100% SUBMISSION

SPECIAL PROVISIONS

SOMERVILLE – MEDFORD - STONEHAM

I-93 Rapid Bridge Replacement

Highway and Bridges

August 17, 2011

ITEM 106.871 SHORING SUPERSTRUCTURE

The work under this item shall consist of shoring the existing bridge superstructures to facilitate modifications to the existing beam seats prior to the weekend shutdown.

Materials

Materials to be used by the Contractor for shoring need not be new but shall be in good condition and the material properties shall be as stated in the design computations.

Design

All temporary shoring systems shall be designed by a Professional Engineer registered in Massachusetts. The design of the shoring systems shall be in accordance with the Allowable Stress Design Method of the AASHTO Design Standard Specifications for Highway Bridges 17th Edition 2002 unless accepted by the Engineer.

High Strength Bolts

All high strength bolts to be used for any shoring or jacking systems shall be new. High strength bolts shall not be reused.

ITEM 113.11 SUPERSTRUCTURE DEMOLITION OF BRIDGE NO. M12025; M12027; M12028; M12029; M12030; M12036; M12039

The work under this item shall conform to the relevant provisions of Section 112 of the Specifications, and the following:

Description

The work under this Item includes the removal and proper disposal of existing superstructures including wearing surface, coping and median barriers, the reinforced concrete deck, steel stringers or beams, endposts and selected demolition along the wingwalls.

Construction Method

Demolition and work involving painted steel shall conform to the General Requirements for Demolition and Work Involving Painted Steel and the requirements of Section 961 of the Specifications.

Existing materials to be removed and disposed of under this Item include, but are not limited to, the following:

1. The existing wearing surface and membrane waterproofing.
2. Existing reinforced concrete in the deck.
3. Existing end diaphragm concrete encasements.
4. All existing reinforced concrete designated to be removed for modifications to the abutment and backwall, wingwalls and pier beam seats.
5. Existing structural steel.
6. Abandoned electrical and telephone components, including conduits.
7. Existing fascia and median barrier

The Contractor shall take care not to damage any concrete to remain. Any items required to be retained as part of the permanent structure which are damaged or otherwise made unsatisfactory for continued use by the Contractor's operations, shall be repaired or replaced at the Contractor's expense, as directed by the Engineer.

The work under this Item also includes sawcuts, if required, at all limits of concrete excavation. Sawcuts shall be provided to a depth of ½" where practical to provide a neat edge.

The Contractor shall make adequate provisions, including the erection of a temporary protective shielding, for the protection of any waterway or roadway from debris and personnel from damage and injury due to excavation operations and debris removal.

The Contractor shall thoroughly clean the bridge seats of all debris and other deleterious material.

All materials removed under Item 113.11 shall become the property of the Contractor and shall be removed from the job site and properly disposed of, unless such materials are designated to be reused in the proposed construction.

The Contractor shall prepare and submit a plan indicating his/her proposed demolition procedures and methods to be used including equipment, tools, devices, crane capacity and location, schedule of operations, methods of utility protection, etc., to the Engineer for approval. The requirements for equipment and all procedures utilized shall be in conformance with the intent of Subsection 960.61D, Erection, of the Standard Specifications for Highways and Bridges. The demolition procedures and any necessary calculations and drawings shall be stamped by a Professional Engineer registered in the Commonwealth of Massachusetts certifying that all existing structural members are suitably braced and supported throughout the demolition process. In determining the stresses to which the retained structure will be subjected, all loading combinations including traffic and the Contractor's equipment at each construction stage shall be

considered. The method of determining stresses shall conform to the latest AASHTO Standard Specifications for Highway Bridges. Work under this Item may not commence until the Engineer has given written approval.

ITEM 127.12 REINFORCED CONCRETE EXCAVATION FOR REPAIRS

The work shall conform to the relevant provisions of Section 120 and the following:

Description
The work to be done under this Item, at the direction of the Engineer, is limited to areas of concrete deteriorated on the abutments, wingwalls, pier columns and pier caps of the bridges covered under this contract. The work shall consist of the removal and proper disposal of all deteriorated concrete found near the bridge seats as described above of all bridges in this contract. The edges of excavated areas shall be cut to neat lines by saw cutting or other method approved by the Engineer.

Construction Methods

General
Existing deteriorated concrete shall be removed to the limits of sound concrete as directed by the Engineer. If no reinforcement is present, deteriorated concrete shall be removed to sound concrete. If reinforcement is present, enough concrete shall be removed to provide a minimum of 1" clearance around bars to provide sufficient clearance for placement of repair concrete.

The Contractor shall take all measures necessary to protect pedestrian or vehicular traffic from construction operations. No debris, tools or incidental equipment of any kind will be permitted to fall into the waterway or where vehicular or pedestrian traffic exists. Any material that accidentally falls into such areas shall be removed immediately.

All materials removed under this item shall be removed from the job site and properly disposed of. The Contractor will not be paid for the removal of any concrete beyond the limits described under this item and approved by the Engineer.

Removal of Deteriorated Concrete
The lateral limits of each area to be repaired will be marked by the Contractor and subsequently approved by the Engineer. The outlines of each such area shall be cut to a depth of ½" with an approved power-saw capable of making straight cuts. In the event that reinforcing steel is encountered within the outer ½" depth during sawing operations, the depth of sawcut shall immediately be adjusted to a shallower depth so as not to damage the steel bars. If so directed by the Engineer, sawcutting shall again be carried down to the ½" depth at other locations of repair provided reinforcing steel is not again encountered. Where over-breakage occurs resulting in a featheredge, the featheredge shall be squared up to a vertical edge in an approved manner. Where sawing is impractical, the area shall be outlined by chisel or other approved means.

The removal of deteriorated concrete under this item shall be accomplished by pneumatic hammers. Pneumatic hammers heavier than the nominal 25 pounds mass (Chicago Pneumatic

No. 111 or equal) shall not be used, unless approved by the Engineer. Also, no use of pneumatic or power driven chipping hammers over the nominal 15 pounds will be permitted to remove any concrete from below any reinforcing bar. Fillets at inside corners of intersecting limit lines shall be carefully removed. After completion of concrete removal, the sides of the patch shall be vertical down to the bottom of the patch.

Pneumatic tools shall not be placed in direct contact with reinforcing steel. Any sound reinforcing steel damaged during the concrete removal operations shall be repaired or replaced at the Contractor's expense and as directed by the Engineer. New steel shall be attached beside existing steel with a minimum splice length as indicated on the Plans, or as directed by the Engineer. The concrete shall be removed to depths as described in paragraph titled General.

Surface Preparation
Surface preparation should be in accordance with the requirements set forth in Item 905.

The Contractor shall take all steps necessary to ensure that pedestrian and vehicular traffic is protected from harm at all times.

All excavated materials shall become the property of the Contractor and shall be removed from the job site.

Method of Measurement and Basis of Payment

Work will be measured and paid for at the contract CY price of $1,000.00 per CY for each CY removed and accepted by the Resident Engineer.

ITEM 127.121 REINFORCED CONCRETE EXCAVATION FOR REMOVAL OF EXISTING CONCRETE PEDESTALS

The work shall conform to the relevant provisions of Section 120 and the following:

Description
The work to be done under this Item is limited to removal of existing beam seat pedestals and seats which interfere with the new bearing locations on of the bridges covered under this contract.

Construction Methods

General
The Contractor shall take all measures necessary to protect pedestrian or vehicular traffic from construction operations. No debris, tools or incidental equipment of any kind will be permitted to fall into the waterway or where vehicular or pedestrian traffic exists. Any material that accidentally falls into such areas shall be removed immediately.

The removal of deteriorated concrete under this item shall be accomplished by pneumatic hammers. Pneumatic hammers heavier than the nominal 25 pounds mass (Chicago Pneumatic No. 111 or equal) shall not be used, unless approved by the Engineer. Also, no use of pneumatic or power driven chipping hammers over the nominal 15 pounds will be permitted to remove any concrete from below any reinforcing bar.

Pneumatic tools shall not be placed in direct contact with reinforcing steel. Any sound reinforcing steel damaged during the concrete removal operations shall be repaired or replaced at the Contractor's expense and as directed by the Engineer.

Surface Preparation

Remaining exposed reinforcement and anchor bolts that are not being encased by any proposed concrete shall be repaired by excavating down and cutting off the steel a minimum of 2" below the top face of existing concrete. The excavated hole shall be patched using cementitious mortar.

The top surface of the concrete to remain beyond the proposed work shall be made trowel smooth by application of a thin layer of cementitious mortar for patching.

ITEM 130. PAVEMENT MILLING

Section 130 – Pavement Milling entirely replaces Subsection 120.66, Bituminous Concrete Excavation by Cold Planer, of the Standard Specifications for Highways and Bridges.

Description

130.20 General.

This work shall consist of milling and removal of existing Hot Mix Asphalt (HMA) pavement courses from the project by the Contractor. Milling shall be performed in conformity with the limits, line, grade, and typical cross-section shown on the plans. Unless otherwise specified, the milled material shall become the property of the Contractor.

Construction Procedures

130.60 General.

The Contractor shall provide satisfactory Quality Control (QC) of the milling operation as further outlined in Subsection 130.67. The specific QC procedures to be implemented shall be identified in the Contractor's Quality Control Plan for Hot Mix Asphalt, submitted in accordance with the requirements of Section 450. The Contractor shall present and discuss in sufficient detail the Quality Control information and activities related to milling at the Construction Quality Meeting required under Section 450.

130.61 Milling Equipment Requirements.

The milling equipment shall be self-propelled with sufficient power, traction, and stability to remove the existing HMA pavement to the specified depth and cross-slope. The milling machine shall be capable of operating at a minimum speed of 10 feet (3 meters) per minute, designed so that the operator can at all times observe the milling operation without leaving the control area of the machine, and equipped with the following:

(a) A built in automatic grade control system that can control the longitudinal profile and the transverse cross-slope to produce the specified results.
(b) Longitudinal controls capable of operating from any longitudinal grade reference, including string line, 30 foot (10 meter) ski minimum, 30 foot (10 meter) mobile string line minimum, or a matching shoe.
(c) The transverse controls shall have an automatic system for controlling cross-slope at a given rate.
(d) Cutting heads able to provide a minimum 6 foot (2 meter) cutting width and a 0 to 4 inch (0 to 100 mm) deep cut in one pass. The teeth on the revolving cutting drum must be continually maintained and shall be replaced as warranted to provide a uniform pavement texture.
(e) An integral pickup and conveying device to immediately remove milled material from the roadway and discharge the millings into a truck, all in one operation.
(f) All necessary safety devices such as reflectors, headlights, taillights, flashing lights and back up signals so as to operate safely in both day and night.
(g) A means of effectively limiting the amount of dust escaping from the milling and removal operation in accordance with local, State, and Federal air pollution control laws and regulations.

When milling smaller areas or areas where it is impractical to use the above described equipment, the use of a smaller or lesser-equipped milling machine may be permitted when approved by the Engineer.

130.62 Sweeper Equipment Requirements.

The Contractor shall provide a mechanical sweeper equipped with a water tank, spray assembly to control dust, a pick-up broom, a dual gutter broom, and a dirt hopper. The sweeper shall be capable of removing millings and loose debris from the textured pavement.

130.63 Milling Operations.

The milling operations shall be scheduled to minimize the duration and placement of traffic on the milled surface. The Engineer may allow the Contractor to adjust the limits of milling production when necessary.

The existing pavement shall be removed to the average depth shown on the plans, in a manner that will restore the pavement surface to a uniform cross-section and longitudinal profile. The longitudinal profile of the milled surface shall be established using a 30 foot

(10 meter) mobile ski, mobile string line, or stationary string line. The cross-slope of the milled surface shall be established by a second sensing device or by an automatic cross-slope control mechanism. The Contractor will be responsible for providing all grades necessary to remove the material to the proper line, grade, and typical cross-section shown on the plans. The requirement for automatic grade or slope controls may be waived by the Engineer in locations warranted by the situation, including intersections and closely confined areas.

The Engineer may adjust the average milling depth specified on the plans by ± 3/4" (± 20mm) during each milling pass at no additional payment to minimize delamination of the underlying pavement course or to otherwise provide a more stable surface. If delamination or exposure of concrete occurs when milling a HMA pavement course from an underlying Portland Cement Concrete (PCC) pavement, the Contractor shall cease milling operations and consult the Engineer to determine whether to reduce the milling depth or make other adjustments to the operation.

130.64 Protection of Inlets and Utilities.

Throughout the milling operation, protection shall be provided around existing catch basin inlets, manholes, utility valve boxes, and any similar structures. Any damage to such structures as a result of the milling operation is the Contractor's responsibility and shall be repaired at the Contractor's expense. To prevent the infiltration of milled material into the storm sewer system the Contractor shall take special care to prevent the milled material from falling into the inlet openings or inlet grates. Any milled material that falls into inlet openings or inlet grates shall be removed at the Contractor's expense.

130.65 Vertical Faces.

All permanent limits of the milled area shall be sawcut or otherwise neatly cut by mechanical means to provide a clean and sound vertical face. Each vertical face shall be thoroughly coated with a hot poured rubberized asphalt sealant meeting the requirements of ASTM D3405 immediately prior to placing new HMA mixture adjacent to the vertical face. No vertical faces, transverse or longitudinal, shall be left exposed to traffic. If any vertical face is formed in an area exposed to traffic a temporary paved transition with a maximum 12:1 slope shall be established. If the milling machine is used to temporarily transition the milled pavement surface to the existing pavement surface, the temporary transition shall be constructed at a maximum 12:1 slope.

130.66 Opening to Traffic.

Prior to opening a milled area to traffic, the milled surface shall be thoroughly swept with a mechanical sweeper to remove all remaining millings and dust. This operation shall be conducted in a manner so as to minimize the potential for creation of a traffic hazard and to comply with local, State, and Federal air pollution control laws and regulations. Any damage to vehicular traffic as a result of milled material becoming airborne is the responsibility of the Contractor and shall be repaired at the Contractor's expense. Temporary pavement markings shall be placed in accordance with the provisions of Subsection 850.64.

130.67 Milled Surface Inspection.

The milled surface shall provide a satisfactory riding surface with a uniform textured appearance. The milled surface shall be free from gouges, excessive longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, non-uniform milling teeth, improper use of equipment, or otherwise poor workmanship. Any unsatisfactory surfaces produced shall be corrected by remilling at the Contractor's expense and to the satisfaction of the Engineer.

