, Employment and Training Administration.

**2.b** The ratio of trainees to journeyman-level employees on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

**2.c** Every trainee must be paid at not less than the rate specified in the approved program for his/her level of progress, expressed as a percentage of the journeyman-level hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits according to the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman-level wage rate on the wage determination which provides for less than full fringe benefits for apprentices, in which case such trainees shall receive the same fringe benefits as apprentices.

**2.d** In the event the Employment and Training Administration withdraws approval of a training program, the Contractor or subcontractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

**3. Helpers.**

**3.a** Helpers will be permitted to work on a project if the helper classification is specified and defined on the applicable wage determination or is approved pursuant to the conformance procedure set forth in Section IV, (b). Any worker listed on a payroll at a helper wage rate, who is not a helper under an approved definition, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed.

**(e) Apprentices and Trainees (Programs of the U.S. DOT).**

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of (d) of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

**(f) Withholding.**

The Department shall, upon its own action or upon written request of an authorized representative of the DOL, withhold, or cause to be withheld, from the Contractor or subcontractor under this contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements which is held by the same prime contractor, as much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the Department's contracting officer may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

**(g) Overtime Requirements.**

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers, mechanics, watchmen, or guards (including apprentices, trainees, and helpers described in (d) and (e) above) shall require or permit any laborer, mechanic, watchman, or guard in any workweek in which he/she is employed on such work, to work in excess of 40 hours in such workweek unless such laborer, mechanic, watchman, or guard receives compensation at a rate not less than one-and-one-half times his/her basic rate of pay for all hours worked in excess of 40 hours in such workweek.

**(h) Violation.**

Liability for Unpaid Wages; Liquidated Damages: In the event of any violation of the clause set forth in (g) above, the Contractor and any subcontractor responsible thereof shall be liable to the affected employee for his/her unpaid wages. In addition, such Contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory) for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer, mechanic, watchman, or guard employed in violation of the clause set forth in (g), in the sum of $10 for each calendar day on which such employee was required or permitted to work in excess of the standard work week of 40 hours without payment of the overtime wages required by the clause set forth in (g).

**(i) Withholding for Unpaid Wages and Liquidated Damages.**

The Department shall, upon its own action or upon written request of any authorized representative of the DOL, withhold, or cause to be withheld, from any monies payable on account of work performed by the Contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in (h) above.

## V. STATEMENTS AND PAYROLLS—

(Applicable to all Federal-aid construction contracts exceeding $2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural collectors, which are exempt.)

**(a) Compliance with Copeland Regulations (29 CFR 3).**

The Contractor shall comply with the Copeland Regulations of the Secretary of Labor, which are herein incorporated by reference.

**(b) Payrolls and Payroll Records.**

**1.** Payrolls and basic records relating thereto shall be maintained by the Contractor and each subcontractor during the course of the work and preserved for a period of 3 years from the date of completion of the contract for all laborers, mechanics, apprentices, trainees, watchmen, helpers, and guards working at the site of the work.

**2.** The payroll records shall contain the name, social security number, and address of each such employee; his/her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for BONA FIDE fringe benefits or cash equivalent thereof the types described in Section 1(b)(2)(B) of the Davis Bacon Act); daily and weekly number of hours worked; deductions made; and actual wages paid. In addition, for Appalachian contracts, the payroll records shall contain a notation indicating whether the employee does, or does not, normally reside in the labor area as defined in Attachment A, (a). Whenever the Secretary of Labor, pursuant to Section IV, (c)2, has found that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1(b)(2)(B) of the

Davis Bacon Act, the Contractor and each subcontractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, that the plan or program has been communicated in writing to the laborers or mechanics affected, and show the cost anticipated or the actual cost incurred in providing benefits. Contractors or subcontractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprentices and trainees, and ratios and wage rates prescribed in the applicable programs.

**3.** Each contractor and subcontractor shall furnish, each week in which any contract work is performed, to the Department's Representative a payroll of wages paid each of its employees (including apprentices, trainees, and helpers, described in Section IV, (d) and (e), and watchmen and guards engaged on work during the preceding weekly payroll period). The payroll submitted shall set out accurately and completely all of the information required to be maintained under (b)2 of this Section V. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal stock number 029-005-0014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime Contractor is responsible for the submission of copies of payrolls by all subcontractors.

**4.** Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his/her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

- that the payroll for the payroll period contains the information required to be maintained under (b)2 of this Section V and that such information is correct and complete;

- that such laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in the Regulations, 29 CFR 3;

- that each laborer or mechanic has been paid not less that the applicable wage rate and fringe benefits or cash equivalent for the classification of worked performed, as specified in the applicable wage determination incorporated into the contract.

**5.** The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by (b)4 of this Section V.

**6.** The falsification of any of the above certifications may subject the Contractor to civil or criminal prosecution under 18 U.S.C. 1001 and 31 U.S.C. 231.

**7.** The Contractor or subcontractor shall make the records required under (b)2 of this Section V available for inspection, copying, or transcription by authorized representatives of the Department, the FHWA, or the DOL, and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Department, the FHWA, the DOL, or all may, after written notice to the Contractor, sponsor, applicant, or owner, take such actions as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

## VI. RECORD OF MATERIALS, SUPPLIES, AND LABOR—

**(a)** On all Federal-aid contracts on the National Highway System, except those which provide solely for the installation of protective devices at railroad grade crossings, those which are constructed on a force account or direct labor basis, highway beautification contracts, and contracts for which the total final construction cost for roadway and bridge is less than $1,000,000 (23 CFR 635) the Contractor shall:

**1.** Become familiar with the list of specific materials and supplies contained in Form FHWA-47, "Statement of Materials and Labor Used by Contractor of Highway Construction Involving Federal Funds," prior to the commencement of work under this contract.

**2.** Maintain a record of the total cost of all materials and supplies purchased for and incorporated in the work, and also of the quantities of those specific materials and supplies listed on Form FHWA-47, and in the units shown on Form FHWA-47.

**3.** Furnish, upon the completion of the contract, to the Department's Representative on Form FHWA-47 together with the data required in (a)2 relative to materials and supplies, a final labor summary of all contract work indicating the total hours worked and the total amount earned.

**(b)** At the prime contractor's option, either a single report covering all contract work or separate reports for the Contractor and for each subcontract shall be submitted.

## VII. SUBLETTING OR ASSIGNING THE CONTRACT—

**(a)** The Contractor shall perform with its own organization contract work amounting to not less than 30% (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the State. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the Contractor's own organization (23 CFR 635).

**1.** "Its own organization" shall be construed to include only workers employed and paid directly by the prime contractor and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor, assignee, or agent of the prime contractor.

**2.** "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid on the contract as a whole and in general are to be limited to minor components of the overall contract.

**3.** The contract amount upon which the requirements set forth in (a) of Section VII is computed includes the cost of material and manufactured products, which are to be purchased or produced by the Contractor under the contract provisions.

**4.** The Contractor shall furnish:

- a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work according to the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and

- such other of its own organizational resources (supervision, management, and engineering services) as the Department's contracting officer determines is necessary to ensure the performance of the contract.

**5.** No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the Department's contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the Contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the Department has ensured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

## VIII. SAFETY: ACCIDENT PREVENTION—

**(a)** In the performance of this contract the Contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the Department's contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

**(b)** It is a condition of this contract, and shall be made a condition of each subcontract, which the Contractor enters into pursuant to this contract, that the Contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, according to Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 333).

**(c)** Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 333).

## IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS—

In order to ensure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, the following notice shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

**NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID HIGHWAY PROJECTS**

18 U.S.C. 1020 reads as follows:

- *"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or*

- *Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or*

- *Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;*

- *Shall be fined not more that $10,000 or imprisoned not more than 5 years or both."*

## X. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT—

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $100,000 or more.)

By submission of this bid or the execution of this contract, or subcontract, as appropriate, the bidder, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

**(a)** That any facility that is or will be utilized in the performance of this contract, unless such contract is exempt under the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Pub.L. 91-604), and under the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Pub.L. 92-500), Executive Order 11738, and regulations in implementation thereof (40 CFR 15) is not listed, on the date of contract award, on the U.S. Environmental Protection Agency (EPA) List of Violating Facilities pursuant to 40 CFR 15.20.

**(b)** That the firm agrees to comply and remain in compliance with all the requirements of Section 114 of the Clean Air Act and Section 308 of the Federal Water Pollution Control Act and all regulations and guidelines listed thereunder.

**(c)** That the firm shall promptly notify the Department of the receipt of any communication from the Director, Office of Federal Activities, EPA, indicating that a facility that is or will be utilized for the contract is under consideration to be listed on the EPA List of Violating Facilities.

**(d)** That the firm agrees to include or cause to be included the requirements of (a) through (d) of this Section X in every nonexempt subcontract, and further agrees to take such action as the government may direct as a means of enforcing such requirements.

## XI. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION—

### (a) Instructions for Certification - Primary Covered Transactions.

(Applicable to all Federal-aid contracts—49 CFR 29.)

**1.** By signing and submitting this proposal, the prospective primary participant is providing the certification set out below.

**2.** The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the Department's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

**3.** The certification in this clause is a material representation of fact upon which reliance was placed when the Department determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the Department may terminate this transaction for cause of default.

**4.** The prospective primary participant shall provide immediate written notice to the Department to whom this proposal is submitted if any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

**5.** The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the Department to which this proposal is submitted for assistance in obtaining a copy of those regulations.

**6.** The prospective primary participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the Department entering into this transaction.

**7.** The prospective primary participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," provided by the Department entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

**8.** A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the nonprocurement portion of the "Lists of Parties Excluded From Federal Procurement or Nonprocurement Programs" (Nonprocurement List) which is compiled by the General Services Administration.

**9.** Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

**10.** Except for transactions authorized under (a)6 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the Department may terminate this transaction for cause or default.

* * * * *

**Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Primary Covered Transactions**

**(a)** The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

**1.** Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

**2.** Have not within a 3-year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

**3.** Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in (a)2 of this certification; and

**4.** Have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

**(b)** Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

**(b) Instructions for Certification - Lower Tier Covered Transactions.**

(Applicable to all subcontracts, purchase orders, and other lower tier transactions of $25,000 or more—49 CFR 29)

**1.** By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

**2.** The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the Department with which this transaction originated may pursue available remedies, including suspension and/or debarment.

**3.** The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

**4.** The terms "covered transaction," "debarred," "suspended," "ineligible," "primary covered transaction," "participant," "person," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

**5.** The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the Department with which this transaction originated.

**6.** The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

**7.** A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

**8.** Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

**9.** Except for transactions authorized under (b)5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the Department with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

**Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions:**

**(a)** The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

**(b)** Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

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**XII. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING—**

(Applicable to all Federal-aid construction contracts and to all related subcontracts that exceed $100,000—49 CFR 20)

**(a)** The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his/her knowledge and belief, that:

**1.** No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

**2.** If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," according to its instructions.

**(b)** This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

**(c)** The prospective participant also agrees by submitting his/her bid or proposal that he/she shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

## ATTACHMENT A—EMPLOYMENT PREFERENCE FOR APPALACHIAN CONTRACTS

(Applicable to Appalachian contracts only.)

**(a)** During the performance of this contract, the Contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

**1.** To the extent that qualified persons regularly residing in the area are not available.

**2.** For the reasonable needs of the Contractor to employ supervisory or specially experienced personnel necessary to ensure an efficient execution of the contract work.

**3.** For the obligation of the Contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (a)3 shall not exceed 20% of the total number of employees employed by the Contractor on the contract work, except as provided in subparagraph (d) below.

**(b)** The Contractor shall place a job order with the State Employment Service indicating

- the classifications of the laborers, mechanics and other employees required to perform the contract work,
- the number of employees required in each classification,
- the date on which he/she estimates such employees will be required, and
- any other pertinent information required by the State Employment Service to complete the job order form.

The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the Contractor in the original job order is substantially modified, he/she shall promptly notify the State Employment Service.

**(c)** The Contractor shall give full consideration to all qualified job applicants referred to him/her by the State Employment Service. The Contractor is not required to grant employment to any job applicants who, in his/her opinion, are not qualified to perform the classification of work required.

**(d)** If, within 1 week following the placing of a job order by the Contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the Contractor, or less than the number requested, the State Employment Service will forward a certificate to the Contractor indicating the unavailability of applicants. Such certificate shall be made a part of the Contractor's permanent project records. Upon receipt of this certificate, the Contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (a)3 above.

**(e)** The Contractor shall include the provisions of Sections (a) through (d) of this Attachment A in every subcontract for work, which is, or reasonably may be, done as on-site work.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 9 (DSP9)

## SPECIAL SUPPLEMENT[1]
## ANTI-POLLUTION MEASURES

### PART I, SECTION A
### PENNSYLVANIA STATUTES

Act Relating to Abandoned Mines, Act of May 7, 1935, 52 Pa. Stat. §§ 809 et seq., as amended.

Act Relating to Black Powder, Act of May 31, 1974, 73 Pa. Stat. §§ 169 et seq., as amended.

Act Relating to Camp Regulation, Act of Nov. 10, 1959, 35 Pa. Stat. §§ 3001 et seq., as amended.

Act Relating to Cave-in or Subsidence of Surface Above Mines, Act of July 2, 1937, 52 Pa. Stat. §§ 1407 et seq., as amended.

Act Relating to Caving-in, Collapse, Subsidence, Act of May 27, 1921, 52 Pa. Stat. §§ 661 et seq., as amended.

Act Relating to Coal Land Improvement, Act of July 19, 1965, 52 Pa. Stat. §§ 30.101 et seq., as amended.

Act Relating to Coal Mine Subsidence Insurance Fund, Act of Aug. 23, 1961, 52 Pa. Stat. §§ 3201 et seq., as amended.

Act Relating to Coal Stripping, Act of June 18, 1941, 52 Pa. Stat. §§ 1471 et seq., as amended.

Act Relating to Coal Under State Lands, Act of June 1, 1933, 52 Pa. Stat. §§ 1501 et seq., as amended.

Act Relating to Control and Drainage of Water from Coal Formations, Act of July 7, 1955, 52 Pa. Stat. §§ 682 et seq., as amended.

Act Relating to Delaware River Pollution, Act of Apr. 19, 1945, 32 Pa. Stat. §§ 815.31 et seq., as amended.

Act Relating to Discharge of Coal into Banks of Streams, Act of June 27, 1913, 52 Pa. Stat. §§ 631 et seq., as amended.

Act Relating to Excavation and Demolition, Act of Dec. 10, 1974, 73 Pa. Stat. §§ 176 et seq., as amended.

Act Relating to Explosives, Act of July 1, 1937, 73 Pa. Stat. §§ 151 et seq., as amended.

Act Relating to Explosives, Act of July 10, 1957, 73 Pa. Stat. §§ 164 et seq., as amended.

Act Relating to Flood Control, Act of Aug. 7, 1936, 32 Pa. Stat. §§ 653 et seq., as amended.

Act Relating to General Safety, Act of May 18, 1937, 43 Pa. Stat. §§ 25-1 et seq., as amended.

Act Relating to Hazardous Materials Transport, Act of June 30, 1984, 75 Pa. C.S.A. §§ 8301 et seq., as amended.

Act Relating to Junkyards along Highways, Act of July 28, 1966, 36 Pa. Stat. §§ 2719.1 et seq., as amended.

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[1] The listed State and Federal statutes and regulations are for informational use. Not all of the statutes and regulations that may be applicable are listed. In addition, new statutes and regulations and amendments to existing statutes and regulations are promulgated at various times and sections of the statutes and regulations are renumbered.

Act Relating to Land Use, Act of Jan. 13, 1966, 16 Pa. Stat. §§ 11941 et seq., as amended.

Act Relating to Maps and Plans, Act of June 15, 1911, 52 Pa. Stat. §§ 823, as amended.

Act Relating to Mine Fires and Subsidence, Act of April 3, 1968, 52 Pa. Stat. §§ 30.201 et seq., as amended.

Act Relating to Mining Safety Zones, Act of Dec. 22, 1959, 52 Pa. Stat. §§ 3101 et seq., as amended.

Act Relating to Noise Pollution, Act of June 2, 1988, 35 Pa. Stat. §§ 4501 et seq., as amended.

Act Relating to Pollution Control Devices, Act of March 4, 1971, 72 Pa. Stat. §§ 7602.1 et seq., as amended.

Act Relating to Pollution From Abandoned Mines, Act of Dec. 15, 1965, 35 Pa. Stat. §§ 760.1 et seq., as amended.

Act Relating to Potomac River Pollution, Act of May 29, 1945, 32 Pa. Stat. §§ 741 et seq., as amended.

Act Relating to Preservation and Acquisition of Land for Open Space Uses, Act of Jan. 19, 1968, 32 Pa. Stat. §§ 5001 et seq., as amended.

Act Relating to Public Eating and Drinking Places, Act of May 23, 1945, 35 Pa. Stat. §§ 655.1 et seq., as amended.

Act Relating to Schuylkill River Pollution, Act of Apr. 19, 1945, 32 Pa. Stat. §§ 815.31 et seq., as amended.

Act Relating to Stream Clearance, Act of June 5, 1947, 32 Pa. Stat. §§ 701 et seq., as amended.

Act Relating to Water Power and Water Supply Permits, Act of June 14, 1923, 32 Pa. Stat. §§ 591 et seq., as amended.

Act Relating to Weather Modification, Act of Jan. 19, 1968, 3 Pa. Stat. §§ 1101 et seq. as amended.

Administrative Code of April 9, 1929, 71 Pa. Stat. §§ 194, 510 et seq., as amended.

Agricultural Liming Material Act of March 17, 1978, 3 Pa. Stat. §§ 132-1 et seq., as amended.

Air Pollution Control Act of Jan. 8, 1960, 35 Pa. Stat. §§ 4001 et seq., as amended.

Anthracite Strip Mining and Conservation Act of June 27, 1947, 52 Pa. Stat. §§ 681.1 et seq., as amended.

The Bituminous Mine Subsidence and Land Conservation Act of Apr. 27, 1966, 52 Pa. Stat. §§ 1406.1 et seq., as amended.

Bluff Recession and Setback Act of May 13, 1980, 32 Pa. Stat. §§ 5201 et seq., as amended.

Brandywine River Valley Compact Act of Sept. 9, 1959, 32 Pa. Stat. §§ 818 et seq., as amended.

Cave Protection Act of Nov. 21, 1990, 32 Pa. Stat. §§ 5601 et seq., as amended.

Chesapeake Bay Commission Agreement, Act of June 25, 1985, 32 Pa. Stat. §§ 820.11 et seq., as amended.

The Clean Streams Law of June 22, 1937, 35 Pa. Stat. §§ 691.1 et seq., as amended.

Coal and Gas Resource Coordination Act of Dec. 18, 1984, 58 Pa. Stat. §§ 501 et seq., as amended.

The Coal Mine Sealing Act of June 30, 1947, 52 Pa. Stat. §§ 28.1 et seq., as amended.

Coal Refuse Disposal Control Act of September 24, 1968, 52 Pa. Stat. §§ 30.51 et seq., as amended.

Conservation and Natural Resources Act of June 28, 1995, 71 Pa. Stat. §§ 1340.101 et seq., as amended.

Conservation District Law, Act of May 15, 1945, 3 Pa. Stat. §§ 849 et seq., as amended.

The Crimes Code, Act of Dec. 6, 1972, 18 Pa. C.S.A. §§ 101 et seq., as amended.

Dam Safety and Encroachments Act of Nov. 26, 1978, 32 Pa. Stat. §§ 693.1 et seq. as amended.

Delaware River Basin Compact, Act of July 7, 1961, 32 Pa. Stat. §§ 815.101 et seq., as amended.

Fish and Boat Code, Act of October 16, 1980, 30 Pa. C.S.A. §§ 101 et seq., as amended.

Flood Plain Management Act of Oct. 4, 1978, section 302 and 402, 32 Pa. Stat. §§ 679 et seq., as amended.

The Game and Wildlife Code, Act of July 8, 1986, 34 Pa. C.S.A. §§ 101 et seq., as amended.

Great Lakes Protection Fund Act of July 6, 1989, 32 Pa. Stat. §§ 817.11 et seq., as amended.

Hazardous Material Emergency Planning and Response Act of Dec. 7, 1990, 35 Pa. Stat. §§ 6022.101 et seq., as amended.

Hazardous Sites Cleanup Act of Oct. 18, 1988, 35 Pa. Stat. §§ 6020.101 et seq., as amended.

Highway Vegetation Control Act of Dec. 20, 1983, 36 Pa. Stat. §§ 2720.1 et seq., as amended.

History Code, Act of May 26, 1988, 37 Pa. C.S.A. §§ 101 et seq., as amended.

Interstate Mining Compact, Act of May 5, 1966, 52 Pa. Stat. §§ 3251 et seq., as amended.

Land Recycling and Environmental Remediation Standards Act of May 19, 1995, 35 Pa. Stat. §§ 6026.101 et seq., as amended.

Land and Water Conservation and Reclamation Act of Jan. 19, 1968, 32 Pa. Stat. §§ 5101 et seq., as amended.

Low-Level Radioactive Waste Disposal Act of February 9, 1988, 35 Pa. Stat. §§ 7130.101 et seq.

Noncoal Surface Mining Conservation and Reclamation Act of Dec. 19, 1984, 52 Pa. Stat. §§ 3301 et seq., as amended.

Noxious Weed Control Law, Act of April 7, 1982, 3 Pa. Stat. §§ 255.1 et seq., as amended.

Nutrient Management Act of May 20, 1993, 3 Pa. Stat. §§ 1701 et seq.

Ohio River Valley Water Sanitation Compact, Act of Apr. 2, 1945, 32 Pa. Stat. §§ 816.1 et seq., as amended.

Oil and Gas Act of Dec. 19, 1984, 58 Pa. Stat. §§ 601.101 et seq., as amended.