The Contractor shall perform Quality Control inspection of all work items addressed under Section 130 as further specified in Table 130.1. Inspection activities during milling of HMA pavement may be performed by qualified Production personnel (e.g. Skilled Laborers, Foremen, Superintendents). However, the Contractor's QC personnel shall have overall responsibility for QC inspection. The Contractor shall not rely on the results of Department Acceptance inspection for Quality Control purposes. The Engineer shall be provided the opportunity to monitor and witness all QC inspection.

The milled surface of each travel lane shall be divided into longitudinal Sublots of 500 feet (150 meters). The Contractor shall perform a minimum of one random QC measurement within each Sublot with a 10 foot (3 meter) straightedge in the transverse direction across the milled surface. Additional selective QC measurements within each Sublot will be performed as deemed necessary by the QC personnel. All QC inspection results shall be recorded on NETTCP Inspection Report Forms. The Engineer will also randomly inspect a minimum of 25% of the Sublots. The variation from the edge of the straightedge to the top of ridges between any two ridge contact points shall not exceed 1/2 inch (12.5 mm). The difference in height from the top of any ridge to the bottom of the groove adjacent to that ridge shall not exceed 5/8" (16 mm). Any point in the surface not meeting these requirements shall be corrected as directed by the Engineer at the Contractor's expense.

In isolated areas where surface delamination between existing HMA layers or a surface delamination of HMA on Portland Cement Concrete causes a non-uniform texture to occur, the straightedge surface measurement requirements stated in the preceding paragraph may be waived, subject to the approval of the Engineer.

TABLE 130.1 - MINIMUM QC INSPECTION OF MILLING OPERATIONS

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Environmental Conditions	Protection of Inlets & Utilities	Per QC Plan	Existing Surface	Visual Check
	Removal of Millings & Dust	Per QC Plan	Milled Surface	Visual Check
Workmanship	Milling Depth	Per QC Plan	Milled Surface	Check Measurement
	Cross-Slope & Profile	Per QC Plan	Milled Surface	Check Measurement
	Milled Surface Texture	Per QC Plan	Milled Surface	Visual Check
	Milled Surface Roughness	Once per 500 feet (150 meters) per milled lane	Milled Surface per Subsection 130.67	10 foot (3 meter) standard straightedge
	Sawcut Limit Vertical Face	Per QC Plan	Sawcut Limits	Visual Check

ITEM 153. CONTROLLED DENSITY FILL - EXCAVATABLE

Controlled Density Fill material used in this project when applicable and approved by the Resident Engineer for utility trenches crossing the existing paved roadway shall be Type 2E Flowable/Excavatable in accordance with Standard Specification Section M4.08 Controlled Density Fill.

ITEM 180.1 HEALTH AND SAFETY PLAN

It is the Contractor's ultimate responsibility to ensure the health and safety of all the Contractor's employees and subcontracting personnel, representatives, and the public from any on-site hazards.

The Health & Safety Plan (HASP) shall be prepared by a Certified Industrial Hygienist or other experienced individual with the appropriate OSHA required training to prepare such a plan. It

shall include the components required by OSHA 29 CFR 1910.120(b). The preparer's name and work experience shall be included as part of the Health and Safety Plan submittal. The plan shall be designed to identify, evaluate, and control health and safety hazards and provide for emergency response if needed. The Health and Safety Plan shall be a dynamic document with provision for change to reflect new information, new practices or procedures, changing site environmental conditions or other situations which may affect site workers and the public. Health and safety procedures provided by the Contractor shall comply with all the appropriate regulations that address employee working conditions (e.g. OSHA, RCRA, CERCLA). In addition, guidelines of NIOSH, OSHA, USCG, EPA, etc., shall be followed. Equipment used for the purpose of health and safety shall be approved and meet pertinent standards and specifications of the appropriate regulatory agencies.

The Health and Safety Plan shall be submitted to MassDOT. This submission of the plan to MassDOT does not relieve the Contractor of the responsibility for attaining the required degree of protection and training, or to comply with all laws, rules, regulations, standards or guidelines in effect during the execution of the contract.

A copy of the Health and Safety Plan shall be maintained on-site at all times by the Contractor.

ITEM 180.2 IMPLEMENTATION OF HEALTH AND SAFETY PLAN

For all construction activities that require handling or exposure to potentially hazardous materials, the Health and Safety Plan shall specify an on-site Safety Officer. The Site Safety Officer's duties shall include, but are not limited to: implementation of the site Health and Safety Plan, training, evaluating risks, safety oversight, determining levels of personnel protection required, and performing any required monitoring at the site.

In the event that subsurface contamination is discovered during construction, the Site Safety Officer shall be present to oversee all handling, storage, sampling, and transport of such contaminated materials.

The level of protection, relative to respiratory and dermal hazards, required to ensure the health and safety of on-site personnel will be stipulated in the Health and Safety Plan and will be subject to modification by the on-site Safety Officer based on changing site and weather conditions.

The Contractor shall be required to provide appropriate personnel protective equipment for anyone who is working in an area either containing or suspected of containing a hazardous environment. This work will include both individuals physically working in these areas and those directing the work of same. Contingencies for upgrading the level of protection for on-site workers will be identified in the Health and Safety Plan and the contractor shall have the necessary materials/equipment on hand to implement the level of protection upgrade in a timely manner.

ITEM 180.3 PERSONNEL PROTECTION

The Contractor shall provide to all workers disposable, protective clothing appropriate to the hazard level of the work. The protective equipment and its use shall be in strict compliance with the Health and Safety Plan (Item 180.1), and all appropriate regulations that address employee working conditions.

ITEM 187.32 REMOVAL AND DISPOSAL OF DRAINAGE SYSTEM SEDIMENTS

The work to be done under this item shall consist of removing the accumulated dirt, refuse, and other debris from drainage structures, drainage pipes and culverts as noted on the Plans. Drainage systems shall be cleaned, if required, prior to connection to existing drainage structures and as directed by the Resident Engineer.

No casting shall be removed until immediately preceding the work and shall be replaced immediately after the cleaning of that portion of the drainage system is completed. The uncovered catch basin shall not be left unattended at any time.

The cast iron hood shall be removed from all catch basins so equipped, prior to cleaning.

The material removed from the drainage system shall be transported immediately to the place of disposal in machines or trucks that will not spill the material along the roadway. Any material falling on the roadway shall be removed and cleaned up by the Contractor.

Hydraulic lift trucks should be used during drainage system cleaning operations so that after sufficient material is loaded onto the truck, the truck can then be elevated so any free flowing liquid may drain back into the drainage structure. Material must arrive at the disposal facility sufficiently dry to pass the Paint Filter Liquids Test (or no liquid drips from it when a handful is taken and squeezed).

All material removed from the drainage system shall be properly handled and disposed of by the Contractor, and this must be done in accordance with all DEP regulations, policies and guidance. The responsibility for the proper handling and disposal of this material shall be solely the Contractor's. Drainage system cleanings are classified as a solid waste by the Massachusetts Department of Environmental Protection (DEP) and may be disposed of at any landfill that is permitted by DEP to accept solid waste. Materials containing free-flowing liquids are prohibited from being accepted at landfills. The DEP encourages the beneficial reuse of this material whenever possible; however, use not in accordance with DEP determination, or disposal or use as fill in an unapproved location is not acceptable.

ITEM 201. CATCH BASIN
ITEM 202. MANHOLE

The work shall conform to the relevant provisions of Section 201 and the following:

All flat top slabs shall be rated for H-20 loading

ITEM 222.21 SECURED MANHOLE FRAME AND COVER

The work under this item shall conform to the relevant provisions of Section 201 and 220 and the following:

The work shall include the furnishing and installation of new manhole frames and covers, equipment and incidental costs required for the work, as shown on the plans and as directed by the Engineer. The work shall also entail removing and resetting manhole frames and covers to meet with final grade and as directed by the Engineer.

Manhole frames and covers shall be secured using bolts to prevent accidental removal.

Each manhole casting shall be equipped with a bolt down and gasketed cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow the cleanout of sand, dirt, and other debris.

Frames and covers shall be classified as heavy duty and shall meet the requirements of AASHTO M306.

Manhole covers shall have a diameter of 24". Frames shall have a clear diameter opening of 21".

Manhole covers shall have a non-skid surface with letters cast in the depression on the top. Each letter shall be raised 0.2". The legends shall be italic and shall read "*MassDOT*" (13.25" width x 2.0" height) with "*LIGHTING"* (3.5" width x 0.5"height) located directly below.

Shop Drawings

Within 30 days following execution of the Contract, the Contractor shall submit shop drawings for handholes, frames/covers, and manufacturer's equipment specifications to the Engineer in accordance with the relevant provisions of Section 815.20.

Approval of these drawings will be general in character and shall not relieve the Contractor from the responsibility of, or the necessity of, furnishing materials and workmanship conforming to the plans and specifications.

The Contractor shall deliver to the Engineer a certificate of compliance with the manufacturer for all materials purchased from the manufacturer.

ITEM 415. PAVEMENT MICROMILLING

Description

General.

This work shall consist of Pavement Micro-milling to be performed in conformity with Section 130 Pavement Milling and the following:

The work under this item shall consist of micro-milling the existing pavement to the depth and at the locations specified in the Contract Documents or as directed by the Engineer. The micro-milling operation shall include a control strip to be approved by the Engineer for construction. Unless otherwise specified, the milled material shall become the property of the Contractor. The work under this item also shall include the removal of the existing raised pavement markers.

Control Strip

The Contractor shall micro-mill a control strip in length and width as required by the QC plan for the control strip and to the nominal depth shown on the plans. The surface shall be tested transversely and longitudinally with a 10 foot straightedge furnished by the Contractor. The control strip will be performed during the 1st night of production milling

The micromilling shall have a transverse pattern of 0.2 – 0.3 inch center to center of each strike area. The difference between the bottom of the 10 foot straightedge and the milled surface shall not exceed 1/8" (3mm). The difference between the high and the low of the grooves for a micro-milled textured surface shall not exceed 1/16" (1.6mm).

Construction

The existing pavement shall be milled same as produced for the control strip to the nominal depth shown on the plans, and as directed by the Engineer in a manner that will restore the pavement cross section and ride quality. The Engineer may adjust the average milling depth by ±1/2" (± 12.5mm) during each milling pass at no additional payment to make slight adjustment for milling operations to minimize delamination of the underlying pavement course or to otherwise provide a more stable surface.

The micro-milled surface strip shall provide a smooth riding surface with a uniform textured appearance free from gouges, excessive longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, non-uniform milling teeth, improper use of equipment or poor workmanship. Any unsatisfactory surfaces not consistent with the approved control strip shall be corrected by additional micro-milling at the Contractor's expense and to the satisfaction of the Engineer.

Any roadway patching shall be performed before micro-milling. Additional roadway patching may be required to correct pavement defects made visible by micro-milling. After the micro-milling has been completed, all depressions, potholes and other irregularities shall be patched with HMA. Any existing manholes or other structures shall be temporarily ramped as directed by the Engineer.

The Contractor shall coordinate milling and paving operations to minimize the exposure of milled textured surfaces to traffic. Under no circumstances shall the milled surface be left exposed to traffic for a period exceeding seven days. The Contractor shall ensure that milled surfaces are overlaid in a timely manner to avoid damage to the pavement structure.

The Contractor will be responsible for providing all grades necessary to remove the material to the proper line and grade, superelevation, and transitions shown on the plans or as directed by the Engineer.

If delamination or exposure of a concrete or penetrated stone base occurs when milling an asphalt pavement course, the Contractor shall cease milling operations and consult the Engineer to determine whether to reduce the milling depth or make other adjustments to the operation.

Equipment

The milling equipment shall be self-propelled with sufficient power, traction, and stability to remove the existing HMA pavement to the specified depth and cross-slope. The milling machine shall be capable of operating at a minimum speed of 10 feet (3 meters) per minute, designed so that the operator can at all times observe the milling operation without leaving the control area of the machine, and equipped with the following:

(a) A built in automatic grade control system that can control the longitudinal profile and the transverse cross-slope.

(b) Cutting drum able to provide a minimum nominal 6 foot (2.0 meter) cutting width in one pass. The cutting drum shall use tungsten carbide teeth.

(c) An integral pickup and conveying device to immediately remove milled material from the roadway and discharge the millings into a truck, all in one operation.

(e) All necessary safety devices such as reflectors, headlights, taillights, flashing lights and back up signals so as to operate safely in both day and night.

(f) A small amount of water to cool the cutting teeth and control the amount of dust created by the milling process.

When milling smaller areas or areas where it is impractical to use the above described equipment, the use of a smaller or lesser-equipped milling equipment shall be permitted and approved by the Engineer.

Sweeper Equipment Requirements.

The Contractor shall provide a sufficient number of mechanical sweepers to ensure that the milled surface is free of millings and debris at the end of each day's milling operations. Each sweeper shall be equipped with a water tank, spray assembly to control dust, a pick-up broom, a dual gutter broom, and a dirt hopper. The sweepers shall be capable of removing millings and loose debris from the textured pavement.

2010 Quality Assurance Specifications for Hot Mix Asphalt Pavement

SECTION 450

HOT MIX ASPHALT PAVEMENT

Section 450 - Hot Mix Asphalt Pavement entirely replaces the following Sections and Subsections of the Standard Specifications for Highways and Bridges:

- Section 420 - Class I Bituminous Concrete Base Course Type I-1
- Section 460 - Class I Bituminous Concrete Pavement Type I-1
- Subsection M3.01.0 - Asphalt Cement
- Subsection M3.11.06 - Bituminous Materials
- Subsection M3.11.08 - Inspection
- Subsection M3.11.09 - Composition and Compaction Acceptance Tests

The Contractor shall adhere to all of the requirements herein of Section 450, Hot Mix Asphalt Pavement. All QC Inspection Report Forms and Test Report Forms must be submitted to the Department by the Contractor at the completion of each Lot. Material produced and placed must conform to the Quality Limits specified in Subsection 450.77. Contractor QC data and Department Acceptance data for each Lot falling under HMA Lot Category A (Large Lot) or Category B (Small Lot) will be evaluated using Quality Level Analysis and must meet the minimum Percent Within Limits specified in Subsection 450.77.

NOTE: The Pay Adjustment provisions included in Subsection 450.92 will be applied to items under this contract.