Oil and Gas Conservation Law, Act of July 25, 1961, 58 Pa. Stat. §§ 401 et seq., as amended.

Oil Spill Responder Liability Act of June 11, 1992, 35 Pa. Stat. §§ 6023.1 et seq., as amended.

Pennsylvania Anthracite Coal Mine Act of Nov. 10, 1965, 52 Pa. Stat. §§70-101 et seq., as amended.

Pennsylvania Appalachian Trail Act of Apr. 28, 1978, 64 Pa. Stat. §§ 801 et seq., as amended.

Pennsylvania Bituminous Coal Mine Act of July 17, 1961, 52 Pa. Stat. §§ 701-101 et seq., as amended.

Pennsylvania Fertilizer Law of May 29, 1956, 3 Pa. Stat. §§ 68.1 et seq., as amended.

Pennsylvania Occupational Disease Act of June 21, 1939, 77 Pa. Stat. §§ 1201 et seq., as amended.

Pennsylvania Pesticide Control Act of 1973, Act of March 1, 1974, 3 Pa. Stat. §§ 111.21 et seq., as amended.

Pennsylvania Safe Drinking Water Act of May 1, 1984, 35 Pa. Stat §§ 721.1 et seq., as amended.

Pennsylvania Scenic Rivers Act of Dec. 5, 1972, 32 Pa. Stat. §§ 820.21 et seq., as amended.

Pennsylvania Sewage Facilites Act of Jan. 24, 1966, 35 Pa. Stat. §§ 750.1 et seq., as amended.

Pennsylvania Solid Waste Management Act of July 7, 1980, 35 Pa. Stat. §§ 6018.101 et seq., as amended.

Pennsylvania Solid Waste-Resource Recovery Development Act of July 20, 1974, 35 Pa. Stat. §§ 755.1 et seq., as amended.

Pennsylvania Used Oil Recycling Act of Apr. 9, 1982, 58 Pa. Stat. §§ 471 et seq., as amended.

Pennsylvania Workmen's Compensation Act of June 2, 1915, 77 Pa. Stat. §§ 1 et seq., as amended.

Phosphate Detergent Act of July 5, 1989, 35 Pa. Stat. §§ 722.1 et seq., as amended.

Plant Pest Act of Dec. 16, 1992, 3 Pa. Stat. §§ 258.1 et seq.

Plumbing System Lead Ban and Notification Act of July 6, 1989, 35 Pa. Stat. §§ 723.1 et seq., as amended.

Project 70 Land Acquisition and Borrowing Act of June 22, 1964, 72 Pa. Stat. §§ 3946.1 et seq., as amended.

The Public Bathing Law, Act of June 23, 1931, 35 Pa. Stat. §§ 672 et seq., as amended.

Publicly Owned Treatment Works Penalty Law, Act of March 26, 1992, 35 Pa. Stat. §§ 752.1 et seq., as amended.

Radiation Protection Act of July 10, 1984, 35 Pa. Stat. §§ 7110.101 et seq., as amended.

Rails to Trails Act of Dec. 18, 1990, 32 Pa. Stat. §§ 5611 et seq.

Seasonal Farm Labor Act of June 23, 1978, 43 Pa. Stat. §§ 1301.101 et seq., as amended.

Sewage System Cleaner Control Act of May 28, 1992, 35 Pa. Stat. §§ 770.1 et seq., as amended.

Sewage Treatment Plant and Waterworks Operators' Certification Act of Nov. 18, 1968, 63 Pa. Stat. §§ 1004 et seq., as amended.

Site Development Act of May 6, 1968, 73 Pa. Stat. §§ 361 et seq., as amended.

Snowmobile Law, Act of June 17, 1976, 75 Pa. C.S.A. §§ 7701 et seq., as amended.

State Highway Law, Act of June 1, 1945, 36 Pa. Stat. §§ 670-101 et seq., as amended.

Storage Tank and Spill Prevention Act of July 6, 1989, 35 Pa. Stat. §§ 6021.101 et seq., as amended.

Storm Water Management Act of Oct. 4, 1978, 32 Pa. Stat. §§ 680.1 et seq., as amended.

Surface Mining Conservation and Reclamation Act of May 31, 1946, 52 Pa. Stat. §§ 1396.1 et seq., as amended.

Susquehanna River Basin Compact, Act of July 17, 1968, 32 Pa. Stat. §§ 820.1 et seq., as amended.

Vehicle Code, Act of June 17, 1976, 75 Pa. C.S.A. §§ 101 et seq., as amended.

Water Power and Water Supply Act of June 14, 1923, 32 Pa. Stat. § 597, as amended.

Water Well Drillers License Act of May 29, 1956, 32 Pa. Stat. §§ 645.1 et seq., as amended.

Wheeling Creek Watershed Protection and Flood Prevention District Compact, Act of Aug. 2, 1967, 32 Pa. Stat. §§ 819.1 et seq., as amended.

Wild Resource Conservation Act of June 23, 1982, 32 Pa. Stat. §§ 5301 et seq., as amended.

**PART I, SECTION B**
**PENNSYLVANIA REGULATIONS**

Pursuant to the above statutes, regulations are promulgated by State agencies and are published in the Pennsylvania Code (PA. Code). The following are the sections of the PA. Code that are assigned to the following State agencies:

Pennsylvania Department of Environmental Protection—Title 25 of the PA. Code;

Pennsylvania Department of Conservation and Natural Resources—Title 17 of the PA. Code;

Pennsylvania Department of Transportation—Title 67 of the PA. Code;

Pennsylvania Department of Labor and Industry—Title 34 of the PA. Code;

Pennsylvania Department of Agriculture—Title 7 of the PA. Code;

Pennsylvania Historical and Museum Commission—Title 46 of the PA. Code;

Public Utility Commission—Title 52 of the PA. Code;

Pennsylvania Fish and Boat Commission—Title 58, Part II of the PA. Code;

Pennsylvania Game Commission—Title 58, Part III of the PA. Code;

Delaware River Commission—Title 4 of the PA. Code.

**PART II**
**FEDERAL STATUTES AND REGULATIONS**

Abandoned Mine Reclamation Act of 1990, 30 U.S.C.[2] §§ 1231 et seq.

Acid Precipitation Act of 1980, 42 U.S.C. §§ 8901-8905, 8911, 8912.

Act to Prevent Pollution from Ships, 33 U.S.C. §§ 1901-1915, as amended.
40 C.F.R[3]. Part 122

Agricultural Act of 1970, 16 U.S.C. §§ 1501-1510.

Airport and Airway Development Act of 1970, 49 U.S.C. §§ 1701-1703, 1711-1727.

Anadromous Fish Conservation Act, 16 U.S.C. §§ 757a-757g et seq., as amended.

Appalachian Regional Development Act of 1965, 40 app. §1, 2, 101-109, 201-208, 211-214, 221-225, 226, 301-304, 401-405, as amended.

Asbestos Hazard Emergency Response Act of 1986 (See Toxic Substances Control Act, Sections 201-214 (15 U.S.C. §§ 2641-2654)).

Atomic Energy Act of 1954, 42 U.S.C. §§ 2011 et seq., as amended.
10 C.F.R. Parts 1, 2, 4, 10, 15, 19, 20, 21, 25, 26, 30-36, 39, 40, 50, 52-55, 60-62, 70-76, 95, 100, 110, 150, 171, 605, 707, 710, 730, 760, 768, 770-777, 779, 782, 785-791, 799, 810, 820, 862, 960, 962, 1004, 1009, 1017, 1046, 1047
32 C.F.R. Part 518
37 C.F.R. Part 5
40 C.F.R. Parts 23, 191, 192
48 C.F.R. Parts 901, 910, 912, 917, 919-933, 935-937, 942-945, 949-952

Aviation Safety and Noise Abatement Act of 1979, 49 App. U.S.C. §§ 47501 et seq., as amended.

Bankhead-Jones Farm Tenant Act, 7 U.S.C. §§ 1000 et seq., as amended.

Clean Air Act 42 U.S.C. §§ 7401 et seq., as amended.
40 C.F.R. Parts 2, 6, 9, 15, 22, 23, 30, 31, 34, 35, 40, 42, 45, 46, 50, 51, 52, 55, 56, 57, 58, 60, 61, 62, 63, 65, 67, 69, 70, 72-74, 76-78, 80, 81, 82, 85, 86, 87, 88, 89, 90, 93, 122-124, 144, 145, 233, 270, 271, 450, 600, 613, 771, 1500, 1503-1507
10 C.F.R. Parts 101, 201
14 C.F.R. Parts 34, 1216
18 C.F.R. Parts 101, 201
19 C.F.R. Part 12
23 C.F.R. Part 450
29 C.F.R. Part 24

Clean Vessel Act of 1992, Pub. L. 102-587, Title V, 106 Stat. 5086.

Coastal Wetlands Planning, Protection and Restoration Act, 16 U.S.C. §§ 3951-3956

Coastal Zone Management Act of 1972, 16 U.S.C. §§ 1451-1464, as amended.

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[2] U.S.C. refers to the United States Code.

[3] Pursuant to the above statutes, regulations are promulgated by the Federal agencies and are published in the Code of Federal Regulations (C.F.R.).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, 42 U.S.C. §§ 9601 et seq., as amended.
40 C.F.R. Parts 9, 51, 279, 300

Department of Transportation Act, 49 U.S.C. §§ 503, 20302, 20304, 20305, 20701-20703, 20901, 20902, 21302, as amended.

Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. §§ 11001 et seq., as amended.
40 C.F.R. Part 17

Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544, as amended.

Energy Supply and Environmental Coordination Act of 1974, 15 U.S.C. §§ 791-798, as amended.
10 C.F.R. Parts 303, 305
18 C.F.R. Parts 157, 270, 271, 275, 290, 292

Environmental Quality Improvement Act of 1970, 42 U.S.C. §§ 4371-4375, as amended.
40 C.F.R. Parts 1500-1508, 1515

Federal Agriculture Improvement and Reform Act of 1996, 7 U.S.C. §§ 1932, 2204f, 3224, 3319d, 2279c, 1101, 7201-7491.

Federal Aid in Fish Restoration Act (of 1950), 16 U.S.C. §§ 777 et seq., as amended.
43 C.F.R. Part 17
*Note: also known as "Fish Restoration and Management Projects Act" and the "Dingell-Johnson Sport Fish Restoration Act".*

Federal Facility Compliance Act of 1992, Pub. L. 102-386, 106 Stat. 1505.

Federal-Aid Highway Act, 23 U.S.C.A. §§101 et seq., as amended.

Federal Aid in Wildlife Restoration Act, 16 U.S.C. §§ 669, 669a-669i, as amended.

Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. §§ 136-136y, as amended.
19 C.F.R. Part 12
29 C.F.R. Part 1440
40 C.F.R. Parts 2, 16, 23, 30-32, 34, 35, 152, 153, 155-158, 160, 162, 166, 168, 169, 170-173

Federal Land Policy and Management Act of 1976, 43 U.S.C. §§ 1701-1785, as amended.
7 C.F.R. Part 1
36 C.F.R. Parts 222, 242, 251, 254
43 C.F.R. Parts 37, 1600, 1820, 1860, 1880, 2090, 2200, 2210, 2300, 2540, 2710, 2740, 2800, 2810, 2910, 2920, 3000, 3110, 3120, 3130, 3140, 3150, 3160, 3200, 3400, 3410, 3420, 3430, 3450, 3460, 3470, 3500, 3510, 3520, 3530, 3540, 3550, 3560, 3570, 3580, 3590, 3730, 3800, 3830, 4100, 4200, 4300, 4700, 5000, 8000, 8200, 8300, 8340, 8350, 8360, 8370, 8560, 9180, 9210, 9260

Federal Power Act, 16 U.S.C. §§ 791a et seq., as amended.
10 C.F.R. Part 205
18 C.F.R. Parts 1b, 2, 3, 4, 6, 8, 9, 11, 12, 16, 20, 24, 32-35, 45, 46, 101, 116, 125, 131, 141, 154, 225, 290, 292, 294, 375, 381, 385
33 C.F.R. Parts 208, 209, 221, 222

Federal Water Project Recreation Act, 16 U.S.C. §§ 460*l*-5, 460*l*-12 to -21, 662, as amended.
36 C.F.R. Part 297
43 C.F.R. Part 17

Fish and Game Sanctuary Act, 16 U.S.C. §§ 694-694b

Fish and Wildlife Act of 1956, 15 U.S.C. §§ 713c-3; 16 U.C.S.A. §§ 742a-742j, as amended.
30 C.F.R. Part 773
33 C.F.R. Part 209
43 C.F.R. Parts 17, 21
50 C.F.R. Parts 25-33, 70, 71

16 U.S.C. §§ 742a – 742j
50 C.F.R. Parts 10, 19, 20, 36, 217, 250, 251, 260

Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661-666c, as amended.
30 C.F.R. Part 773
33 C.F.R. Part 209
43 C.F.R. Parts 17, 21
50 C.F.R. Parts 25-33, 70, 71

Flood Control, 33 U.S.C. §§ 701 et seq., as amended
7 C.F.R. Parts 622, 624, 654
33 C.F.R. Parts 208, 222

Fishermen's Protective Act of 1967 (Pelly Amendment), 22 U.S.C. §§ 1971 – 1980, as amended.
22 C.F.R. Part 33
50 C.F.R. Part 611

Food Quality Protection Act of 1996, 7 U.S.C. §§ 136-136y.

Forest and Rangeland Renewable Resources Planning Act of 1974, 16 U.S.C. §§ 1600-1614, as amended.

Forest Ecosystems and Atmospheric Pollution Control Act of 1988, 16 U.S.C. § 1641.

Game and Wildlife Act, 16 U.S.C. §§ 141b, 715d-1, 715d-3, 715e, 715e-1, 715k-1, 715s, 718b – 718e, as amended.

Geothermal Energy Research, Development, and Demonstration Act of 1974 (GERDDA), 30 U.S.C. §§ 1101, 1102, 1121-1126, 1141-1144, 1161-1164, as amended.

Global Climate Protection Act of 1987, 15 U.S.C. § 2901, as amended.

Hazardous Material Transportation Act, 46 U.S.C. § 170; 49 U.S.C. §§ 103, 104, 106; 49 App. §§ 1471, 1472, 1801-1819, as amended.

Hazardous Substance Response Revenue Act of 1980, 26 U.S.C. §§ 4611, 4612, 4661, 4662.

Hazardous Materials Transportation Authorization Act of 1994, 49 U.S.C. §§ 5101-5127, as amended.

Hazardous Materials Transportation Uniform Safety Act of 1990, 49 App. §§ 1801-1819, 2509.

Intermodal Surface Transportation Efficiency Act of 1991 (see Transportation Equity Act of the 21st Century (TEA 21)).

Lacey Act Amendments of 1981 16 U.S.C. §§ 3371 et seq., as amended.

Land and Water Conservation Fund Act of 1965, 16 U.S.C. §§460d, 460l-4 – 460l-11, as amended.

Lead-Based Paint Exposure Reduction Act, 15 U.S.C. §§ 2681-2692.

Lead-Based Paint Poisoning Prevention Act, 42 U.S.C. §§ 4801, 4811, 4821, 4822, 4831, 4841-4843, as amended.

Lead Contamination Control Act of 1988, 42 U.S.C. §§ 201 note, 247b-1, 300j-4, 300j-21 to –26.

Low-Level Radioactive Waste Policy Amendments Act of 1985, 42 U.S.C. §§ 2021b-2021j, as amended.

Magnuson-Stevens Fisheries Conservation and Management Act, 16 U.S.C. §§ 1801 et seq., as amended.

Marine Protection, Research and Sanctuaries Act of 1972, 33 U.S.C. §§ 1401-1445, as amended.

Migratory Bird Conservation Act, 16 U.S.C. §§ 715-715r, as amended.

Migratory Bird Treaty Act, 16 U.S.C. §§703-708, 709a, 710, 711.

Mining and Mineral Resources Research Institutes Act, 30 U.S.C. 1221-1230.

Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. §§ 475, 528, 531, as amended.

National Climate Program Act, 15 U.S.C. §§ 2901-2908, as amended.

National Coastal Monitoring Act, 33 U.S.C. §§ 2801-2805.

National Contaminated Sediment Assessment and Management Act, 33 U.S.C. §§ 1271.

National Emission Standards Act, 42 U.S.C. §§7521-7550, as amended.

National Energy Conservation Policy Act, Pub. L. 95-619, 92 Stat. 306, as amended.

National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended.

National Invasive Species Act of 1996, 16 U.S.C. §§ 4701-4751.

National Ocean Pollution Planning Act of 1978, 33 U.S.C. §§ 1701-1709, as amended.

National Trails System Act, 16 U.S.C. §§ 1241-1249, as amended.

National Wildlife Refuge System Administration Act of 1966, 16 U.S.C. §§ 668dd, 668ee, 715s, as amended.

Noise Control Act of 1972, 42 U.S.C. §§ 4901-4918.

Nuclear Waste Policy Act of 1982, 42 U.S.C. §§ 10101-10270, as amended.

Oil Pollution Act, 1961, 33 U.S.C. §§ 1001-1015, as amended.

Oil Pollution Act of 1990, 33 U.S.C. §§ 2701-2761, as amended.

Organotin Antifouling Paint Control Act of 1988, 33 U.S.C. §§ 2401-2410, as amended.

Outer Continental Shelf Lands Act Amendments of 1978, 43 U.S.C. §§ 1801-1866, as amended.

Pollution Prevention Act of 1990, 42 U.S.C. §§ 13101-13109.

Public Health Service Act, 42 U.S.C. §§ 300f-300j-11.

Radon Gas and Indoor Air Quality Research Act of 1986, 42 U.S.C. § 7401.

Recreation Use of Conservation Areas Act, 16 U.S.C. § 560k.

Refuse Act of 1899, 33 U.S.C. §§ 401 et seq., as amended.

Renewable Resources extension Act of 1978, 16 U.S.C. §§ 1671-1676 as amended.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. §§ 6901-6991.

River and Harbor Act of 1958, 33 U.S.C. §610 as amended.

Safe Drinking Water Act (see Public Health Service Act Sections 1401-1451 (42 U.S.C. §§ 300f - 300j-11, as amended)).

Shore Protection Act of 1988, 33 U.S.C. §§2601-2609, 2622, 2623.

Soil and Water Resources Conservation Act of 1977, 16 U.S.C. §§ 2001-2009, as amended.

Soil Conservation and Domestic Allotment Act, 16 U.S.C. §§ 590a et seq., as amended.

Solid Waste Disposal Act, 42 U.S.C. §§ 6901 et seq., as amended.

Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. §§ 1201 et seq., as amended.

Toxic Substances Control Act, 15 U.S.C. §§ 2601-2692, as amended.

Transportation Equity Act of the 21st Century (TEA 21), Pub. L. 105-178, 112 Stat. 107, as amended.

Travel and Transportation Reform Act of 1998, 5 U.S.C. §§ 5701 et seq.

United States Public Vessel Medical Waste Anti-Dumping Act of 1988, 33 U.S.C. §§ 2501-2504.

Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. §§ 7901 - 7942.

Water Bank Act, 16 U.S.C. §§ 1301-1311, as amended.

Water Pollution Prevention and Control Act, 33 U.S.C. §§ 1251 et seq., as amended.
*Commonly known as the Clean Water Act.*

14 C.F.R. Part 1204

40 C.F.R. Parts 7, 9, 15, 30 – 32, 34, 104, 108, 110, 113, 116, 117, 122, 124, 125, 129, 130, 131 – 133, 136, 144, 145, 270, 271, 401, 403, 405 – 413, 415, 417 – 429, 436, 440, 443, 446, 447, 454, 457-460, 501, 503

Water Resources Research Act of 1984, 42 U.S.C. §§ 10301-10309.

Water Resources Development Act of 1996, 33 U.S.C. §§ 467-467j.

Watershed Protection and Flood Prevention Act, 16 U.S.C. §§ 1001-1008; 33 U.S.C. § 701b.

Wetlands Loan Act, 16 U.S.C. §§ 715k-3-715k-5, as amended.

Wilderness Act, 16 U.S.C. §§ 1331-1336, as amended.

Wood Residue Utilization Act of 1980, 16 U.S.C. §§ 1681-1687.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 10 (DSP10)

## NONDISCRIMINATION/SEXUAL HARASSMENT CLAUSE

During the term of the Contract, the Contractor agrees as follows:

**(a)** In the hiring of any employees for the manufacture of supplies, performance of work, or any other activity required under the Contract or any subcontract, the Contractor, subcontractor or any person acting on behalf of the Contractor or subcontractor shall not by reason of gender, race, creed, or color discriminate against any citizen of this State who is qualified and available to perform the work to which the employment relates.

**(b)** Neither the Contractor nor any subcontractor nor any person on their behalf shall in any manner discriminate against or intimidate any employee involved in the manufacture of supplies, the performance of work or any other activity required under the Contract on account of gender, race, creed, or color.

**(c)** The Contractor and any subcontractors shall establish and maintain a written sexual harassment policy and shall inform their employees of the policy. The policy must contain a notice that sexual harassment will not be tolerated and employees who practice it will be disciplined.

**(d)** The Contractor shall not discriminate by reason of gender, race, creed, or color against any subcontractor or supplier who is qualified to perform the work to which the contract relates.

**(e)** The Contractor and each subcontractor shall furnish all necessary employment documents and records to and permit access to its books, records, and accounts by the contracting officer and the Department of General Services', Bureau of Contract Administration and Business Development (DGS, BCABD) for purposes of investigation to ascertain compliance with the provisions of this Nondiscrimination/Sexual Harassment Clause. If the Contractor or any subcontractor does not possess documents or records reflecting the necessary information requested, it shall furnish such information on reporting forms supplied by the contracting officer or the BCABD.

**(f)** The Contractor shall include the provisions of this Nondiscrimination/Sexual Harassment Clause in every subcontract so that such provisions will be binding upon each subcontractor.

**(g)** The State may cancel or terminate the Contract, and all money due or to become due under the Contract may be forfeited for a violation of the terms and conditions of this Nondiscrimination/Sexual Harassment Clause. In addition, the agency may proceed with debarment or suspension and may place the Contractor in the Contractor Responsibility File.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 11 (DSP11)

## CONTRACTOR INTEGRITY PROVISIONS

**(a)** For purposes of this clause only, the words "confidential information," "consent," "contractor," "financial interest," and "gratuity" shall have the following definitions.

1. **Confidential information** means information that is not public knowledge, or available to the public on request, disclosure of which would give an unfair, unethical, or illegal advantage to another desiring to contract with the State.

2. **Consent** means written permission signed by a duly authorized officer or employee of the State, provided that where the material facts have been disclosed, in writing, by prequalification, bid, proposal, or contractual terms, the State shall be deemed to have consented by virtue of execution of this agreement.

3. **Contractor** means the individual or entity that has entered into the Contract with the State, including directors, officers, partners, managers, key employees and owners of more than a 5% interest.

4. **Financial interest** means:

   **4.a** Ownership of more than a 5% interest in any business; or

   **4.b** Holding a position as an officer, director, trustee, partner, employee, or the like, or holding any position of management.

5. **Gratuity** means any payment of more than nominal monetary value in the form of cash, travel, entertainment, gifts, meals, lodging, loans, subscriptions, advances, deposits of money, services, employment, or contracts of any kind.

**(b)** The Contractor shall maintain the highest standards of integrity in the performance of the Contract and shall take no action in violation of State or federal laws, regulations, or other requirements that govern contracting with the State.

**(c)** The Contractor shall not disclose to others any confidential information gained by virtue of the Contract.

**(d)** The Contractor shall not, in connection with this or any other agreement with the State, directly, or indirectly, offer, confer, or agree to confer any pecuniary benefit on anyone as consideration for the decision, opinion, recommendation, vote, other exercise of discretion, or violation of a known legal duty by any officer or employee of the State.

**(e)** The Contractor shall not, in connection with this or any other agreement with the State, directly or indirectly, offer, give, or agree or promise to give to anyone any gratuity for the benefit of or at the direction or request of any officer or employee of the State.

**(f)** Except with the consent of the State, neither the Contractor nor anyone in privity with him or her shall accept or agree to accept from, or give or agree to give to, any person, any gratuity from any person in connection with the performance of work under the Contract except as provided therein.

**(g)** Except with the consent of the State, the Contractor shall not have a financial interest in any other contractor, subcontractor, or supplier providing services, labor, or material on this project.

**(h)** The Contractor, upon being informed that any violation of these provisions has occurred or may occur, shall immediately notify the State in writing.

**(i)** The Contractor, by execution of the Contract and by the submission of any bills or invoices for payment pursuant thereto, certifies, and represents that he or she has not violated any of these provisions.

**(j)** The Contractor, upon the inquiry or request of the Inspector General of the State or any of that official's agents or representatives, shall provide, or if appropriate, make promptly available for inspection or copying, any information of any type or form deemed relevant by the Inspector General to the Contractor's integrity or responsibility, as those terms are defined by the State's statutes, regulations, or management directives. Such information may include, but shall not be limited to, the Contractor's business or financial records, documents, or files of any type or form that refer to or concern the Contract. Such information shall be retained by the Contractor for a period of 3 years beyond the termination of the Contract unless otherwise provided by law.

**(k)** For violation of any of the above provisions, the State may terminate this and any other agreement with the Contractor, claim liquidated damages in an amount equal to the value of anything received in breach of these provisions, claim damages for all expenses incurred in obtaining another Contractor to complete performance hereunder, and debar and suspend the Contractor from doing business with the State. These rights and remedies are cumulative, and the use or nonuse of any one shall not preclude the use of all or any other. These rights and remedies are in addition to those the State may have under law, statute, regulation, or otherwise.

# APPENDIX C
# DESIGNATED SPECIAL PROVISION 12 (DSP12)

# EXECUTIVE ORDER 11246
# (WITH APPENDIX A AND B)

**NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY**

**(a)** The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

**(b)** The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

| Timetables | *Goals for minority participation in each trade | *Goals for female participation in each trade |
|---|---|---|
| | SEE ATTACHED APPENDIX B | SEE ATTACHED APPENDIX A |

* The hours of minority and female employment is to be reported monthly, by the Contractor, on Standard Form 257 (to be supplied by PENNDOT) and expressed in percentage terms of the Contractor's aggregate workhours for each trade (craft).

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from contractor to contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

**(c)** The Contractor shall provide written notification to PENNDOT within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

**(d)** As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is indicated in the special provision entitled "E.E.O. Covered Area". Goals for females are listed in Appendix A, and for minorities includes the areas listed in Appendix B.

**STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246)**

**(a)** As used in these Specifications:

**1.** "Covered area" means the geographical area described in the solicitation from which this contract resulted;

**2.** "Director" means Director, Office of Federal Contract Compliance Programs, U.S. Department of Labor (DOL), or any person to whom the Director delegates authority;

**3.** "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941; and

**4.** "Minority" includes:

- Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
- Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
- Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
- American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

**(b)** Whenever the Contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these Specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitation from which this contract resulted.

**(c)** If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. DOL in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be according to that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

**(d)** The Contractor shall implement the specific affirmative action standards provided in paragraphs (g)1 through (g)16 of these Specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in geographical areas where they do not have a Federal or Federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

**(e)** Neither the provisions of any collective bargaining agreement, nor the failures by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Constructor's obligations under these Specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

**(f)** In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. DOL.

**(g)** The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these Specifications shall be based upon its efforts to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

**1.** Ensure and maintain a working environment free of harassment, intimidation, and coercion of all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

**2.** Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available and maintain a record of the organizations' responses.

**3.** Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions the Contractor may have taken.

**4.** Provide immediate written notification to PENNDOT when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

**5.** Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the DOL. The Contractor shall provide notice of these programs to the sources compiled under (g)2 above.

**6.** Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

**7.** Review, at least annually, the company's EEO policy and affirmative action obligations under these Specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with on-site supervisory personnel such as superintendents, general foreman, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

**8.** Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other contractors and subcontractors with whom the Contractor does or anticipates doing business.

**9.** Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than 1 month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

**10.** Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of the Contractor's workforce.

**11.** Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

**12.** Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc.; such opportunities.

**13.** Ensure that seniority practices, job classifications, work assignments, and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these Specifications are being carried out.

**14.** Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to ensure privacy between the sexes.

**15.** Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

**16.** Conduct a review, at least annually of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

**(h)** Contractors are encouraged to participate in voluntary associations that assist in fulfilling one or more of their affirmative action obligations ((g)1 through (g)16). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the Contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under (g)1 through (g)16 or these Specifications provided that the Contractor actively participates in the group, makes every effort to ensure that the group has a positive impact on the employment of minorities and women in the Industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female

workforce and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

**(i)** A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

**(j)** The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

**(k)** The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

**(l)** The Contractor shall carry out such sanctions and penalties for violation of these Specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these Specifications and Executive Order 11246, as amended.

**(m)** The Contractor, in fulfilling its obligations under these Specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph (g) of these Specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, regulations, or these Specifications, PENNDOT shall proceed according to 41 CFR 60-4.8.

**(n)** The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

**(o)** Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area resident (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

## APPENDIX A

The following goals and timetables for female utilization shall be included in all Federal and federally assisted construction contracts and subcontracts in excess of $10,000. The goals are applicable to the Contractor's aggregate on-site construction workforce (public and private) whether or not part of that workforce is performing work on a Federal or federally assisted construction contract or subcontract.

AREA COVERED: See special provision entitled "E.E.O. Covered Area".

### Goals and Timetables

| Timetable | Goals (Percent) |
|---|---|
| From April 1, 1980, until further notice | 6.9 |

Goals are applicable in each construction craft employed by the Contractor in the covered area.

## APPENDIX B

Until further notice, the following goals for minority utilization in each construction craft shall be included in Federal or federally assisted construction contracts and subcontracts in excess of $10,000 to be performed in the respective covered areas in the State. The goals are applicable to the Contractor's aggregate on-site construction workforce regardless of whether that workforce is performing work on a Federal, federally assisted, or non-federally related construction contract or subcontract. This Appendix B shall be used jointly with Appendix A.

**Economic Areas**

| Area | Goal (Percent) |
|---|---|
| Scranton – Wilkes Barre, PA | |
| SMSA Counties: | |
| Northeast Pennsylvania | 0.6 |
| PA Lackawanna; PA Luzerne; PA Monroe | |
| Non-SMSA Counties | 0.5 |
| PA Columbia; PA Wayne; PA Wyoming | |
| Williamsport, PA | |
| SMSA Counties: | |
| Williamsport, PA | 1.0 |
| PA Lycoming | |
| Non-SMSA Counties | 0.7 |
| PA Cameron; PA Centre; PA Clearfield; PA Clinton; PA Elk; PA Jefferson; PA Montour; PA Northumberland; PA Snyder; PA Sullivan; PA Union | |
| Erie, PA | |
| SMSA Counties: | |
| Erie, PA | 2.8 |
| PA Erie | |
| Non-SMSA Counties | 1.8 |
| PA Clarion; PA Crawford; PA Forest; PA Venango; PA Warren | |
| Pittsburgh, PA | |
| SMSA Counties | |
| Altoona, PA | 1.0 |
| PA Blair | |
| Johnstown, PA | 1.3 |
| PA Cambria; PA Somerset | |
| Pittsburgh, PA | 6.3 |
| PA Beaver; PA Washington; PA Westmoreland; PA Allegheny | |
| Non-SMSA Counties | 4.8 |
| PA Armstrong; PA Bedford PA Butler; PA Fayette; PA Greene; PA Indiana; MD Allegheny; MD Garrett; WV Mineral | |
| Harrisburg – York – Lancaster, PA | |
| SMSA Counties: | |
| Harrisburg, PA | 6.2 |
| PA Cumberland; PA Dauphin; PA Perry | |
| Lancaster, PA | 2.0 |
| PA Lancaster | |
| York, PA | 2.2 |
| PA Adams; PA York | |
| Non-SMSA Counties | 3.1 |
| PA Franklin; PA Fulton; PA Huntingdon; PA Juniata; PA Lebanon; PA Mifflin | |