SECTION 450

HOT MIX ASPHALT PAVEMENT
DESCRIPTION

450.20 General.

This work shall consist of producing and placing Hot Mix Asphalt (HMA) pavement. HMA mixtures shall be composed of the following: Mineral aggregate, mineral filler (if required), Performance Graded Asphalt Binder (PGAB), and as permitted, reclaimed materials (limited to Reclaimed Asphalt Pavement (RAP), Manufactured Asphalt Shingles (MAS), and Processed Glass Aggregate (PGA)). The HMA pavement shall be constructed as shown on the plans and as directed on the prepared or existing base in accordance with these specifications and in close conformity with the lines, grades, compacted thickness and typical cross section as shown on the plans. Unless specified otherwise, each HMA pavement course placed shall be comprised of one of the mixture types listed in Table 450.1.

Table 450.1 – HMA Pavement Courses & Mixture Types

Pavement Course	Mixture Type	Mixture Designation
Friction Course	• Open-Graded Friction Course - Polymer Modified	OGFC-P
Surface Course	• SUPERPAVE Surface Course - 4.75 • SUPERPAVE Surface Course - 9.5 • SUPERPAVE Surface Course - 12.5 • SUPERPAVE Surface Course - 19.0	SSC - 4.75 SSC - 9.5 SSC - 12.5 SSC - 19.0
Intermediate Course	• SUPERPAVE Intermediate Course - 12.5 • SUPERPAVE Intermediate Course - 19.0	SIC - 12.5 SIC - 19.0
Base Course	• SUPERPAVE Base Course - 25.0 • SUPERPAVE Base Course - 37.5	SBC - 25.0 SBC - 37.5
Leveling Course	• SUPERPAVE Leveling Course - 4.75 • SUPERPAVE Leveling Course - 9.5 • SUPERPAVE Leveling Course -12.5	SLC - 4.75 SLC - 9.5 SLC - 12.5
Bridge Surface Course	• SUPERPAVE Bridge Surface Course - 9.5 • SUPERPAVE Bridge Surface Course - 12.5	SSC-B - 9.5 SSC-B - 12.5
Bridge Protective Course	• SUPERPAVE Bridge Protective Course - 9.5 • SUPERPAVE Bridge Protective Course - 12.5	SPC-B - 9.5 SPC-B - 12.5

450.30 Quality Assurance.

A. Quality Assurance Responsibilities.

This is a Quality Assurance Specification wherein the Contractor is responsible for controlling the quality of materials and workmanship and the Department is responsible for accepting the completed work based on the measured quality. Quality Assurance is simply defined as "making sure the Quality of a product is what it should be".

The core elements of Quality Assurance include: Contractor Quality Control (QC), Department Acceptance, Department Independent Assurance (IA), Dispute Resolution, Qualified Laboratories, and Qualified Personnel. Although Quality Assurance utilizes test results to control production and determine acceptance of the HMA, inspection remains as an important element in controlling the process and accepting the product.

The Contractor is responsible for providing an appropriate Quality Control system to ensure that all materials and workmanship meet the required quality levels for each specified Quality Characteristic. The Contractor will perform all required Quality Control inspection, sampling, and testing in accordance with these specifications and the Contractor's Quality Control Plan.

The Department will monitor the adequacy of the Contractor's QC activities and will perform Acceptance inspection, sampling, and testing. The Department's Acceptance information will be utilized in the acceptance determination for each Lot of material produced and placed.

Independent Assurance is the responsibility of the Department's Central Materials Laboratory. The function of IA testing is to periodically provide an unbiased and independent evaluation of the sampling and testing procedures used in the acceptance decision. Contractor QC and Department Acceptance testing procedures and equipment will be evaluated by IA personnel using one or more of the following: observation, calibration checks, split sample comparison, or proficiency samples (homogeneous samples distributed and tested by two or more laboratories). QC and Acceptance testing personnel are evaluated by observation and split samples or proficiency samples.

B. Hot Mix Asphalt Lots & Sublots.

The quality of each HMA pavement course of the same mixture type produced and placed will be inspected, tested, and evaluated on the basis of Lots and Sublots. A Lot is defined as "an isolated quantity of material from a single source which is assumed to be produced or placed by the same controlled process".

The Lot size and corresponding unit of measure is a function of the individual Quality Characteristic evaluated. Lot sizes for Quality Characteristics subject to Department Acceptance are as shown in Table 450.2.

Changes in the target values, material sources, or JMF for an HMA mixture type will constitute a change in Lot, requiring the establishment of a new Lot. All Lots will be properly identified for accurate evaluation and reporting of HMA quality.

Table 450.2 - HMA Lot Sizes

Quality Characteristic	Lot Size & Unit of Measure
PG Asphalt Binder Grading	Total Tons of HMA from all JMFs using the same PGAB Grade (from same PGAB Supplier), produced by a single plant and placed within same construction season.
PG Asphalt Binder Content	Total quantity of an HMA mixture type with same JMF for same individual pavement course, produced by a single plant using the same source of materials and placed at a uniform plan thickness within the same construction season, not to exceed 18,000 tons. (See Table 450.3).
Volumetrics - Air Voids	
In-place Density	
Thickness	
Ride Quality (IRI)	Total length (miles) of individual wheel paths (in all travel

Quality Characteristic	Lot Size & Unit of Measure
Wheel Path Deviations	lanes and ramps) of in-place HMA with same JMF for same individual pavement course, produced by a single plant and placed within same construction season, and which is located within the same posted speed limit range as defined in Table 450.19

C. HMA Quality Assurance Requirements.

These Specifications establish three categories under which Hot Mix Asphalt Lots will be produced, placed, evaluated and accepted. Table 450.3 below defines each of the Lot categories and outlines the required Quality Assurance activities of the Contractor and the Department. The division of the Lot categories is based on the total estimated contract quantity of each individual HMA mixture type per each project location. For contracts containing multiple Hot Mix Asphalt items, it is possible to have work performed under more than one HMA Lot category.

(1) Determination of Lot Size and Lot Category

When the total contract quantity of an HMA mixture type is < 2,100 tons (1,925 Mg), it shall be classified as a Minor Lot (Category C Lot).

When the total contract quantity of an HMA mixture type is ≥ 2,100 tons (1,925 Mg), but < 7,500 tons (6,875 Mg), it shall be classified as a Small Lot (Category B Lot).

When the total contract quantity of an HMA mixture type is ≥ 7,500 tons (6,875 Mg), but ≤ 15,000 tons (13,750 Mg), it shall be classified as a Large Lot (Category A Lot).

When the total contract quantity of an HMA mixture type is > 15,000 tons (13,750 Mg), each 15,000 tons (13,750 Mg) will represent a Category A Lot. If the quantity remaining after all 15,000 ton (13,750 Mg) Category A Lots is ≤ 3,000 tons (2,750 Mg), it shall be added to the final Lot providing a final Lot quantity not to exceed 18,000 tons (16,500 Mg). If the quantity remaining after all 15,000 ton (13,750 Mg) Category A Lots is > 3,000 tons (2,750 Mg), it shall constitute a separate Category A Lot.

(2) Determination of Sublot Size

Each HMA Lot will be divided into Sublots of uniform size. The size of each HMA Sublot shall be as listed in Table 450.10 and Table 450.17. If the HMA quantity at the end of a Lot is equal to or greater than one half of a full Sublot, then such quantity shall be identified and evaluated as a separate Sublot. If the HMA quantity at the end of a Lot is less than one half of a full Sublot, then

such quantity shall be combined with the previous full Sublot quantity and shall be identified and evaluated as the final Sublot.

Table 450.3 - HMA Lot Categories & Quality Assurance Requirements

Quality Assurance Requirements	Category A (Large Lot)	Category B (Small Lot)	Category C (Minor Lot)
Total Quantity for individual Lot of HMA:	≥ 7,500 tons (6,875 Mg), but ≤ 15,000 tons (13,750 Mg) (See Note 1)	≥ 2,100 tons (1,925 Mg), but < 7,500 tons (6,875 Mg)	< 2100 tons (1,925 Mg)
QC Plan Required:	YES	YES	(See Note 2)
Contractor QC Inspection Required:	YES (Subsection 450.64)	YES (Subsection 450.64)	YES (Subsection 450.64)
Contractor QC Testing Required:	YES (Subsection 450.65)	YES (Subsection 450.65)	YES (Subsection 450.65)
Control Strip Required:	YES	NO	NO
Control Charts Required:	YES	NO	NO
Quality Level Analysis Required:	YES	YES	NO
MassDOT Acceptance Inspection & Testing Performed:	Minimum 25% of Sublots (Subsection 450.74)	Minimum 50% of Sublots), But Minimum 3 Sublots (Subsection 450.74)	100% of Sublots (Subsection 450.74)
QC Test Results included in MassDOT Acceptance Determination:	YES (If Validated)	YES (If Validated)	NO
Pay Adjustment Applied:	YES (Subsection 450.92)	YES (Subsection 450.92)	NO

Note 1: Category A Lots shall not exceed 18,000 tons (16,500 Mg) as specified in Subsection 450.30C(1)

Note 2: If all HMA Lots fall under Category C then a QC Plan is not required. However, if any Lots on the project fall under Category A or Category B, then any Category C Lots must be addressed in the QC Plan.

MATERIALS

450.40 General.

Materials shall meet the requirements in the following Subsections of Division III, Materials and as otherwise specified herein:

Asphalt Emulsion	M3.03.0
Hot Poured Joint Sealer	M3.05.0
Asphalt Anti-Stripping Additive	M3.10.0
Job-Mix Formula	M3.11.03
Mineral Aggregate	M3.11.04
Mineral Filler	M3.11.05
Plant Requirements	M3.11.07

450.42 Hot Mix Asphalt Mix Design.

The Contractor shall be responsible for development of all HMA Laboratory Trial Mix Formulas (LTMF). The aggregate gradation structure and target PG Asphalt Binder content of each LTMF for HMA base courses, HMA intermediate courses, and HMA surface courses shall conform to the Control Points in Section 455. The aggregate gradation structure and target PG Asphalt Binder content for Open-Graded Friction Course (OGFC-P) shall conform to the master ranges in M3.11.03 – Table B.

All LTMFs for HMA pavement courses shall be supported by volumetric mix designs. Volumetric mix designs are not required for OGFC-P.

All HMA LTMF's will be submitted to the Engineer with adequate samples of individual ingredients for verification of each proposed mixture. Upon the Engineer's laboratory verification of the LTMF for Category A Lots, a Control Strip will be necessary. Once each LTMF for Category B Lots or Category C Lots is laboratory verified and accepted by the Engineer, the LTMF will become the approved job mix formula (JMF).

Two or more job-mix formulas per HMA mixture type may be approved for a particular plant, however, only HMA conforming to one job-mix formula is permitted to be produced and placed on any given day.

450.44 Reclaimed Asphalt Pavement (RAP).

Reclaimed Asphalt Pavement (RAP) shall consist of the material obtained from the highways or streets by crushing or milling existing HMA pavements. This material shall be transported to the HMA production facility yard and processed through an appropriate crusher so that the resulting material will contain no particles larger than the maximum aggregate size of the HMA mixture in which it will be used. The material shall be stockpiled on a free draining base, covered and kept separate from the virgin aggregates. The material contained in the RAP stockpiles shall have a reasonably uniform gradation from fine to coarse and shall be protected from accumulation of excessive moisture and shall not be contaminated by foreign materials.

The use of RAP will be permitted at the option of the Contractor provided that the end product is in conformance with the approved job-mix formula. The proportion of RAP to virgin aggregate for base course mixtures and intermediate course mixtures shall be limited to a maximum of 40% for drum mix plants and 20% for modified batch plants. The maximum amount of RAP for all surface course mixtures listed in Table 450.1 shall be 15%. No RAP will be allowed in OGFC-P mixtures.

450.46 Manufactured Asphalt Shingles (MAS)

Manufactured Asphalt Shingles (MAS), as defined in M3.11.04, may be used in HMA leveling courses, HMA base courses, and HMA intermediate courses at a maximum rate of 5% by weight only when RAP is not included in the job mix formula. When MAS is used in HMA mixtures containing RAP or other reclaimed materials, the MAS will be considered as part of the overall allowable mass of reclaimed materials in the mixture, as defined in M3.11.06. HMA mixtures containing MAS shall be designed, produced, and placed in accordance with the requirements contained in Section M3.

450.48 Performance Graded Asphalt Binder.

A. Standard Asphalt Binder Grade.

The Asphalt Binder shall be a Performance Graded Asphalt Binder (PGAB) which meets the specification requirements of AASHTO Standard M320. PGAB shall be provided by an Approved Supplier (AS) in accordance with the Approved Supplier Certification (ASC) system outlined in AASHTO R26, “Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders”.

The standard PGAB grade for Massachusetts has been determined based upon the expected minimum and maximum pavement in-service temperature using the ***LTPPBind software*** with a High Reliability (96-98%). Unless indicated otherwise on the Plans or in the Special Provisions, the standard PGAB Grade of PG64-28 shall be used.

B. Asphalt Binder Modifiers for Reclaimed Materials.

For any HMA containing reclaimed materials, an asphalt binder modifier shall be added to the mixture to restore the asphalt binder properties of the reclaimed materials to a level that is consistent with the specified virgin PGAB. If greater than 25% RAP is used in an HMA mixture, the PGAB modifier grade used shall be in accordance with Table 450.4. The type and amount of asphalt binder modifier to be used shall be included as part of the LTMF. Only Performance Graded Asphalt Binders will be used as modifiers and shall meet the requirements of AASHTO M 320. However, the resulting final PGAB grade shall be in accordance with Table 450.4 (or the specified PGAB grade per the contract).

For HMA Category A Lots and Category B Lots incorporating greater than 25% RAP in the LTMF, the Contractor shall perform, as part of the mix design, full binder testing per AASHTO M 320 on samples of asphalt binder recovered from the RAP (by Abson recovery) blended in the appropriate proportion with samples of the virgin PGAB.

For HMA Category A Lots containing greater than 25% RAP, the Contractor shall also perform full binder testing (on asphalt binder recovered from the RAP blended with the virgin PGAB) for the Control Strip and for Quality Control during HMA production and placement as specified in Subsection 450.65.

Table 450.4 - PGAB Grades for HMA Mixtures Containing RAP

Amount of RAP in Mixture	PGAB Modifier Grade	Resulting PGAB Grade
≤ 25% RAP by Weight of Mixture	None	64-28
> 25% to 40% RAP by Weight of Mixture	52-34	64-28 ± 2ºC

CONSTRUCTION PROCEDURES

450.50 General.

Prior to the start of any work activity addressed in Subsections 450.53 thru 450.59 below, a Construction Quality Meeting shall be held to review the Contractor's Quality Control system. The Contractor shall present and discuss with the Engineer in sufficient detail the specific Quality Control information and activities contained in each section of their QC Plan as outlined in Subsection 450.61 below. The meeting is intended to ensure that the Contractor has an adequate Quality Control system in place and that the Contractor's personnel are fully knowledgeable of the roles and activities for which they are responsible to achieve the specified level of quality. Contractor personnel required to attend the Construction Quality Meeting include; the Project QC Manager, all other QC personnel (production facility and field operations), all Superintendents, and the Foremen for field operations. The Contractor shall provide a copy of the approved QC Plan for each Contractor and Department attendee of the meeting.

450.51 Control of Grade and Cross-Section.

The Contractor will provide a longitudinal and transverse reference system, with a maximum spacing of 100 ft (30 meters), for the purpose of locating and documenting sampling and testing locations and related uses. It is the Contractor's responsibility to clearly mark this reference system in the field. Work related to this reference system is incidental and will be included as part of the Contractor's Quality Control system. The Department shall provide information tying in the Contractor's reference system to the State Mile Marker System.

The Contractor shall furnish, set and maintain all line and grade stakes necessary to guide the automated grade control equipment. Where required these control stakes shall be maintained by the Contractor and used throughout the operations, from the grading of the subbase material up to and including the final course of the pavement.

Under normal conditions, where more than one course of HMA is to be constructed, the use of the string line for grade control may be eliminated or discontinued after the construction of the initial course of HMA. For resurfacing projects, where only one course of HMA is to be constructed, the use of the string line for grade control may be eliminated. The use of approved automation may then be substituted for the string line where lines and grades are found to be satisfactory by the Engineer.

450.52 Weather Limitations.

HMA shall only be placed on dry, unfrozen surfaces and only when the temperature requirements contained in Table 450.5 below are met.

The Contractor may continue HMA placement when overtaken by sudden rain, but only with material which is in transit from the HMA production facility at the time, and then only when the temperature of the HMA mixture is within the temperature limits specified and when the existing surface on the roadway is free of standing moisture.

The construction of HMA pavement shall terminate November 15 and shall not be resumed prior to April 1 except as determined and directed in writing by the Engineer depending upon the necessity and emergency of attendant conditions, weather conditions, and location of the project. Only in extreme cases will the placement of surface courses be permitted between November 15 and April 1. Regardless of any temperature requirements, OGFC-P mixtures shall not be placed after October 31 or before May 1 without the written permission of the Engineer.

Table 450.5 - Temperature Limitations for HMA Placement

HMA Pavement Course	**Lift Thickness Inches (mm)**	**Minimum Air Temperature** °F (°C)	**Minimum Surface Temperature** °F (°C)
Friction Course	1 (25)	50 (10)	55 (13)
Surface Course	< 1¾ (45)	45 (7)	50 (10)
Surface Course	≥ 1¾ (45)	40 (4)*	45 (7)
Intermediate Course	All	40 (4)*	45 (7)
Base Course	All	40 (4)*	45 (7)
Leveling Course	As Specified	45 (7)	50 (10)

*When the air temperature falls below 50° F (10° C), extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, and in placing and compacting the mixtures.

The Contractor shall supply the Engineer with an approved dial type thermometer with a temperature range of -50° to 500° F (10° to 260° C) and an infrared pistol thermometer for each paving machine in operation on the project. The infrared pistol thermometer shall be Fahrenheit or Celsius selectable and conform to the following requirements:

- Portable and battery operated
- LCD Display to nearest 1° F (1° C)
- Temperature operating range of 0° to 750° F (–18° to 400° C)
- Accuracy of ± 2%
- Repeatability of +/- 5° F (± 3° C)

- Emissivity preset at 0.95

The thermometers will remain the property of the Contractor upon completion of the project.

450.53 Preparation of Underlying Surface.

HMA mixtures shall be placed only upon properly prepared surfaces that are clean from foreign materials. The underlying surface shall be prepared in accordance with the requirements below, prior to the placement of HMA pavement courses.

A. Subbase or Reclaimed Base.

Prior to the placement of HMA base course mixtures, the Contractor shall inspect the prepared subbase or reclaimed base material to ensure that it is in conformance with the required grade, cross-section, and in-place density. Subbase or reclaimed base material that is not in accordance with the plans or specifications shall be reworked or replaced to meet the applicable requirements of Sections 401, 402, or 403 before the start of HMA placement. The subbase or reclaimed base shall not be frozen or have standing water when placing HMA.

B. Milling Existing HMA Pavement.

When specified on the plans, existing HMA pavement courses shall be milled and removed from the project by the Contractor. Milling shall be performed in conformity with the limits, line, grade, and typical cross-section shown on the plans and in accordance with Section 130, Milling Existing HMA Pavement. All Quality Control activities for milling shall be addressed in the Contractor's HMA QC Plan.

C. Patching Existing Pavement Courses.

Areas of existing HMA pavement courses that are significantly distressed or unsound shall be removed and replaced with patches using new Hot Mix Asphalt. The location and limits of patching will be as identified in the plans or as directed by the Engineer.

Each existing pavement course determined to be unsound shall be removed to the full depth of the pavement course within a rectangular area. For each patch location equal to or greater than 50 square feet (4.6 square meters) in area (and having a minimum dimension of 4 feet (1.2 meters)) where the existing pavement courses are removed down to subbase, the subbase shall be compacted by mechanical means to not less than 95% of the maximum dry density of the subbase material as determined by AASHTO T 99 method C at optimum moisture content. Each edge of the patch area shall be sawcut or otherwise neatly cut by mechanical means to provide a clean and sound vertical face. The vertical face of each edge shall be thoroughly coated with a hot poured rubberized asphalt sealant meeting the requirements of ASTM D3405 immediately prior to placing the HMA patching mixture.

Delaminated areas of existing pavement courses resulting from pavement milling shall be cut back neatly by mechanical means to the limits of any unsound material. After removing all unsound material, the underlying pavement surface within the patch limits shall receive a thorough tack coat at a rate of application of 1/10 gal/s.y. (0.40 liters/square meter) immediately prior to placing the HMA patching mixture.

HMA patching mixture shall be the same mixture type as the existing pavement course being patched or as specified on the plans or as directed by the Engineer. The lift thickness of the patching mixture shall not exceed four times the nominal maximum aggregate size of the mixture. The patching mixture will be placed by hand or by mechanical means and shall match the thickness, grade, and cross-slope of the surrounding pavement. The HMA patching mixture shall be compacted using a steel wheel roller. For patch areas not large enough to permit use of a roller, compaction shall be accomplished using a mechanical tamper capable of achieving the required in-place density. The Contractor shall test the in-place density of each patched area using a calibrated density gauge and record the test data for each patched area on NETTCP Test Report Forms. The in-place density of the HMA patching mixture shall be not less than 92% of the maximum theoretical density of the mixture as determined by AASHTO T 209.

D. Leveling Courses.

HMA Leveling Courses shall only be used when specified in the Plans or Special Provisions. The HMA mixture used for a Leveling Course shall be as specified in the Plans or Special Provisions and shall conform to the relevant Materials requirements of Section 450.

E. Preparation of Curbs, Edging, and Utilities.

All curbs or edging shall be installed or reset to the line and grade established on the plans. The surface elevation of all catch basin frames and grates, manholes, utility valve boxes, or other utility structures located in the pavement shall uniformly match the grade and cross-slope of the final pavement riding surface. Adjustment of all curbs, edging, and utilities shall be completed prior to the placement of the HMA surface course. When OGFC-P is specified to be placed over the HMA surface course, all curbs, edging, and utilities shall be adjusted prior to placement of the surface course mixture. Hand placement of HMA along curbs and edging or around utilities after placement and compaction of the surface course shall not be permitted.

F. Sweeping Underlying Surface.

The Contractor shall provide a mechanical sweeper equipped with a water tank, spray assembly to control dust, a pick-up broom, a dual gutter broom, and a dirt hopper. The sweeper shall be capable of removing millings and loose debris from the underlying surface.

All milled pavement surfaces shall be thoroughly swept in accordance with Section 130, prior to opening a milled area to traffic, to remove all remaining millings and dust. All other existing

pavement surfaces shall be swept immediately prior to application of the tack coat. Any new HMA pavement course that has been open to traffic, or that was placed 30 days prior to placement of the subsequent pavement course, shall also be swept immediately prior to application of the tack coat.

G. Tack Coat.

A tack coat of asphalt emulsion, grade RS-1 shall be uniformly applied to existing or new pavement surfaces prior to placing pavement courses as specified below. The existing surface shall be swept clean of all foreign matter and loose material using a mechanical sweeper and shall be dry before the tack coat is applied.

(1) Tack Distributor System.

A pressure distributor shall be used to apply the tack coat. The tack distributor system shall be equipped with the following to control and monitor the application:

(a) System for heating the asphalt emulsion uniformly to specified temperature.
(b) Thermometer for measuring the asphalt emulsion temperature.
(c) Adjustable full circulation spray bar.
(d) Positive controls including tachometer, pressure gauge, and volume measuring device.

(2) Tack Application Requirements.

The tack coat material shall be applied by a pressure distributor. All nozzles on the distributor shall be open and functioning. All nozzles shall be turned at the same angle to the spray bar. Proper nozzle angle shall be as determined by the manufacturer of the distributor spray bar. The spray bar shall be adjusted so that it is at the proper height above the pavement surface to provide a double overlap spray for a uniform coverage of the pavement surface. A double lap application requires that the nozzle spray patterns overlap one another such that every portion of the pavement receives spray from exactly two nozzles.

When an HMA pavement course is placed on an existing tight smooth pavement surface, a tack coat shall be applied at the rate of 1/20 gal/s.y. (0.20 liters/square meter). All existing surfaces subjected to milling shall receive a tack coat at the rate of 1/15 gal/s.y. (0.28 liters/square meter). Tack coat shall be applied to cover approximately 90% of the pavement surface.

Any new HMA pavement course that has been open to traffic, or that was placed 30 days prior to placement of the subsequent pavement course, shall receive a tack coat at an application rate of 1/20 gal/s.y. (0.20 liters/square meter).

When the surface of a new HMA pavement course is in a condition which in the Engineer's judgment is unsatisfactory for the direct placement of the subsequent pavement course, a tack

coat shall be applied at the applicable rate specified above for the particular pavement surface condition.

In addition to the requirements above, all vertical surfaces of curbs, edging, utilities, and drainage structures shall receive a thorough tack coat application immediately prior to placing each HMA pavement course.

(3) Tack Inspection.

The asphalt emulsion temperature and application rate shall be periodically measured and properly recorded by the Contractor on NETTCP Inspection Report Forms. If the temperature or application rate is determined to not be in conformance with the specification requirements above, the Contractor shall make appropriate adjustments to the tack application operations.

450.54 Hot Mix Asphalt Transportation and Delivery.

A. Haul Unit Equipment.

The trucks used to transport HMA to the field placement site shall have tight, clean, smooth metal beds. When necessary to maintain the required HMA temperature, trucks shall be equipped with insulated beds. The truck beds shall be evenly and lightly coated with an approved release agent to prevent HMA mixture adherence. Release agents may consist of soapy water or commercial oil emulsions (also known as soluble oils) in the proportions recommended by the manufacturer. Truck beds shall be kept free of kerosene, gasoline, fuel oil, solvents, or other materials that could adversely affect the HMA mixture. Excess lubricant shall not be allowed to accumulate in low spots in the body. The Contractor shall employ sufficient procedures and QC inspection to ensure that all truck beds are free of contaminants, residual HMA, or excess release agent.

B. HMA Protection During Transport.

The HMA shall be transported from the plant to the field placement site in trucks previously cleaned of all foreign materials. During transportation of the HMA from the plant to the placement equipment at the site, each load shall be fully covered at all times, without exception, with canvas or other suitable material of sufficient size and thickness, which is tightly secured to furnish complete protection. The HMA shall not be transported such a distance that segregation of the mixture takes place or that a crust is formed on the surface, bottom or sides of the HMA.

C. Coordination and Inspection of HMA Delivery.

The dispatching of trucks from the plant shall be continuously coordinated to ensure that all HMA mixture planned to be delivered to the field placement site may be placed and compacted before the end of the scheduled work day. During paving operations, the Contractor shall provide for ongoing

two-way radio or cellular phone communication between the field placement site and the HMA plant.

The target temperature and allowable range of the HMA when delivered at the field placement site will be established in the Contractor's Quality Control Plan. The Contractor shall measure the temperature of the HMA, either from the trucks prior to discharge or from the paver hopper, using a metal stemmed dial type thermometer at the minimum frequency indicated in the approved QC Plan. All QC temperature measurement results of the delivered HMA mixture shall be recorded on NETTCP Inspection Report Forms. The Contractor shall also visually inspect the delivered HMA for crusting or material (physical) segregation. The Contractor shall reject any loads of HMA with material which is crusted, segregated, or which is not within the delivery temperature range established in the Contractor's Quality Control Plan.

450.55 Hot Mix Asphalt Placement.

A. Material Transfer Vehicles

For projects on all controlled access highways with HMA Category A Lots, a Material Transfer Vehicle (MTV) will be required. The MTV shall be used to place each pavement course, with the exception of leveling courses, on the mainline of the traveled way including all travel lanes, auxiliary lanes, and collector/distributor (C/D) lanes.

(1) MTV Equipment Requirements.

The MTV shall be self-propelled and capable of remixing and transferring the HMA mixture to the paver so that the HMA mat behind the paver has a uniform homogeneous temperature and appearance. The MTV shall be equipped with the following:

(a) A truck unloading system, capable of 600 tons per hour (550 Mg per hour), which shall receive HMA from the trucks and independently deliver the mixture from the trucks to the paver.

(b) A paver hopper insert with a minimum capacity of 14 tons (12.7 Mg) shall be installed in the hopper of conventional paving equipment. The paver hopper insert shall be marked to identify the point at which the insert is 50% full.

(c) An internal storage bin with a minimum capacity of 25 tons (22.7 Mg) of mixture and a remixing system in the bottom of the storage bin to continuously blend the mixture as it discharges to a conveyor system; or a dual pugmill system located in the paver hopper insert with two full length longitudinally mounted counter-rotating screw augers to continuously blend and feed the mixture through the paver to the screed.