**Economic Areas**

| Area | Goal (Percent) |
|---|---|
| Philadelphia, PA | |
| SMSA Counties: | |
| Allentown-Bethlehem-Easton, PA-NJ | 1.6 |
| PA Carbon; PA Lehigh; PA Northampton; NJ Warren | |
| Philadelphia, PA-NJ | 17.3 |
| PA Bucks; PA Chester; PA Delaware; PA Montgomery; PA Philadelphia; NJ Burlington; NJ Camden; NJ Gloucester | |
| Reading, PA | 2.5 |
| PA Berks | |
| Non-SMSA Counties | 14.5 |
| PA Schuylkill; DE Kent; DE Sussex; NJ Cape May | |
| Buffalo, NY | |
| Non-SMSA Counties | 6.3 |
| PA McKean; PA Potter; NY Allegany; NY Cattaraugus; NY Chautauqua; NY Wyoming | |
| Binghamton-Elmira, NY | |
| SMSA Counties: | |
| Binghamton, NY-PA | 1.1 |
| PA Susquehanna; NY Broome; NY Tioga | |
| Non-SMSA Counties | 1.2 |
| PA Bradford; PA Tioga; NY Chenango; NY Delaware; NY Otsego; NY Schuyler; NY Tompkins | |
| New York, NY | |
| Non-SMSA Counties | 17.0 |
| PA Pike; NJ Hunterdon; NJ Ocean; NJ Sussex; NY Orange; NY Sullivan; NY Ulster | |
| Ohio | |
| Non-SMSA Counties | 6.7 |
| PA Lawrence; PA Mercer; OH Columbiana; OH Cleveland | |

# APPENDIX D
# GUIDELINES FOR ITEM NUMBER IDENDIFICATION AND DATA

## SECTION 309 AND SECTION 409
## (ENGLISH AND METRIC)

**I. SECTION 309 (ENGLISH)—**

| ITEM NUMBER | UNIT MEAS | OPER CODE | WK CL CODES | DBE CODES | ITEM DESCRIPTION |
|---|---|---|---|---|---|
| 0309-0001 | sy | 04 | E | | Superpave Asphalt Mixture Design, HMA Base Course, PG 58-28, <0.3 Million ESALS, 37.5 mm Mix, 4 1/2" Depth |

There are over 260 base course standard construction items in this section. Table A provides information on the numbering and description of these items. The following guidelines will assist users in determining complete item identification and data:

**ITEM NUMBER:** Each item has a unique eight-digit number. The first four digits are 0309-. The last four digits (i.e., the 5th, 6th, 7th, and 8th digits) are found in Table A, keyed to the item descriptions.

**UNIT MEASUREMENT:** Units are square yards, except item numbers that end in 15 or 37. These items are measured by the ton. For example, item number 0309-01<u>15</u> is measured in tons, while 0309-02<u>08</u> is measured in square yards.

**DESCRIPTION:** The complete description for each item begins with <u>Superpave Asphalt Mixture Design, HMA Base Course</u>. The rest of the item description is found in the 6th, 7th, and 8th digit columns in Table A.

**TABLE A**
**Superpave Base Courses (English)**

| 1st through 4th Digits | 5th Digit | | 6th Digit | | 7th and 8th Digits | |
|---|---|---|---|---|---|---|
| **Section** | **Course Type** | | **PG-Binder & Design Life ESALs,** | | **Mixture Size & Depth** | |
| 0309- | 0 | HMA Base Course, | 0 | PG 58-28, < 0.3 Million ESALs, | 01 | 37.5 mm Mix, 4 1/2" Depth |
| | | | 1 | PG 58-28, 0.3 to < 3 Million ESALs, | 02 | 37.5 mm Mix, 5" Depth |
| | | | 2 | PG 58-28, 3 to < 10 Million ESALs, | 03 | 37.5 mm Mix, 5 1/2" Depth |
| | | | 3 | PG 64-22, < 0.3 Million ESALs, | 04 | 37.5 mm Mix, 6" Depth |
| | | | 4 | PG 64-22, 0.3 to < 3 Million ESALs, | 05 | 37.5 mm Mix, 6 1/2" Depth |
| | | | 5 | PG 64-22, 3 to < 10 Million ESALs, | 06 | 37.5 mm Mix, 7" Depth |
| | | | 6 | PG 64-22, 10 to < 30 Million ESALs, | 07 | 37.5 mm Mix, 7 1/2" Depth |
| | | | 7 | PG 64-22, >/= 30 Million ESALs, | 08 | 37.5 mm Mix, 8" Depth |
| | | | | | 09 | 37.5 mm Mix, 8 1/2" Depth |
| | | | | | 10 | 37.5 mm Mix, 9" Depth |
| | | | | | 11 | 37.5 mm Mix, 9 1/2" Depth |
| | | | | | 12 | 37.5 mm Mix, 10" Depth |
| | | | | | 13 | 37.5 mm Mix, 11" Depth |
| | | | | | 14 | 37.5 mm Mix, 12" Depth |
| | | | | | 15 | 37.5 mm Mix |
| | | | | | 20 | 25.0 mm Mix, 3" Depth |
| | | | | | 21 | 25.0 mm Mix, 3 1/2" Depth |
| | | | | | 22 | 25.0 mm Mix, 4" Depth |
| | | | | | 23 | 25.0 mm Mix, 4 1/2" Depth |
| | | | | | 24 | 25.0 mm Mix, 5" Depth |
| | | | | | 25 | 25.0 mm Mix, 5 1/2" Depth |
| | | | | | 26 | 25.0 mm Mix, 6" Depth |
| | | | | | 27 | 25.0 mm Mix, 6 1/2" Depth |
| | | | | | 28 | 25.0 mm Mix, 7" Depth |
| | | | | | 29 | 25.0 mm Mix, 7 1/2" Depth |
| | | | | | 30 | 25.0 mm Mix, 8" Depth |
| | | | | | 31 | 25.0 mm Mix, 8 1/2" Depth |
| | | | | | 32 | 25.0 mm Mix, 9" Depth |
| | | | | | 33 | 25.0 mm Mixt, 9 1/2" Depth |
| | | | | | 34 | 25.0 mm Mix, 10" Depth |
| | | | | | 35 | 25.0 mm Mix, 11" Depth |
| | | | | | 36 | 25.0 mm Mix, 12" Depth |
| | | | | | 37 | 25.0 mm Mix |

**II. SECTION 309 (METRIC)—**

| ITEM NUMBER | UNIT MEAS | OPER CODE | WK CL CODES | DBE CODES | ITEM DESCRIPTION |
|---|---|---|---|---|---|
| 2309-0001 | $m^2$ | 04 | E | | Superpave Asphalt Mixture Design, HMA Base Course, PG 58-28, <0.3 Million ESALS, 37.5 mm Mix, 110 mm Depth |

There are over 260 base course standard construction items in this section. Table B provides information on the numbering and description of these items. The following guidelines will assist users in determining complete item identification and data:

**ITEM NUMBER:** Each item has a unique eight-digit number. The first four digits are 2309-. The last four digits (i.e., the 5th, 6th, 7th, and 8th digits) are found in Table B, keyed to the item descriptions.

**UNIT MEASUREMENT:** Units are square yards, except item numbers that end in 15 or 37. These items are measured by the tonne. For example, item number 2309-01<u>15</u> is measured in tonnes, while 2309-02<u>08</u> is measured in square meters.

**DESCRIPTION:** The complete description for each item begins with <u>Superpave Asphalt Mixture Design, HMA Base Course</u>. The rest of the item description is found in the 6th, 7th, and 8th digit columns in Table B.

**TABLE B**
**Superpave Base Courses (Metric)**

| 1st through 4th Digits | 5th Digit | | 6th Digit | | 7th and 8th Digits | |
|---|---|---|---|---|---|---|
| **Section** | **Course Type** | | **PG-Binder & Design Life ESALs,** | | **Mixture Size & Depth** | |
| 2309- | 0 | HMA Base Course, | 0 | PG 58-28, < 0.3 Million ESALs, | 01 | 37.5 mm Mix, 110 mm Depth |
| | | | 1 | PG 58-28, 0.3 to < 3 Million ESALs, | 02 | 37.5 mm Mix, 130 mm Depth |
| | | | 2 | PG 58-28, 3 to < 10 Million ESALs, | 03 | 37.5 mm Mix, 140 mm Depth |
| | | | 3 | PG 64-22, < 0.3 Million ESALs, | 04 | 37.5 mm Mix, 150 mm Depth |
| | | | 4 | PG 64-22, 0.3 to < 3 Million ESALs, | 05 | 37.5 mm Mix, 170 mm Depth |
| | | | 5 | PG 64-22, 3 to < 10 Million ESALs, | 06 | 37.5 mm Mix, 180 mm Depth |
| | | | 6 | PG 64-22, 10 to < 30 Million ESALs, | 07 | 37.5 mm Mix, 190 mm Depth |
| | | | 7 | PG 64-22, >/= 30 Million ESALs, | 08 | 37.5 mm Mix, 200 mm Depth |
| | | | | | 09 | 37.5 mm Mix, 220 mm Depth |
| | | | | | 10 | 37.5 mm Mix, 230 mm Depth |
| | | | | | 11 | 37.5 mm Mix, 240 mm Depth |
| | | | | | 12 | 37.5 mm Mix, 250 mm Depth |
| | | | | | 13 | 37.5 mm Mix, 280 mm Depth |
| | | | | | 14 | 37.5 mm Mix, 300 mm Depth |
| | | | | | 15 | 37.5 mm Mix |
| | | | | | 20 | 25.0 mm Mix, 80 mm Depth |
| | | | | | 21 | 25.0 mm Mix, 90 mm Depth |
| | | | | | 22 | 25.0 mm Mix, 100 mm Depth |
| | | | | | 23 | 25.0 mm Mix, 110 mm Depth |
| | | | | | 24 | 25.0 mm Mix, 130 mm Depth |
| | | | | | 25 | 25.0 mm Mix, 140 mm Depth |
| | | | | | 26 | 25.0 mm Mix, 150 mm Depth |
| | | | | | 27 | 25.0 mm Mix, 170 mm Depth |
| | | | | | 28 | 25.0 mm Mix, 180 mm Depth |
| | | | | | 29 | 25.0 mm Mix, 190 mm Depth |
| | | | | | 30 | 25.0 mm Mix, 200 mm Depth |
| | | | | | 31 | 25.0 mm Mix, 220 mm Depth |
| | | | | | 32 | 25.0 mm Mix, 230 mm Depth |
| | | | | | 33 | 25.0 mm Mix, 240 mm Depth |
| | | | | | 34 | 25.0 mm Mix, 250 mm Depth |
| | | | | | 35 | 25.0 mm Mix, 280 mm Depth |
| | | | | | 36 | 25.0 mm Mix, 300 mm Depth |
| | | | | | 37 | 25.0 mm Mix |

**III. SECTION 409 (ENGLISH)—**

| ITEM NUMBER | UNIT MEAS | OPER CODE | WK CL CODES | DBE CODES | ITEM DESCRIPTION |
|---|---|---|---|---|---|
| 0409-0001 | sy | 04 | F | | Superpave Asphalt Mixture Design, HMA Wearing Course, PG 58-28, <0.3 Million ESALS, 19.0 mm Mix, 2" Depth, SRL-E |

There are over 1400 wearing course and 200 binder course standard construction items in this section. The following tables provide information on the numbering and description of these items; Table C for the wearing course and Table D for the binder course. The following guidelines will assist users in determining complete item identification and data:

**ITEM NUMBER:** Each item has a unique eight-digit number. The first four digits are 0409-. The last four digits (i.e., the 5th, 6th, 7th, and 8th digits) are found on the Tables below (Table C for wearing courses and Table D for binder courses), keyed to the item's descriptions.