(2) MTV Operations.

The Contractor shall ensure that the MTV is loaded continuously to keep the paver moving. The volume of HMA in the paver hopper insert shall remain above the 25% capacity mark during all paving operations. In the event the MTV malfunctions during HMA placement operations, the Contractor shall continue placement of material until such time there is sufficient HMA placed to maintain traffic in a safe manner. The Contractor may continue placement of HMA until any additional mixture in transit has been placed. Paving Operations may resume only after the MTV has been repaired and is fully operational.

(3) Bridge Loading Restrictions.

The MTV shall be subject to all bridge load restrictions. The Contractor shall verify the sufficiency of the current bridge ratings with the Engineer. In the event that the MTV exceeds the maximum allowable bridge load, the MTV shall be empty when crossing the bridge and shall be moved across without any other Contractor vehicles or equipment being on the bridge. The MTV shall be moved across the bridge in a travel lane and shall not be moved across the bridge on the shoulder. The MTV shall be moved at a speed no greater than five miles per hour (8 kph) without any acceleration or deceleration.

B. Pavers.

Each HMA pavement course shall be placed with one or more pavers at the specified grade, cross-slope, and lift thicknesses.

(1) Paver Equipment Requirements.

Each paver shall be a self-contained, power propelled unit and shall produce a finished surface of smooth and uniform texture without segregating, tearing, shoving or gouging the HMA. The pavers shall be equipped with the following:

(a) A receiving hopper having sufficient capacity to ensure a uniform and continuous placement operation.
(b) Automatic feed controls, which are properly adjusted to maintain a uniform depth of material ahead of the screed.
(c) Automatic screed controls with sensors capable of sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope.
(d) An adjustable vibratory screed with full-width screw augers and heated for the full width of the screed.
(e) Capable of spreading and finishing HMA pavement courses in widths at least 12 inches (300mm) more than the width of one travel lane.
(f) Capable of being operated at forward speeds to satisfactorily place the HMA.

(2) Paver Operations.

The Contractor shall ensure that the paver is loaded continuously to keep the placement operation moving. The volume of HMA in the paver receiving hopper shall remain above the paver tunnel during all paving operations. Proper practices shall be utilized to ensure that HMA is not dumped or spilled onto the prepared underlying surface in front of the paver by trucks unloading into the receiving hopper.

C. HMA Placement Inspection.

The HMA shall be free of identifiable material (physical) segregation or temperature related segregation. The HMA placed shall be a homogeneous mixture that is of uniform temperature. The Contractor shall inspect the HMA in the paver receiving hopper for material (physical) segregation. The Contractor will also inspect the uncompacted HMA mat behind the paver for longitudinal streaks, end-of-load segregation or other irregularities.

The Contractor shall also measure the temperature differential in the uncompacted mat behind the paver. Each HMA pavement course behind the paver shall be divided into longitudinal Sublots of 500 feet (150 meters). The mat temperature differential of the uncompacted HMA shall be measured at a minimum of one location in each Sublot along a straight transverse line behind the paver at a minimum frequency of once per Sublot. The transverse line for mat temperature measurement shall be established at a distance within 10 feet (3 meters) behind the paver screed. Temperature measurements shall be obtained by the Contractor using an infrared pistol thermometer at two (2) foot intervals along the transverse line across the width of the mat and recorded on NETTCP Inspection Report Forms. The difference between the highest and lowest temperature measurement shall not exceed 20°F (10°C).

If the maximum mat temperature differential is exceeded, or if material segregation or irregularities in the HMA mat behind the paver are noted, the Contractor shall review the production, transportation, and placement operations and take corrective action. The Contractor shall make every effort to prevent or correct any irregularities in the HMA, such as changing pavers or using different and additional equipment. The Contractor's Quality Control Plan shall fully outline procedures for inspecting the HMA mat during placement, identifying and troubleshooting material segregation or temperature related segregation, and implementing corrective action.

450.56 Hot Mix Asphalt Compaction.

A. Compaction Equipment Requirements.

The Contractor shall employ compaction equipment as outlined in the approved Quality Control Plan. Equipment used for compaction of HMA Base Courses, Intermediate Courses and Surface

Courses may include steel wheeled rollers, vibratory rollers, oscillation rollers, or pneumatic-tired (rubber tired) rollers as determined appropriate by the Contractor for the particular mixture type being placed. The number and type of rollers used for breakdown, intermediate, and finish rolling shall be sufficient to achieve the target in-place density and specified course thickness.

B. Compaction Operations.

The rollers shall not crush the aggregate in the HMA mixture and shall be capable of reversing without shoving or tearing the mixture. The Contractor shall outline in the Quality Control Plan the proposed rolling sequence for each HMA pavement course to be placed. For HMA Category A Lots, the initial rolling pattern for each pavement course will be confirmed or adjusted during placement of the Control Strip in accordance with the requirements of Subsection 450.66B. As Lot placement progresses during the construction season, the rolling pattern shall be adjusted as necessary to achieve the specified HMA in-place density.

C. Compaction of Open-Graded Friction Course.

Vibratory rollers, oscillation rollers, or rubber tire rollers will not be permitted on Open Graded Friction Course (OGFC-P) mixtures. Initial rolling of OGFC-P should be accomplished with the breakdown roller within a short distance of the paver. Any subsequent rolling shall be accomplished without over-rolling the mixture. Breakdown and intermediate rolling of OGFC-P shall be completed before the material has cooled to 195°F (90°C).

D. Inspection & Testing of Compacted HMA.

The compacted HMA pavement course shall be free of material (physical) segregation and shall meet the requirements for in-place density, thickness, and ride quality specified in Subsection 450.65F. The Contractor shall inspect each Sublot of HMA throughout the compaction operation and shall further inspect the in-place HMA after Sublot completion and identify any areas of visible material (physical) segregation. The Contractor shall reject any in-place Sublot of HMA which is determined to be segregated through procedures established in the Quality Control Plan. The Contractor will also test each Sublot for in-place density, thickness, and ride quality as specified in Subsection 450.65F.

450.57 Hot Mix Asphalt Joints.

The Contractor shall plan the sequence of HMA placement to minimize transverse and longitudinal joints in each pavement course. Paving operations should employ long pulls or tandem pavers, whenever practicable, to reduce the number and length of joints.

A. Transverse Joints.

Where the start or end of a new HMA pavement course meets existing HMA pavement, the existing pavement shall be sawcut to form a transverse butt joint for the full depth of all new pavement

courses. The sawcut shall follow a straight line and provide a clean and sound vertical face. Material at any intermediate transverse joint resulting from suspension of placement of a new HMA pavement course shall also be sawcut and removed to provide a clean vertical face before continuing placement of the pavement course.

When traffic is to be carried over any transverse joint before completion of an HMA pavement course, the Contractor shall provide a temporary tapered joint with a maximum 12:1 slope. The HMA mixture forming the taper shall be placed on heavy wrapping paper or other suitable material to serve as a bond breaker. The temporary tapered joint shall be sawcut to reveal the full depth of the pavement course and form a transverse butt joint with a clean vertical face. The temporary tapered joint material shall be completely removed before resuming placement of the HMA pavement course.

Prior to the start of HMA placement at each transverse joint, the vertical joint face shall be thoroughly coated with a hot poured rubberized asphalt sealant meeting the requirements of ASTM D3405, with a minimum of 15% ground reclaimed tire rubber. The asphalt sealant temperature and application rate for each pavement course shall be established in the

Contractor's Quality Control Plan. No reheating of the joint face shall be permitted. Equipment used to apply the hot poured rubberized asphalt sealant shall be capable of maintaining the sealant at the established temperature and application rate sufficient to uniformly coat the vertical joint face without runoff or accumulation of the asphalt sealant.

B. Longitudinal Joints.

All longitudinal joints in HMA surface courses shall be located on the roadway centerline or on a lane line or edge line of the traveled way. The longitudinal joints in each pavement course below the surface course shall be successively offset from the joint in the surface course by no more than 12 inches (300 mm) and no less than six inches (150 mm).

(1) Vertical Joints.

When an HMA pavement course is placed using single paver pulls, the Contractor shall employ suitable equipment to confine the longitudinal edge of the HMA mixture to establish an edge that is near vertical. For all HMA surface course mixtures placed, when the Contractor's placement operations do not provide a confined and near vertical edge, the longitudinal edge of the surface course shall be sawcut full depth and removed to provide a clean vertical face before placement of the adjacent course of HMA.

All longitudinal joint edges of HMA surface courses, regardless of whether the joint edge is required to be sawcut, shall be treated prior to placing the adjacent pull of HMA. The vertical joint shall be coated with a hot poured rubberized asphalt sealant meeting the requirements of ASTM D3405, with a minimum of 15% ground reclaimed tire rubber. The asphalt sealant shall be applied

at a sufficient temperature and application rate sufficient to uniformly coat the vertical joint face without runoff or accumulation of the sealant. The asphalt sealant temperature and application rate shall be established in the Contractor's Quality Control Plan. No reheating of the joint shall be permitted.

When placing an HMA surface course with pavers in tandem, the use of the hot poured rubberized asphalt sealant will be omitted, provided the temperature of the mixture at the longitudinal joint does not fall below 200ºF (95ºC) prior to the placement of the adjacent mat.

When the longitudinal edge of any HMA pavement course is placed against an adjoining edge such as existing pavement, curb, gutter, drainage or utility structure, or any metal surface, a tack coat shall be uniformly applied to the entire vertical joint surface in accordance with Subsection 450.53 prior to placement of the HMA.

(2) Wedge Joints.

The Contractor may use a longitudinal wedge joint when placing HMA pavement courses at a thickness of 1.75 inches (45 mm) or greater.

When a wedge joint is proposed for use, the joint detail shall be included in the Contractor's QC Plan. The wedge joint shall include a notched vertical edge with a minimum depth of 0.5 inches (12.5 mm). The sloped surface of the wedge joint shall not exceed a 6:1 slope. The Contractor shall use a commercially manufactured wedge joint attachment to the paver, or other attachment approved by the Engineer, to form the wedge joint.

Hot poured rubberized asphalt sealant shall not be applied to wedge joints. A tack coat shall be applied to the entire surface of the wedge joint in accordance with Subsection 450.53 prior to placement of the adjacent pull of HMA.

C. Inspection & Testing of HMA Joints.

The hot poured rubberized asphalt sealant temperature and application rate shall be measured and properly recorded by the Contractor on NETTCP Inspection Report Forms a minimum of once per transverse joint and once per 1,000 feet (300 meters) of longitudinal joint. If the temperature or application rate is determined to not be in conformance with the requirements established in the Contractor's Quality Control Plan, the Contractor shall make appropriate adjustments to the asphalt sealant application operations.

The placement and compaction of HMA at each transverse joint or longitudinal joint shall provide a tight bond between the existing pavement and the new pavement course. The Contractor shall visually inspect each transverse joint and longitudinal joint throughout the placement and compaction operations and shall further inspect the joints after Sublot completion and identify any bumps, depressions, openings, or other visible defects. The Contractor shall reject any in-

place Sublot of HMA which is determined to have defective joints through procedures established in the Quality Control Plan.

Finished joint surfaces shall be smooth and true to the required grade and cross-slope without deviations exceeding 0.25 inches (6 mm), both transversely and parallel to the joint, when measured with a 10 foot (3 meter) standard straightedge. The in-place density of the completed HMA pavement course, within 1 foot (300 mm) of either side of the finished joint, shall be not less than 90% of the maximum theoretical density of the mixture as determined by AASHTO T 209. The Contractor will measure the surface smoothness and test the in-place density of each transverse joint and longitudinal joint of each Sublot of HMA as specified in Subsection 450.65F. All joint inspection and testing data shall be recorded on NETTCP Inspection Report Forms and Test Report Forms.

450.58 HMA Pavement on Bridges.

A. Bridge Course Mixture Requirements.

HMA pavement courses for bridge decks shall consist of a bridge protective course, placed first, followed by a bridge surface course. Unless specified otherwise on the plans, the bridge protective course mixture shall consist of Dense Binder treated with an approved anti-stripping compound as specified under M3.10.0.

The bridge protective course and bridge surface course shall be placed only after all curbing and edging, when included in the work, are in place. The bridge protective course shall be placed within 24 hours after the membrane waterproofing has been placed, unless an exception is granted by the Engineer. No vehicular traffic shall be permitted over any bare membrane waterproofing except as provided for under Subsection 965.62. Equipment used for placement and compaction of the bridge protective course and bridge surface course shall be sufficient to place the HMA mixture at the required grade, cross-slope, thickness, and in-place density without damaging the underlying membrane waterproofing.

B. Inspection & Testing of Bridge Course Mixtures.

The Contractor shall inspect and test each Sublot of bridge protective course HMA mixture and bridge surface course HMA mixture in accordance with the requirements for mixture temperature, mat temperature, segregation, and joint quality as specified in Subsections 450.54 through 450.57. QC sampling and testing of each Sublot shall be performed for all HMA loose mix Quality Characteristics specified in Subsection 450.65F. The in-place density of the bridge protective course and bridge surface course shall be randomly tested using a calibrated density gauge and the test data recorded on NETTCP Test Report Forms. The in-place density of the bridge protective course and bridge surface course shall be not less than 90% of the maximum

theoretical density of the mixture as determined by AASHTO T 209 and tested per AASHTO TP-68 or ASTM D2950. Cores shall only be allowed for Dispute Resolution. When the HMA bridge surface course is placed in conjunction with mainline pavement, QC testing for ride quality shall be performed as specified in Subsection 450.65F(11).

450.59 Opening to Traffic.

No vehicular traffic or loads shall be permitted on the newly completed HMA pavement until adequate stability has been attained and the material has cooled sufficiently to a temperature of 140° F (60° C) or less as indicated by a surface type thermometer. The Contractor shall clearly outline, in the Quality Control Plan, the specific criteria related to opening new pavement to traffic.

HMA cores shall be obtained by the Contractor for all Sublots placed each day in accordance with the approved Quality Control Plan prior to opening to traffic. At the discretion of the Engineer, based on climactic or other conditions, obtaining of cores may be delayed for a period up to, but not to exceed, 48 hours. In the event of force majeure resulting from direction by Traffic Police or the Engineer, the Contractor shall document the event and may submit a claim in accordance with current Department procedures. In such event, the affected Sublots will be isolated from the relevant HMA Lot and the HMA quality will be evaluated as a separate Lot.

CONTRACTOR QUALITY CONTROL

450.60 General.

The Contractor shall provide a Quality Control (QC) system, as outlined in their Quality Control Plan, adequate to ensure that all materials and workmanship meet the required quality levels for each specified Quality Characteristic. The Contractor shall provide qualified QC personnel and QC laboratory facilities and perform Quality Control inspection, sampling, testing, data analysis, corrective action (when necessary), and documentation as outlined further below.

450.61 Contractor Quality Control Plan.

For projects with HMA Category A Lots (Large Lot) or Category B Lots (Small Lot), the Contractor shall provide and maintain a detailed Quality Control Plan, hereinafter referred to as the "QC Plan". If all HMA Lots fall under Lot Category C (Minor Lot) then a QC Plan is not required. However, if any Lots on the project fall under Lot Category A or Category B, then any Category C Lots must be addressed in the QC Plan. The QC Plan should sufficiently document the QC processes of all Contractor parties (i.e. Prime Contractor, Subcontractors, Producers) performing work required under Section 450. The QC Plan is not intended to be a generic document, but rather must be project specific.

A. QC Plan Submittal Requirements.

At the pre-construction conference, the Contractor shall be prepared to discuss the Quality Control Plan. Information to be discussed shall include the proposed QC Plan submittal date, QC organization, and sources of materials. The Contractor shall submit one (1) hard copy and one (1) electronic copy of the QC Plan to the Engineer for approval not less than forty-five (45) days prior to the start of any work activities related to HMA pavement construction (including preparation of underlying surface) addressed in Subsections 450.53 thru 450.59. The Contractor shall not start work on the subject work items without an approved QC Plan.

B. QC Plan Format and Contents.

The QC Plan shall be structured to follow the format and section headings outlined below. and as outlined in further detail in the New England Transportation Technician Certification Program (NETTCP) "Model QC Plan" for HMA. In the event of discrepancies between the section headings below and the NETTCP Model QC Plan, the current version of the Model QC Plan shall take precedence. The pages of the QC Plan shall be sequentially numbered. The QC Plan shall address, in sufficient detail, the specific information requested under each section and subsection contained in the NETTCP Model QC Plan.

C. QC Plan Approval and Modifications.

Approval of the QC Plan will be based on the inclusion of the required information. Revisions to the QC Plan may be required prior to approval for any part of the QC Plan that is determined by the Department to be insufficient. Approval of the QC Plan does not imply any warranty by the Engineer that the QC Plan will result in completed work that complies with the specifications. It remains the responsibility of the Contractor to demonstrate such compliance. The Contractor may modify the QC Plan as work progresses when circumstances necessitate changes in Quality Control personnel, laboratories, or procedures. In such case, the Contractor shall submit an amended QC Plan to the Department for approval a minimum of three calendar days prior to the proposed changes being implemented.

QUALITY CONTROL PLAN OUTLINE

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2.1 QC Organizational Chart

2.2 QC Personnel

450.62 Quality Control Personnel Requirements.

The Contractor's Quality Control organization shall, at a minimum, consist of the personnel outlined below that meet the described minimum qualifications. Every effort should be made to maintain consistency in the Quality Control organization, however substitution of qualified personnel shall be allowed. When circumstances necessitate substitution of QC personnel not originally listed in the approved QC Plan, the Contractor shall submit an amended QC Plan for approval in accordance with Subsection 450.61C.

A. Quality Control Manager.

The Contractor's Quality Control system and QC Plan shall be administered by a qualified project assigned Quality Control Manager (QC Manager). The QC Manager must be a full-time employee of the Contractor or a Quality Control consultant engaged by the Contractor. The QC Manager shall have full authority to institute any and all actions necessary for the successful implementation of the QC Plan. The QC Manager (or their assistant in the QC Manager's absence) shall be available to communicate with the Engineer at all times.

Principal responsibilities of the QC Manager shall include preparation and submittal of the Contractor's QC Plan, managing the activities of all QC personnel, communicating on quality issues within the Contractor's organization, and ensuring that all requirements outlined in the approved QC Plan are met.

For all projects with HMA Category A Lots (Large Lot), the QC Manager shall be certified by the NETTCP as a Quality Assurance Technologist. For projects having only HMA Category B Lots or Category C Lots, the Contractor may submit alternate qualifications for the QC Manager acceptable to the Department.

B. Production Facility Quality Control Technician(s).

All Contractor Quality control sampling, testing, and inspection conducted at the HMA production facility shall be performed by qualified Production Facility Quality Control Technicians (Plant QCTs). The Contractor shall provide a sufficient number of Plant QCTs to adequately implement the minimum Quality Control requirements contained in Section 450 and as outlined in the approved QC Plan. A minimum of one (1) qualified Plant QCT shall be present at each production facility location. HMA will not be accepted by the Department unless the Plant QCT is physically present at the plant during production and correctly performs the required Quality Control inspection, testing and documentation.

All Plant QCTs shall be certified as a HMA Plant Technician by the NETTCP.

C. Laboratory Quality Control Technician(s).

Any QC testing that is performed at off site laboratories (i.e. other than at the production facility or field site) shall be performed by qualified Laboratory Quality Control Technicians (Laboratory QCTs). The Contractor shall provide a sufficient number of Laboratory QCTs to adequately implement the minimum Quality Control requirements contained in Section 450 and as outlined in the approved QC Plan.

All Laboratory QCTs shall be certified as a HMA Plant Technician by the NETTCP.

D. Field Quality Control Technician(s).

All Contractor Quality Control sampling, testing, and inspection conducted at the HMA field placement site shall be performed by qualified Field Quality Control Technicians (Field QCTs). The Contractor shall provide a sufficient number of Field QCTs to adequately implement the minimum Quality Control requirements contained in Section 450 and as outlined in the approved QC Plan. A minimum of one (1) qualified Field QCT will be present at each field placement site. HMA will not be accepted by the Department unless the Field QCTs is physically present at the site during pre-placement and placement operations and correctly performs the required Quality Control inspection, testing and documentation.

All Field QCTs shall be certified as a HMA Paving Inspector as certified by the NETTCP.

450.63 Quality Control Laboratory Facility Requirements.

All Contractor Quality Control testing shall be performed in laboratories qualified through the NETTCP Laboratory Certification Program (LCP) or accredited through the AASHTO Accreditation Program (AAP). Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The QC Manager shall have overall responsibility for ensuring that all laboratories utilized for Quality Control are in compliance with the requirements of the NETTCP LCP. This includes providing required AASHTO, ASTM, and NETTCP reference documents and ensuring that all required equipment and tools are properly functioning and calibrated.

The Engineer shall be permitted unrestricted access to inspect and review the Contractor's laboratory facility. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. Deficiencies shall be grounds for the Engineer to order an immediate stop to incorporating materials into the work until deficiencies are corrected. The Engineer shall be provided with laboratory space and the availability of laboratory testing equipment to conduct Acceptance testing at the HMA plant.

450.64 Quality Control Inspection.

The Contractor shall perform Quality Control inspection of all work items addressed under Section 450. Inspection activities during HMA production and placement may be performed by qualified Production personnel (e.g. Skilled Laborers, Foremen, and Superintendents). However, the Contractor's QC personnel shall have overall responsibility for QC inspection. The Contractor shall not rely on the results of Department Acceptance inspection for Quality Control purposes. The Engineer shall be provided the opportunity to monitor and witness all QC inspection.

Quality Control inspection activities must address the following four primary components:

- Equipment
- Materials
- Environmental Conditions
- Workmanship

The minimum frequency of Quality Control inspection activity shall be in accordance with the requirements below and as outlined in the approved QC Plan. The results and findings of QC inspection shall be documented on NETTCP Inspection Report Forms (IRFs).

A. QC Inspection for Preparation of Underlying Surface.

The Contractor's personnel will perform Quality Control inspection during preparation of the underlying surface in accordance with the requirements of Subsection 450.53. The minimum items to be inspected shall be as outlined in Table 450.6 and Table 450.7. The Contractor shall identify in the QC Plan the specific inspection activities necessary to ensure the quality of the work, including any additional inspection activities not specifically listed in Table 450.6 and Table 450.7.

Table 450.6 - Minimum QC Inspection of HMA Patching Operations

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Materials	Aggregates & PG Binder (Correct Type)	Per QC Plan	HMA Production Facility	Visual Check + Manufacturer COC
	Rubberized Asphalt Sealant (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
	Temperature of HMA Mix	4 per Day(1)	From Haul Vehicle at Patching Site	Check Measurement
Environmental Conditions	Underlying Surface Soundness & Moisture	Per QC Plan	Underlying Surface	Visual Check
	Temperature of Air & Underlying Surface	1 per Day(2)	At Patching Site	Check Measurement
Workmanship	Sawcut Limit Vertical Face	Per QC Plan	Sawcut Limits	Visual Check
	Rubberized Asphalt Sealant Application Rate	Per QC Plan	Sawcut Limits	Check Measurement
	HMA Lift Thickness	Per QC Plan	HMA Lift	Check Measurement
	Cross-Slope & Profile	Per QC Plan	Compacted HMA	Check Measurement

(1) The initial temperature measurements will be taken from haul vehicles on the first or second load.

(2) As a minimum, the temperature measurements of the air and underlying surface shall be obtained prior to starting the HMA patching placement.

Table 450.7 - Minimum QC Inspection of Tack Coat Operations

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Materials	Asphalt Emulsion (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC
	Asphalt Emulsion Temperature	(See Note 1)	From Tack Distributor System	Check Measurement
Environmental Conditions	Underlying Surface Cleanliness & Moisture	Per QC Plan	Underlying Surface	Visual Check
	Temperature of Air & Underlying Surface	1 per Day(2)	At Paving Site	Check Measurement
Workmanship	Asphalt Emulsion Application Rate	(See Note 1)	From Tack Distributor System	Check Measurement

(1) The Asphalt Emulsion Temperature and Application Rate shall be checked as follows:
- After application of the first 1,000 lane-feet (300 lane-meters) per HMA pavement course.
- After application of the next 1,500 lane-feet (450 lane-meters) per HMA pavement course.
- After application of the next 2,500 lane-feet (750 lane-meters) per HMA pavement course.
- Thereafter, a minimum of once per 5,000 lane-feet (1500 lane-meters) each day.

(2) As a minimum, the temperature measurements of the air and underlying surface shall be obtained prior to starting the tack coat placement.

B. QC Inspection for Production & Placement of HMA Lots.

The Contractor's QC personnel will perform Quality Control inspection at both the HMA production facility and at the site of HMA field placement to ensure that the production and placement processes are providing work conforming to the contract requirements. The minimum items to be inspected for each HMA Lot shall be in accordance with the requirements of Subsection 450.54 thru Subsection 450.59 and as outlined in Table 450.8a and Table 450.8b. The Contractor shall identify in the QC Plan the specific inspection activities necessary to ensure the quality of the

work, including any additional inspection activities not specifically listed in Table 450.8a and Table 450.8b.

(1) Wheel Path Deviations.

A wheel path is defined as 3 feet (1 meter) from and parallel to each longitudinal edge of a travel lane. Each wheel path for all HMA pavement course Lots shall be inspected for Wheel Path Deviations (high points or low points). Inspection shall be performed using a 10-foot (3 meter) standard straightedge in the longitudinal direction on each wheel path. The Sublot size and minimum frequency of QC inspection for Wheel Path Deviations shall be as specified in Table 450.8b, and in the approved Contractor Quality Control Plan. Each random inspection location shall be established by determining a randomly selected distance along the wheel path in accordance with ASTM D3665. Additional selective QC inspection for Wheel Path Deviations within each Sublot of compacted HMA pavement courses shall be as determined necessary by the Field QCT and as specified in the Contractor's approved QC Plan.

The variation from the edge of the 10-foot (3 meter) straightedge to the top of the wheel path surface between any two contact points in the wheel path shall not exceed 0.25 inches (6 mm). The Contractor shall correct any location in a pavement course wheel path not meeting this requirement. The corrective method(s) proposed by the Contractor shall be subject to the approval of the Department and shall be performed at the Contractor's expense. The Contractor shall re-inspect any Sublots where corrections are made and provide the Department with a copy of the inspection data for the corrected Sublots.

Table 450.8a - Minimum QC Inspection at HMA Production Facility

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Materials	PG Binder (Correct Type)	Per QC Plan	HMA Production Facility	Visual Check + Manufacturer COC
	Aggregates (Correct Type)	Per QC Plan	HMA Production Facility	Visual Check
	RAP	Per QC Plan	HMA Production Facility	Visual Check
	MAS	Per QC Plan	HMA Production Facility	Visual Check + Manufacturer COC
	Release Agent	Per QC Plan	Haul Vehicle Bed at Plant	Check QPL + Visual Check + Manufacturer COC
	Temperature of HMA Mix at Plant	4 per Day(1)	From Haul Vehicle at Plant	Check Measurement
Environmental Conditions	Stockpile Moisture	Per QC Plan	HMA Production Facility	Visual Check
	Air Temperature & Precipitation Forecast	1 per Day(2)	HMA Production Facility	Check Measurement
Workmanship	Uncoated Mixture	Per QC Plan	HMA Production Facility	Visual Check
	Excess Blue Smoke or Moisture	Per QC Plan	HMA Production Facility	Visual Check
	Burnt Mix	Per QC Plan	HMA Production Facility	Visual Check
	Physical Segregation	Per QC Plan	HMA Production Facility	Visual Check

(1) The initial temperature measurements shall be taken from the first or second load.
(2) As a minimum, the air temperature measurements and precipitation forecast shall obtained prior to starting the HMA Plant operation.