**UNIT MEASUREMENT:** Units are square yards, except wearing course item numbers whose next to last digit (7th digit) is 3, 6, or 9 and binder course item numbers that end in 30 or 70 (7th and 8th digits). These items are measured by the ton. For example, wearing course item number 0409-00<u>3</u>1 is measured by the ton, as is binder course item number 0409-61<u>70.</u> While 0409-0041 and 0409-6200 are measured in square yards.

**DESCRIPTION:** The complete description for each item begins with <u>Superpave Asphalt Mixture Design, HMA Wearing (or Binder) Course</u>. The remainder of the item description is found in the 5th, 6th, 7th, and 8th digit columns in Tables C and D to follow.

**TABLE C**
**Superpave Wearing Courses (English)**

| 1st through 4th digits | 5th Digit | | 6th Digit | | 7th Digit | | 8th Digit | |
|---|---|---|---|---|---|---|---|---|
| **Section** | **Course Type** | | **PG-Binder & Design Life ESALs** | | **Mixture Size & Depth** | | **SRL** | |
| 0409- | 0 | HMA Wearing Course, | 0 | PG 58-28, < 0.3 Million ESALs, | 0 | 19.0 mm Mix, 2" Depth, | 0 | N/A (Binder Courses) |
| | 1 | HMA Wearing Course (Leveling),* | 1 | PG 58-28, 0.3 to < 3 Million ESALs, | 1 | 19.0 mm Mix, 2 1/2" Depth, | 1 | SRL-E |
| | 2 | HMA Wearing Course (Scratch), ** | 2 | PG 58-28, 3 to < 10 Million ESALs, | 2 | 19.0 mm Mix, 3" Depth, | 2 | SRL-H |
| | 3 | HMA Wearing Course (Manual Patching), *** | 3 | PG 64-22, < 0.3 Million ESALs, | 3 | 19.0 mm Mix | 3 | SRL-G |
| | 4 | HMA Wearing Course, RPS | 4 | PG 64-22, 0.3 to < 3 Million ESALs, | 4 | 12.5 mm Mix, 1 1/2" Depth, | 4 | SRL-M |
| | | | 5 | PG 64-22, 3 to < 10 Million ESALs, | 5 | 12.5 mm Mix, 2" Depth, | 5 | SRL-L |
| | | | 6 | PG 64-22, 10 to < 30 Million ESALs, | 6 | 12.5 mm Mix | | |
| | | | 7 | PG 76-22, 10 to < 30 Million ESALs, | 7 | 9.5 mm Mix, 1" Depth, | | |
| | | | 8 | PG 76-22, >/= 30 Million ESALs, | 8 | 9.5 mm Mix, 1 1/2" Depth, | | |
| | | | | | 9 | 9.5 mm Mix | | |

* For HMA Wearing Course (Leveling) and HMA Wearing Course (Leveling), RPS, use only the numbers 3, 6, and 9 for the 7th digit (measured in ton only).

** For HMA Wearing Course (Scratch), use only the numbers 0 to 6 for the 6th digit (PG 58-28 and PG 64-22 only), and use only the number 9 for the 7th digit (9.5 mm mixture, ton only).

*** For HMA Wearing Course (Manual Patching), use only the numbers 0 to 6 for the 6th digit (PG 58-28 and PG 64-22 only), and use only the numbers 3, 6, and 9 for the 7th digit (measured in ton only).

| ITEM NUMBER | UNIT MEAS | OPER CODE | WK CL CODES | DBE CODES | ITEM DESCRIPTION |
|---|---|---|---|---|---|
| 0409-6000 | sy | 04 | F | | Superpave Asphalt Mixture Design, HMA Binder Course, PG 58-28, <0.3 Million ESALS, 25.0 mm Mix, 3" Depth |

**Table D**
**Superpave Binder Courses (English)**

| 1st through 4th Digits | 5th Digit | | 6th Digit | | 7th and 8th Digits - Binder Courses | |
|---|---|---|---|---|---|---|
| **Section** | **Course Type** | | **PG-Binder & Design Life ESALs** | | **Mixture Size & Depth** | |
| 0409- | 6 | HMA Binder Course, | 0 | PG 58-28, < 0.3 Million ESALs, | 00 | 25.0 mm Mix, 3" Depth |
| | 7 | HMA Binder Course (Leveling), * | 1 | PG 58-28, 0.3 to < 3 Million ESALs, | 10 | 25.0 mm Mix, 3 1/2" Depth |
| | 8 | HMA Binder Course, RPS | 2 | PG 58-28, 3 to < 10 Million ESALs, | 20 | 25.0 mm Mix, 4" Depth |
| | | | 3 | PG 64-22, < 0.3 Million ESALs, | 30 | 25.0 mm Mix |
| | | | 4 | PG 64-22, 0.3 to < 3 Million ESALs, | 40 | 19.0 mm Mix, 2" Depth |
| | | | 5 | PG 64-22, 3 to < 10 Million ESALs, | 50 | 19.0 mm Mix, 2 1/2" Depth |
| | | | 6 | PG 64-22, 10 to < 30 Million ESALs, | 60 | 19.0 mm Mix, 3" Depth |
| | | | 7 | PG 76-22, 10 to < 30 Million ESALs, | 70 | 19.0 mm Mix |
| | | | 8 | PG 76-22, >/=30 Million ESALs, | | |

* For HMA Binder Course (Leveling) and HMA Binder Course (Leveling), RPS, use only the numbers 30 and 70 for the 7th and 8th digits (measured in ton only).

**IV. SECTION 409 (METRIC)—**

| ITEM NUMBER | UNIT MEAS | OPER CODE | WK CL CODES | DBE CODES | ITEM DESCRIPTION |
|---|---|---|---|---|---|
| 2409-0001 | $m^2$ | 04 | F | | Superpave Asphalt Mixture Design, HMA Wearing Course, PG 58-28, <0.3 Million ESALS, 19.0 mm Mix, 50 mm Depth, SRL-E |

There are over 1400 wearing course and 200 binder course standard construction items in this section. The following tables provide information on the numbering and description of these items; Table E for the wearing course and Table F for the binder course. The following guidelines will assist users in determining complete item identification and data:

**ITEM NUMBER:** Each item has a unique eight-digit number. The first four digits are 2409-. The last four digits (i.e., the 5th, 6th, 7th, and 8th digits) are found on the Tables below (Table E for wearing courses and Table F for binder courses), keyed to the item's descriptions.

**UNIT MEASUREMENT:** Units are square meters, except wearing course item numbers whose next to last digit (7th digit) is 3, 6, or 9 and binder course item numbers that end in 30 or 70 (7th and 8th digits). These items are measured by the tonne. For example, wearing course item number 2409-0031 is measured by the tonne, as is binder course item number 2409-6170. While 2409-0041 and 2409-6200 are measured in square meters.

**DESCRIPTION:** The complete description for each item begins with Superpave Asphalt Mixture Design, HMA Wearing (or Binder) Course. The remainder of the item description is found in the 5th, 6th, 7th, and 8th digit columns in Tables E and F to follow.

**TABLE E**
**Superpave Wearing Courses (Metric)**

| 1st through 4th digits | 5th Digit | | 6th Digit | | 7th Digit | | 8th Digit | |
|---|---|---|---|---|---|---|---|---|
| **Section** | **Course Type** | | **PG-Binder & Design Life ESALs** | | **Mixture Size & Depth** | | **SRL** | |
| 2409- | 0 | HMA Wearing Course, | 0 | PG 58-28, < 0.3 Million ESALs, | 0 | 19.0 mm Mix, 50 mm Depth, | 0 | N/A (Binder Courses) |
| | 1 | HMA Wearing Course (Leveling),* | 1 | PG 58-28, 0.3 to < 3 Million ESALs, | 1 | 19.0 mm Mix, 60 mm Depth, | 1 | SRL-E |
| | 2 | HMA Wearing Course (Scratch), ** | 2 | PG 58-28, 3 to < 10 Million ESALs, | 2 | 19.0 mm Mix, 80 mm Depth, | 2 | SRL-H |
| | 3 | HMA Wearing Course (Manual Patching), *** | 3 | PG 64-22, < 0.3 Million ESALs, | 3 | 19.0 mm Mix | 3 | SRL-G |
| | 4 | HMA Wearing Course, RPS | 4 | PG 64-22, 0.3 to < 3 Million ESALs, | 4 | 12.5 mm Mix, 40 mm Depth, | 4 | SRL-M |
| | | | 5 | PG 64-22, 3 to < 10 Million ESALs, | 5 | 12.5 mm Mix, 50 mm Depth, | 5 | SRL-L |
| | | | 6 | PG 64-22, 10 to < 30 Million ESALs, | 6 | 12.5 mm Mix | | |
| | | | 7 | PG 76-22, 10 to < 30 Million ESALs, | 7 | 9.5 mm Mix, 30 mm Depth, | | |
| | | | 8 | PG 76-22, >/= 30 Million ESALs, | 8 | 9.5 mm Mix, 40 mm Depth, | | |
| | | | | | 9 | 9.5 mm Mix | | |

* For HMA Wearing Course (Leveling) and HMA Wearing Course (Leveling), RPS, use only the numbers 3, 6, and 9 for the 7th digit (measured in tonne only).

** For HMA Wearing Course (Scratch), use only the numbers 0 to 6 for the 6th digit (PG 58-28 and PG 64-22 only), and use only the number 9 for the 7th digit (9.5 mm mixture, tonne only).