Table 450.8b - Minimum QC Inspection at HMA Placement Location

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Materials	Rubberized Asphalt Sealant (Correct Type)	Per QC Plan	Per QC Plan	Check Manufacturer COC
	Temperature of Delivered HMA Mix	4 per Day(1)	From Haul Vehicle or Paver Hopper	Check Measurement
Environmental Conditions	Underlying Surface Soundness & Moisture	Per QC Plan	Underlying Surface	Visual Check
	Temperature of Air & Underlying Surface	1 per Day(2)	At Paving Site	Check Measurement
Workmanship	Joint Location & Alignment	Per QC Plan	Per QC Plan	Visual Check
	Sawcut Joint Vertical Face	Per QC Plan	Joint Vertical Face	Visual Check
	Rubberized Asphalt Sealant Application Rate	Once per 1,000 ft (300 meters) per joint	Joint Vertical Face	Check Measurement
	Temperature Differential in HMA Mat	Once per 500 feet (150 meters) per pavement course	HMA Mat Behind Paver	Per Subsection 450.55C
	Physical Segregation	Per QC Plan	HMA Mat Behind Paver & Compacted HMA	Visual Check
	HMA Lift Thickness	Per QC Plan	HMA Lift	Check Measurement
	Cross-Slope	Per QC Plan	Compacted HMA	Check Measurement
	Joint Tightness	Per QC Plan	Compacted HMA	Visual Check
	Joint Surface Deviations	Once per 500 feet (150 meters) per joint	At Finished Joint	10 foot (3 meter) standard straightedge
	Wheel Path Deviations	Once per 2,000 ft (600 meters) per Wheel Path	Wheel Path	10 foot (3 meter) standard straightedge

(1) The initial temperature measurements will be taken from the first or second load.
(2) As a minimum, the temperature measurements of the air and underlying surface shall be obtained prior to starting the HMA placement.

450.65 Quality Control Sampling and Testing Requirements.

The Contractor's QC personnel will perform Quality Control sampling and testing at both the HMA production facility and at the site of HMA field placement to ensure that the production and placement processes are providing work conforming to the contract requirements. The Engineer will not sample or test for Quality Control or assist in controlling the Contractor's operations. All QC sampling and testing shall be in accordance with the AASHTO, ASTM, NETTCP, or Department procedures specified in Table 450.9 and Table 450.10. The Contractor shall furnish approved containers for all material samples. The Engineer shall be provided the opportunity to monitor and witness all QC sampling and testing.

A. Random Sampling.

The Contractor's Quality Control system shall utilize stratified random sampling of each Lot produced and placed to assure that all material within the Lot has an equal probability of being selected for testing. The Contractor's qualified QC personnel shall obtain random QC samples at the minimum frequencies specified in Table 450.9 and Table 450.10. In all cases, application of the specified QC sampling frequencies shall result in a minimum one random sample per Sublot.

Random sample locations shall be determined using the random number tables and procedures contained in ASTM D 3665 or an electronic random number generator, as presented by the NETTCP. The determination of all random sample locations shall be documented on NETTCP Standard Test Report Form D3665. The Contractor will provide the Engineer with the random QC sampling locations selected and documented for each Sublot prior to production and placement of the relevant Sublots.

B. Selective Sampling.

The Contractor's Quality Control system will also utilize selective sampling (i.e. non-random samples) as needed to provide supplemental information to assist in maintaining all production and placement processes in control. The Contractor's qualified QC personnel shall obtain selective QC samples from any Sublot as determined necessary and in accordance with the guidelines established in the approved QC Plan.

C. QC Sample Identification System.

The Contractor shall establish a reliable system for the identification of all QC samples obtained. All PG Asphalt Binder samples, HMA loose mixture samples, and core samples shall be correctly labeled with the following minimum information:

(a) Contract No.
(b) Date of Sample.
(c) Mixture Type.

(d) Lot & Sublot No.
(e) Sample No.
(f) Sample Type (i.e. Random or Selective).
(g) Sample Location (e.g. Station & Offset).

All QC sampling data for Ride Quality and Wheel Path Deviations will be identified by the Contractor as directed by the Engineer. The Contractor's system and procedures for identification of QC samples shall be outlined in the approved QC Plan.

D. Retention of Split Samples.

The Contractor's qualified QC personnel shall obtain all material samples (PGAB samples, HMA loose mix samples, and cores) for QC testing. The Contractor will retain split samples from each PGAB sample and HMA loose mix sample and provide a split sample to the Engineer if requested. The Contractor shall retain the original core samples after testing to serve as "split samples" and protect them from damage. All split samples shall be properly labeled and stored for a period of (30) days, or until tested. These split samples (PGAB samples, HMA loose mix samples, and cores) will be utilized if necessary, in the Dispute Resolution process. If mutually agreed upon by the Contractor and the Department, the retained split samples may be discarded prior to the required thirty (30) days.

E. Quality Control Testing of Prepared Underlying Surface.

The Contractor's QC personnel will perform Quality Control testing during preparation of the underlying surface. All QC testing shall be in accordance with the AASHTO, ASTM, NETTCP, or Department procedures specified in Table 450.9. The Engineer shall be provided the opportunity to monitor and witness all QC testing.

Table 450.9 - Minimum QC Sampling & Testing of Prepared Underlying Surface

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Sampling Method
HMA Patching Mixture: PG Asphalt Binder Content	AASHTO T164 or AASHTO T308	150 tons (140 Mg)	1 per Sublot	From Haul Vehicle at Plant	Random AASHTO T168
HMA Patching Mixture: Combined Agg. Gradation	AASHTO T30	150 tons (140 Mg)	1 per Sublot	From Haul Vehicle at Plant	Random AASHTO T168
HMA Patching Mixture: Maximum	AASHTO T209	150 tons (140 Mg)	1 per Sublot	From Haul Vehicle at Plant	Random AASHTO T168

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Sampling Method
Theo. Specific Gravity					
HMA Patching Mixture: In-place Density	ASTM D2950 or AASHTO TP68	100 sq. feet. (10 sq. meter) per each Patch Area	1 per Sublot	From Compacted HMA Patch	Random ASTM D2950, AASHTO TP68

F. Quality Control Testing of HMA Lots.

The Contractor's QC personnel will perform Quality Control testing at both the HMA production facility and at the site of HMA field placement to ensure that the production and placement processes are providing work conforming to the contract requirements. The Engineer shall be provided the opportunity to monitor and witness all QC testing of HMA. All QC testing of HMA Lots shall be in accordance with the AASHTO, ASTM, NETTCP, or Department test methods specified in Table 450.10 and the procedures outlined below.

Table 450.10 - Minimum Quality Control Sampling & Testing of HMA Lots

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Sampling Method
PG Asphalt Binder Grading	AASHTO M320	Per Supplier QC Plan or 24,000 tons (22,000 Mg) of HMA per Subsection 450.65F(1)	See Subsection 450.65F(1)	See Subsection 450.65F(1)	Random AASHTO T40
Aggregate Gradation	AASHTO T27	Per QC Plan	Per QC Plan	At HMA Plant Per QC Plan	Random AASHTO T2
PG Asphalt Binder Content	AASHTO T164 or AASHTO T308	600 tons (550 Mg)	1 per Sublot[(1)]	From Haul Vehicle at Plant	Random AASHTO T168
Combined Aggregate Gradation	AASHTO T30	600 tons (550 Mg)	1 per Sublot[(1)]	From Haul Vehicle at Plant	Random AASHTO T168
Maximum Theo. Specific Gravity	AASHTO T209	600 tons (550 Mg)	1 per Sublot[(1)]	From Haul Vehicle at Plant	Random AASHTO T168

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Sampling Method
Bulk Specific Gravity	AASHTO T166 (SSD Method)	600 tons (550 Mg)	1 per Sublot(1)	From Haul Vehicle at Plant	Random AASHTO T168
Volumetrics: Air Voids, VMA, VFA	AASHTO T245	600 tons (550 Mg)	1 per Sublot(1)	From Haul Vehicle at Plant	Random AASHTO T168
In-place HMA Mat Density (Density Gauge)	ASTM D2950 or AASHTO TP68	150 tons (140 Mg)	1 per Sublot(1)	From Compacted HMA Course	Selective & Random ASTM D2950, AASHTO TP68
In-place HMA Mat Density (Cores)	AASHTO T230 AASHTO T166 AASHTO T269	600 tons (550 Mg)	1 per Sublot(1)	From Compacted HMA Course	Random AASHTO T269
Thickness	AASHTO T269	600 tons (550 Mg)	1 per Sublot(1)	From Compacted HMA	Random AASHTO T269
Transverse Joint Density	ASTM D2950 or AASHTO TP68	Each Joint	1 per Sublot(1)	At Finished Joint	Random ASTM D2950, AASHTO TP68
Longitudinal Joint Density	ASTM D2950 or AASHTO TP68	500 feet (150 meters) per Joint	1 per Sublot(1)	At Finished Joint	Random ASTM D2950, AASHTO TP68
Ride Quality (IRI)	AASHTO PP52 Per Subsection 450.65F(11)	0.1 miles (160 meters) per each Wheel Path	3 Runs per Sublot	Each Pavement Course Per Subsection 450.65F(11)	Random Per Subsection 450.65F(11)
Wheel Path Deviations	10 foot (3 meter) standard straightedge	500 feet (150 meters) per each Wheel Path	1 per Sublot(1)	Each Pavement Course Per Subsection 450.65F(12)	Random Per QC Plan

(1) In the event that the total daily HMA production is less than one Sublot, a minimum of one random QC sample shall be obtained for the day's production.

(1) PG Asphalt Binder Grading.

QC testing of PG Asphalt Binder shall be performed by the PGAB Supplier in accordance with AASHTO R26 and the Supplier's approved PGAB Quality Control Plan. The Contractor shall submit to the Engineer a Supplier's Certificate of Compliance (COC) along with copies of the certified AASHTO M320 test results for each Supplier Lot of PGAB from which the HMA Producer's PGAB was obtained.

If the Contractor modifies the PGAB at the HMA production facility through blending or introduction of an asphalt binder modifier, the Contractor (i.e. HMA Producer) shall assume responsibility as the PGAB Supplier per AASHTO R26. In such case, the Contractor shall obtain and test a minimum of one random sample of the modified PGAB for each 24,000 ton (22,000 Mg) HMA Sublot, as defined in Table 450.10, to determine conformance with AASHTO M320. A minimum of two 1-quart (1 Liter) containers of PGAB shall be obtained for each PGAB sample in accordance with AASHTO T40. All QC samples shall be split prior to testing and the un-tested portion of the sample shall be retained for a minimum of 30 days.

For HMA Category A Lots incorporating greater than 25% RAP or greater in the job-mix formula, the Contractor shall perform full asphalt binder grade testing on a minimum of one random sample from the Control Strip and from each Sublot as specified in Table 450.10 during HMA Lot production. The QC testing shall be performed on samples of asphalt binder recovered from the RAP (by Abson recovery) blended in the appropriate proportion with samples of the virgin PGAB to determine conformance with AASHTO M320. The PG Asphalt Binder Grade testing results shall be within ± 2ºC of the specified PGAB grade for the HMA pavement course mixture.

(2) Aggregate Gradation.

The virgin aggregates utilized in each HMA Lot shall be tested for Gradation in accordance with AASHTO T27. The Sublot size and minimum frequency of QC testing for Aggregate Gradation shall be as specified in the Contractor's approved QC Plan. Aggregate samples shall be obtained at the HMA plant from aggregate bins or stockpiles in accordance with AASHTO T2.

(3) PG Asphalt Binder Content.

Each HMA Lot produced and placed shall be tested for PG Asphalt Binder Content in accordance with either AASHTO T164 or T308. When AASHTO T164 is used, the test results shall be reported prior to ash correction. The Sublot size and minimum frequency of QC testing for PG Asphalt Binder Content shall be as specified in Table 450.10. Each material sample for PG Asphalt Binder Content shall be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

(4) Combined Aggregate Gradation.

Each HMA Lot produced and placed shall be tested for Combined Aggregate Gradation in accordance with AASHTO T30. The Sublot size and minimum frequency of QC testing for Combined Aggregate Gradation shall be as specified in Table 450.10. Each material sample for Combined Aggregate Gradation shall be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

The QC test results of Combined Aggregate Gradation must be plotted on Control Charts with Action Limits. Recommended Action Limits are provided in Table 450.11, however, the Action Limits to be used for each HMA Lot shall be as specified in the Contractor's approved QC Plan. If the QC test results for an individual Sublot fall outside of the established Action Limits, the Contractor shall evaluate the HMA production process and determine any adjustments necessary to bring the Combined Aggregate Gradation back within the Action Limits. If the subsequent Sublot test result falls outside of the Action Limits, the Contractor shall suspend Lot production until it can be demonstrated that the HMA mixture can be produced within the Action Limits. The Contractor's QC personnel shall document all action(s) taken to bring the HMA production process into control.

Table 450.11 - Recommended Action limits for Combined Aggregate Gradation

Sieve Size	Action Limit
Passing No. 4 Sieve (4.75mm) and larger sieve sizes	JMF Target +/-6 percent
Passing No. 8 sieves (2.36mm)	JMF Target +/-5 percent
Passing No. 16 (1.18mm) to No. 50 (300μm) sieves (inclusive)	JMF Target +/-3 percent
Passing No. 100(150μm) sieve	JMF Target +/-2 percent
Passing No. 200(75μm) sieve	JMF Target +/-1 percent

(5) Maximum Theoretical Specific Gravity.

Each HMA Lot produced and placed shall be tested for Maximum Theoretical Specific Gravity in accordance with AASHTO T209. The Sublot size and minimum frequency of QC testing for Maximum Theoretical Specific Gravity shall be as specified in Table 450.10. Each material sample for Maximum Theoretical Specific Gravity shall be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

(6) Bulk Specific Gravity.

Each HMA Lot produced and placed shall be tested for Bulk Specific Gravity in accordance with AASHTO T166 (SSD Method). The Sublot size and minimum frequency of QC testing for Bulk

Specific Gravity shall be as specified in Table 450.10. Each material sample for Bulk Specific Gravity shall be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

(7) Volumetrics (Air Voids, VMA, VFA).

Each HMA Lot produced and placed shall be tested for Volumetrics (Air Voids, VMA, VFA) in accordance with AASHTO T245. The requirement for Volumetric testing of laboratory compacted specimens applies to HMA mixtures for all pavement courses, with the exception of Open Graded Friction Courses and Base Courses. The Sublot size and minimum frequency of QC testing for Volumetrics shall be as specified in Table 450.10. Each material sample for Volumetrics shall be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

(8) In-place HMA Mat Density.

Each HMA Lot produced and placed shall be tested for In-place Density using a density gauge or cores as specified below. The requirement for In-Place Density testing applies to all pavement courses, with the exception of Open Graded Friction Courses and Leveling Courses. The Sublot size and minimum frequency of random QC testing for In-place Density by either density gauge or core shall be as specified in Table 450.10.