*** For HMA Wearing Course (Manual Patching), use only the numbers 0 to 6 for the 6th digit (PG 58-28 and PG 64-22 only), and use only the numbers 3, 6, and 9 for the 7th digit (measured in tonne only).

| ITEM NUMBER | UNIT MEAS | OPER CODE | WK CL CODES | DBE CODES | ITEM DESCRIPTION |
|---|---|---|---|---|---|
| 2409-6000 | $m^2$ | 04 | F | | Superpave Asphalt Mixture Design, HMA Binder Course, PG 58-28, <0.3 Million ESALS, 25.0 mm Mix, 80 mm Depth |

**Table F**
**Superpave Binder Courses (Metric)**

| 1st through 4th Digits | 5th Digit | | 6th Digit | | 7th and 8th Digits - Binder Courses | |
|---|---|---|---|---|---|---|
| **Section** | **Course Type** | | **PG-Binder & Design Life ESALs** | | **Mixture Size & Depth** | |
| 2409- | 6 | HMA Binder Course, | 0 | PG 58-28, < 0.3 Million ESALs, | 00 | 25.0 mm Mix, 80 mm Depth |
| | 7 | HMA Binder Course (Leveling), * | 1 | PG 58-28, 0.3 to < 3 Million ESALs, | 10 | 25.0 mm Mix, 90 mm Depth |
| | 8 | HMA Binder Course, RPS | 2 | PG 58-28, 3 to < 10 Million ESALs, | 20 | 25.0 mm Mix, 100 mm Depth |
| | | | 3 | PG 64-22, < 0.3 Million ESALs, | 30 | 25.0 mm Mix |
| | | | 4 | PG 64-22, 0.3 to < 3 Million ESALs, | 40 | 19.0 mm Mix, 50 mm Depth |
| | | | 5 | PG 64-22, 3 to < 10 Million ESALs, | 50 | 19.0 mm Mix, 60 mm Depth |
| | | | 6 | PG 64-22, 10 to < 30 Million ESALs, | 60 | 19.0 mm Mix, 80 mm Depth |
| | | | 7 | PG 76-22, 10 to < 30 Million ESALs, | 70 | 19.0 mm Mix |
| | | | 8 | PG 76-22, >/=30 Million ESALs, | | |

* For HMA Binder Course (Leveling) and HMA Binder Course (Leveling), RPS, use only the numbers 30 and 70 for the 7th and 8th digits (measured in tonne only).

| *Item* | *Section* |
|---|---|
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| Metric | Appendix A |
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| Abrasives, Cleaning Steel | 1070.3(c)6 |
| Absolute Refusal, Pile-Driving to | 1005.3(b)4 |
| Abutment, Protective Coating | 1019.2(b) |
| Abutting Joints, Fabricated Structural Steel | 1105.03(q) |
| Acceptance | |
| Bar Mat Design | 709.2(c) |
| Bituminous Concrete | |
| Base Course | 305.2(f) |
| | 305.3(j) |
| Cement Concrete | 704.1(d) |
| Pavements (RPS) | 506.3(v) |
| Certificate | 110.08(b) |
| Concrete | |
| Block, Precast | 713.2(c) |
| Median Barrier | 623.3(f) |
| Geomembrane | 736.1(c) |
| Geotextiles | 735.1(c) |
| Joint Sealing Material | 705.4(h) |
| Material | 106.03 |
| Plans (RPS) | 106.03(a)3 |
| Plant, | |
| Precast Concrete Products | 714.4 |
| Prestressed Concrete | |
| Bridge Beam | 1107.03(a)4 |
| Plates, Metal Culverts | 603.2(a)3 |
| Ride | 516.3(p) |
| Samples, Plant-Mix | |
| Conventional Mixture | 401.2(f)3.b |
| | 401.3(j)4.c |
| Superpave Mixture | 409.2(h)2.b |
| | 409.3(j)4.c |
| Testing, Cement Concrete | 704.1(d)4 |
| Traffic Signal Materials | 950.2(a) |
| Waterstops (PVC) | 705.5(c)2.c |
| Work | 105.01(c) |
| Accessibility of Fire Hydrants | 107.24 |
| Accommodation, Traffic | 900 |
| Act 247 | 107.27(c) |
| Additional | |
| Traffic Control Signs | 901.4(b) |
| Warning Lights | 901.4(b) |
| Work, Payment | 110.03(b) |
| Adhesive | |
| Exterior Use | 1112.01(b)3, |
| | 1112.02(b) |
| Joint Seal and Lubricant, Bridges | 1008.2(a) |
| Lubricant, Preformed | |
| Neoprene Compression Seals and Strip Seals | 705.4(d)1.b |
| Snowplowable Raised Pavement Markers | 966.2(b) |
| Timber | |
| Members, Glulam | 1112.01(b)3, |
| | 1112.02(b) |
| Structures, Glulam Fabrication | 1031.2(b) |
| Adjustable Extensions, Existing Inlets, Manholes, or Utility Boxes | 606.3(b) |
| Adjusted Payment | 106.03(a)3.c |
| Bituminous Materials | 110.04 |
| Diamond Grinding of Concrete Pavement | 514.4 |
| HMA Courses, Plant-Mixed | |
| Conventional Mixture | 401.4(a) |
| Superpave Mixture | 409.4(a) |
| Inspector's Field Office and Inspection Facilities | 609 |
| Low Strength Cement Concrete | 110.10 |
| Microcomputer | 688.4(a) |
| Plain Cement Concrete Pavements (RPS) | 506.4(a) |
| Portland Cement Concrete Overlay | 524.4(c) |
| Reinforced Cement Concrete Pavements (RPS) | 506.4(a) |
| Adjustment, Grade, Existing Inlets, Manholes, or Utility Boxes | 606 |
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| Admixtures, | |
| Air Entraining | 711.3(d) |
| Cement Concrete | 704.1(e)4, |
| | 711.3 |
| Latex Emulsion | 1042.2(e) |
| Affidavit, Anti-Collusion | 102.06(e) |
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| Aggregate | 703 |
| Bituminous Base Course | 320 |
| Cement | |
| Base Course | 321 |
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| Coarse | 703.2 |
| Control | 106.05(c) |
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| Gabions | 626.2(a) |
| Handling | 106.06(b) |
| Lightweight | 703.2(a)6 |
| Pipe Underdrain | 610.2(b) |
| Potentially Reactive | 704.1(g) |
| Prefabricated Pavement Base Drain | 610.2(b) |
| Production Testing | 703.1(b) |
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| *Item* | *Section* |
|---|---|
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| Pulverized | 804.2(a)1 |
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| Bridge Beams | 1107.03(d)5.b |
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| Fasteners | 1050.3(c)7.c.1 |
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| Panels | 678.2(e) |
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| Structures | 1001.3(f) |
| Setting, Steel Bridge | 1050.3(c)4.d.2 |
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| Superstructure | 1050.3(c)4.d |
| Structural Steel, | |
| Fabricated | 1105.02(c)2 |
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| Material, Pavement Patching | 516.2(k) |
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| Anchorage, Steel Bridge | 1050.3(c)4 |
| Anchorages, | |
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| Anchoring Devices, Erosion Control | 806.2(d) |
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| Reinforcement | 1002.2(b) |
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| Anti-Theft Sign Hardware | 1103.11(m) |
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| Markings | 961.3 |
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| Steel | 1092.3(c), 1092.3(e)3 |
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| Markings | 960.3(b) |
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| Drain | 623.2(a)3 |
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| Arches | |
| Metal Plate | 603.3(b)2 |
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| Arm Mount Luminaire | |
| (Cobra Head) | 1101.06(b) |
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| Compression Dam | 1021 |
| Arrow Panel | 901.4(b) |
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| *Item* | *Section* |
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**B**

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| Sidewalks, Cement Concrete | 676.3(g) |
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| Mats, Refinforcement Steel | 709.2 |
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| *Item* | *Section* |
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| Devices, Post-Tensioning | 1108.02(c) |
| Pads, Plain and Laminated | |
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| Sill Caps, Timber Structures | 1031.3(c)3 |
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**SUBJECT:**

Initial Edition
PENNDOT Publication 408/2007
Specifications (Metric & English)
Year 2007 Edition

**INFORMATION AND SPECIAL INSTRUCTIONS:**

**Applicability:** This Transmittal Letter and its attachment constitutes the Initial Edition of PENNDOT Specifications, Publication 408/2007. Pub 408/2007 is new and complete in its entirety, and is effective on projects let after April 2, 2007.

**Contents of PUB 408/2007.** Pub 408/2007 contains measurement standards in both Metric and English. Furthermore, it contains Designated Special Provisions and information on how users may gain access through the ECMS Website specifics of all Standard Special Provisions (SSPs) and Master Construction Items to Pub 408/2007.

**Change Format:** All subsequent changes to Pub 408/2007 will be made using a "new page" format. To relate changes and conditions that are in effect each bid proposal will contain a SSP named: "GOVERNING SPECIFICATIONS AND APPLICABLE DESIGNATED SPECIAL PROVISIONS". This SSP exists in both CMS and ECMS formats. It will specify the Initial Edition or Numbered Change of the Pub 408, the Measurement Standard, levels/goals, and the Designated Special Provisions that apply to the particular project.

**Availability:** Pub 408/2007 is available in four versions: Hardcopy, Hardcopy with a subscription to semiannual changes, Internet, and CD-ROM. All users may access this Publication and its Changes free of charge on the PENNDOT Website at www.dot.state.pa.us, at either "Doing Business With PENNDOT/Construction Specifications" or at "General Information/Publications".

**Web and CD-ROM Content:** The Internet versions of PUB 408 contain previous Editions, Changes, and their revisions in their entirety, beginning with Pub 408/94 (English).

**CONTENTS AND INSTRUCTIONS:**

On the occasion of subsequent Changes to this Publication found here or attached will be:

1. **A List of Changes.** A list delineating the portions or sections of Pub 408/2007 and their page numbers that have been added, deleted, or otherwise revised subsequent to the issue of the Initial Edition or Numbered Changes to it will be found here, within the context of a future Transmittal Letter.

2. **Index of Changes.** The Index of Changes will catalogue all changes made to Pub 408/2007 since its Initial issue. This Index currently reflects no changes. Change 1 will be issued/posted on or about October 1, 2007, with an effective date of April 2, 2008. This Index will be attached to the Transmittal Letter in all Pub 408/2007 versions.

3. **New Pages.** This attachment is made available to Hardcopy subscription holders only. It contains the new pages to Pub 408/2007 since its Initial Issue or subsequent Numbered Change. Once posted, Hardcopy versions will become current as of the latest change.

   **Note:** New pages issued with a Change will have the notation "Change No. N" beneath the page number in the bottom center of the page. Pages unaffected by the Change, but reissued due to association with their double sided revised counterparts will have an indication they are being "Reissued" beneath the page number in the bottom center of the page.

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# INDEX OF CHANGES TO PUBLICATION 408/2007

**General:** The Index of Changes has been created to assist Pub 408/2007 users in determining the specifics of semiannual changes that have been made since the release of the Initial Edition. Internet and CD-ROM users of this publication may electronically access the specifics of all Changes, which includes where revisions have been made and why. The Index below contains this information. As an attachment to this Index, for Hardcopy subscription holders only, will be copies of all "new pages" associated with a specific Numbered Change.

**The Change Process:** Changes to Pub 408/2007 will be issued biannually. ***Numbered Changes*** will consist of a Transmittal Letter with instructions for posting of revisions, an updated version of this Index, and the "new pages" containing/constituting the revisions. These "new pages" will be available only to hardcopy subscribers. All ***Numbered Changes*** will also be filed electronically in sequential order on the PENNDOT Website and in the CD-ROM version of the publication. ***Numbered Changes*** will be incorporated into the Pub 408/2007 and filed under the ***Change Letters and Indices*** portion of the Publication. A subscription is necessary to update the hardcopy versions of Pub 408/2007. Hardcopy users must physically post the new pages provided. However, this process of posting has been completed prior to release or distribution of the Internet and CD-ROM versions of Pub 408/2007.

**The Researching of Revisions.** It is critical to many users of Pub 408 to be able to determine the point in time revisions were made and what specifically the changes were. This is particularly important from a contractual perspective when researching specifications that were applicable to projects previously awarded. To assist in this process users should refer to the Change Index that follows. If revisions have been made, users can then refer to the specifics found in the Initial Edition or subsequent Numbered Change.

**The Historical Index.** Found in the Change Index below is a listing of all changes made to Pub 408/2007 since the release of the Initial Edition.

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