(a) ***Testing In-Place Density by Density Gauge.*** Initial QC testing of In-Place Density during compaction of HMA pavement courses shall be performed selectively (or randomly when determined appropriate by QC personnel) using a density gauge in accordance with ASTM D2950 or AASHTO TP 68. QC testing of In-Place Density for all HMA bridge protective courses and bridge surface courses shall be performed randomly using a density gauge. Each random sampling and testing location for HMA bridge courses shall be established by determining a randomly selected tonnage and corresponding approximate longitudinal distance within the Sublot, along with a randomly selected offset distance in accordance with ASTM D3665. Additional selective QC sampling and testing within each Sublot of compacted HMA bridge protective courses or bridge surface courses shall be as determined necessary by the Contractor's QC personnel and as specified in the Contractor's approved QC Plan.

(b) ***Testing In-Place Density by Cores.*** Final QC testing of In-Place Density of all applicable HMA pavement courses shall be performed using 6-inch (150 mm) diameter cores in accordance with AASHTO T230, T166, and T269. Cores shall not be obtained from bridge protective surface courses. In-Place Density shall be determined from each core by comparing the Bulk Specific Gravity of the core to the average Maximum Theoretical Specific Gravity for all HMA mixture Sublots produced for the pavement course on the same day's production. Each core location shall be established by determining a randomly selected tonnage and corresponding approximate longitudinal distance within the Sublot, along with a randomly selected offset distance in

accordance with ASTM D3665. If the randomly determined sampling location coincides with one of the following conditions, the sampling location shall be relocated immediately beyond the boundary distance as indicated below for the specific condition:

1. Within 1 foot (300mm) from an edge of pavement course to be left unconfined upon project completion
2. Within 1 foot (300mm) of any longitudinal joint or transverse joint.
3. Within 3 feet (1 meter) of any drainage structure.

Core samples shall be obtained in accordance with AASHTO T230 prior to opening the pavement course to traffic. At the discretion of the Engineer, based on climactic or other conditions, obtaining of cores may be delayed for a period up to, but not to exceed, 48 hours. All cores shall be protected against damage and tested within 24 hours after they have been obtained. The Contractor shall fill all core holes, whether from QC sampling or Department Acceptance sampling, with fresh HMA mixture from the same Lot. The filled core holes shall be thoroughly compacted as outlined in the Contractor's approved QC Plan.

(9) Thickness.

Each HMA pavement course specified to be placed at a compacted thickness of 1 inch (25mm) or greater shall be tested for Thickness using cores, with the exception of the following courses:

1. Open Graded Friction Course.
2. Bridge Surface Course.
3. Bridge Protective Course.
4. Leveling Course.
5. In the absence of a Leveling Course, the first pavement course placed over existing pavement.

The aforementioned pavement courses are exempt only from determination of Thickness using cores and the corresponding statistical evaluation of Lot quality. The Contractor is still responsible for ensuring the minimum required thickness of these pavement courses using an appropriate sampling and testing protocol as outlined in the Contractor's approved QC Plan.

All sampling and testing for Thickness of the applicable pavement courses using cores shall be in accordance with AASHTO T269. The Sublot size and minimum frequency of random QC testing for Thickness shall be as specified in Table 450.10.

(10) Joint Density.

Each transverse joint and longitudinal joint formed during placement of a pavement course shall be tested for Joint Density using a density gauge in accordance with ASTM D2950. The requirement for Joint Density testing applies to all pavement courses, with the exception of Open Graded

Friction Courses and Leveling Courses. The Sublot size and minimum frequency of random QC testing for Joint Density shall be as specified in Table 450.10.

Each random sampling and testing location shall be established by determining a randomly selected distance along the joint, along with a randomly selected offset distance within 1 foot (300 mm) of either side of the finished joint, in accordance with ASTM D3665. Additional selective QC sampling and testing of Joint Density within each Sublot of compacted HMA pavement courses or bridge protective surface courses shall be as determined necessary by the Field QCT and as specified in the Contractor's approved QC Plan.

(11) Ride Quality.

The finished surface of the pavement shall be uniform in appearance, free from irregularities in contour and texture and shall present a smooth riding surface. Ride Quality testing shall be performed for Quality Control on a periodic basis during construction of the HMA pavement courses specified below. QC testing shall be performed for HMA Category A Lots, at a minimum, within 24 hours after each 8 lane-miles (13 lane-kilometers) of an individual pavement course have been placed. QC testing of HMA Category B Lots shall be performed, at a minimum, every other paving day. In addition, the Contractor shall perform QC testing of the entire final pavement course placed upon completion.

(a) ***Pavement Courses Subject to Ride Quality Testing.*** For projects having a posted speed equal to or greater than 40 mph with HMA Lots falling under Lot Category A (Large Lots) or Category B (Small Lots), QC testing shall be performed with an inertial profiler to determine the Ride Quality of the following pavement courses:

- Friction Course (OGFC-P)
- Surface Course
- Intermediate Course (lift immediately beneath Surface Course only)
- Leveling Course (when placed immediately beneath Surface Course)
- Bridge Surface Course (when asphaltic bridge joints are used and when placed on the same contract with the mainline Surface Course)

At a minimum, the finished surface of these pavement courses will be tested for all mainline travel lanes, auxiliary lanes, ramps, and side road travel lanes. The Contractor may also elect to perform Ride Quality testing of the pavement courses beneath the courses indicated above in order to provide adequate Quality Control.

(b) ***Pavement Courses Excluded from Ride Quality Testing***

The following pavement courses and surfaces are specifically excluded from Ride Quality testing:

1. All exposed concrete bridge decks and any Bridge Surface Course without asphaltic bridge joints (including 15 feet (5 meters) before the approach joint and 15 feet (5 meters) after the departure joint).
2. Mainline pavement courses less than one half mile (800 meters) in total length (excluding bridge lengths).
3. Side road pavement courses less than one Sublot (0.1 mile (160 meters)) in total length.
4. Single resurfacing pavement courses placed in one lift at a total plan (compacted) thickness less than 1.50 inches (40 millimeters).
5. Pavement courses on horizontal curves having a centerline radius of curvature of 500 feet (150 meters) or less, including the length of pavement within the super-elevation transition of such curves.
6. Pavement courses for shoulders.
7. Pavement segments with manholes or catch basins in the travel lane (the Ride Quality testing data for such pavement segments shall be excluded, including 15 feet (5 meters) before and after these manholes or catch basins).

(c) ***Inertial Profiler Equipment Requirements.*** All inertial profilers used for Contractor QC testing shall conform to the equipment specifications contained in AASHTO PP50 and ASTM E950. The inertial profiler shall be equipped with a system of transducers (height sensor, accelerometer, distance sensor) to measure the longitudinal pavement profile. An automated triggering system shall be provided that detects a reference mark to start, stop, and event mark the data collection process. The profiler equipment shall include an onboard computer system capable of storing all profile measurement data, calculating the real time International Roughness Index (IRI) per ASTM E1926 (independent of speed), and displaying profile plots.

(d) ***Certification and Correlation of Inertial Profilers.*** All inertial profilers used for Contractor QC testing must be certified for precision and accuracy in accordance with the requirements of AASHTO PP51. In addition, all Contractor QC profilers must be correlated against the Department's reference profiling device in accordance with the Department's correlation procedures. The certification and correlation of all profilers shall be conducted at the Profiler Correlation Center in New Bedford, MA established by the University of Massachusetts at Dartmouth. The certification and initial correlation of the Contractor's inertial profiler shall be completed prior to the start of Ride Quality testing on the project. After the initial correlation is successfully completed, the same inertial profiler can be used on any Department project without re-correlation for the remainder of the construction season. Equipment that does not pass the Department's correlation procedure shall not be used. The Contractor's use of inertial profiler equipment that has not been successfully correlated is sufficient grounds for withholding payment for QC testing of Ride Quality. The Contractor's inertial profiler equipment may be required to undergo re-correlation at any time during the construction season if significant variations are found within the Contractor's QC test data or between the QC test data and the Department's Acceptance test data.

(e) ***Ride Quality Testing Procedures.*** Ride Quality testing shall be performed in accordance with the procedures outlined in AASHTO PP52, as clarified or amended herein.

The Ride Quality will be measured for each wheel path [a wheel path is defined as 3 feet (1 meter) from and parallel to each longitudinal edge of the lane to be measured]. Each wheel path will be divided into 0.1 mile (160 meters) Sublots starting at the project limits in the direction of traffic. Partial Sublots may result at either end of the project or as a result of interruptions of the continuous pavement surface (i.e. bridge approaches, railroad crossing, cessation of daily paving operations, etc.).

Just prior to testing, the Contractor shall sweep the pavement and remove all foreign objects or materials on the pavement course surface. Testing will begin 15 feet (5 meters) after the transverse approach joint and end 15 feet (5 meters) before the transverse departure joint. A minimum of three and up to a maximum of five test runs will be performed on each wheel path. The final test result for each Sublot will be the average of the three best test runs.

(f) ***Data Format and Reporting Requirements.*** All Ride Quality QC testing data shall be collected and saved in electronic format in an ASCII data file. A copy of the raw data file shall be provided to the Engineer on site immediately following testing of completed Sublots. A longitudinal profile shall be determined for all Sublots tested and an average IRI value shall be determined and reported for each Sublot (i.e. each 0.1 mile (160 meters) segment of each wheel path). The Contractor shall summarize the results for all Sublots, by corresponding Ride Quality Lot, in an electronic spreadsheet file (MS Excel) consistent with the format of the Department's QA Spreadsheets. The summary spreadsheet of QC testing data shall be submitted to the Department, electronically and in hardcopy, within two days after the testing is completed.

(g) ***Ride Quality Monitoring & Corrective Action.*** The Contractor shall evaluate and monitor the test data for each pavement course requiring Ride Quality testing for conformance with the applicable Quality Limits specified in Table 450.19. If the running Quality Level for all Sublots placed and tested falls below the Suspension Quality Level (70 PWL), the Contractor shall suspend further placement of the corresponding pavement course and evaluate the Sublots placed for appropriate corrective action. If the running Mean IRI of all Sublots placed and tested for the pavement course immediately below the final course is greater than the Action Limits specified in Table 450.12, corrective action will be required prior to placement of the final pavement course.

When Ride Quality correction is required, the Contractor shall use one or more of the following corrective methods:

1. Removal and replacement of the entire pavement course.
2. Partial depth removal of the pavement course by milling and placement of new pavement course(s) of the same mixture type.
3. Overlaying (not patching) with the specified pavement course.

4. Diamond grinding or use of other surface profiling devices.

The corrective method(s) chosen by the Contractor shall be subject to the approval of the Department and shall be performed at the Contractor's expense. The Contractor shall retest any Sublots where corrections are made and provide the Department with a copy of the raw data file, the profile plot, and the IRI summary spreadsheet data for the corrected Sublots.

Table 450.12 - Action Limits for Pavement Course Below Final Pavement Course

Posted Speed Limit(1)	Target IRI	Maximum Mean IRI of All Sublots Tested
Greater than or equal to 55 mph (90 km/hr)	60 in/mile (0.95 m/km)	≤ 85 in/mile (1.34 m/km)
40 mph (65 km/hr) to 55 mph (90 km/hr)	80 in/mile (1.26 m/km)	≤ 105 in/mile (1.66 m/km)
Less than 40 mph (65km/hr)	Not subject to Ride Quality testing	N/A

(1) Note that projects with posted speed limits that fall into more than one of the Posted Speed Limit ranges above will be divided into multiple Lots and evaluated separately.

450.66 HMA Mix Design Verification and Control Strip Requirements.

For all pavement courses with HMA Lots falling under Lot Category A (Large Lots), the HMA mix design Verification and Control Strip procedures outlined below shall apply.

A. Laboratory Verification of HMA Mix Design.

The Contractor shall develop and submit a Laboratory Trial Mix Formula (LTMF) for each HMA mixture type, which is to be proposed as a Job Mix Formula, a minimum of forty-five (45) days prior to the start of HMA production. The Contractor shall not proceed to HMA production for the Control Strip as outlined below until the LTMF is verified by the Department.

B. HMA Control Strip.

The Contractor shall produce and place a Control Strip Lot for all HMA pavement courses, with the exception of Leveling Courses, on the first day of HMA production. The Control Strip will be used to verify that the HMA can be produced per the LTMF, to establish compaction patterns, and to verify that the equipment and processes for lay-down and compaction are capable of providing the HMA pavement course in conformance with these specifications. The Control Strip Lot shall consist of a minimum of 600 tons (550 Mg) of HMA, but not more than 1,800 tons (1,650 Mg). Each Control Strip will be divided into three (3) equal Sublots. The Contractor

and the Department will both perform inspection, sampling, and testing on the Control Strip and evaluate the corresponding data as outlined below.

(1) Control Strip Inspection.

The Contractor's QC personnel shall perform inspection of each Control Strip Sublot at both the HMA production facility and at the site of HMA field placement. The specific items to be inspected for the Control Strip shall include the four primary inspection components (Equipment, Materials, Environmental Conditions, Workmanship) in accordance with the requirements of Table 450.8a, Table 450.8b and as specified in the Contractor's approved QC Plan. The Department will also inspect each Control Strip Sublot for the inspection components of Materials and Workmanship.

(2) Control Strip Sampling and Testing.

The Contractor and the Department shall independently sample and test the Control Strip Lot for the Quality Characteristics identified in Table 450.13. The Contractor and the Department shall each sample and test each Sublot produced and placed. Each Contractor QC sample and each Agency Acceptance sample shall be randomly obtained from each Sublot in accordance with ASTM D3665 and the prescribed sampling protocols for each Quality Characteristic as outlined in Subsection 450.65F. Split samples shall be retained for each Sublot by both the Contractor and the Department in accordance with Subsection 450.65D.

(3) Evaluation of Control Strip Inspection Data.

The Contractor and the Department shall each evaluate their respective Control Strip inspection data against the requirements for Materials and Workmanship specified in Subsection 450.53 thru Subsection 450.58.

(4) Evaluation of Control Strip Sampling and Testing Data.

The Contractor and the Department shall each evaluate their respective individual Sublot test results against the Control Strip Quality Limits in Table 450.13. The Contractor and the Department shall also evaluate the Control Strip Lot Quality Level (PWL) using the Specification Limits in Table 450.13 for those Quality Characteristics subject to Quality Level Analysis. The Contractor's QC test data shall be combined with the Agency's Acceptance test data to determine the Lot Quality Level, provided that the QC data is Validated against the Acceptance data in accordance with Subsection 450.77. The Control Strip Lot Quality Level must be 70 PWL or greater.

Table 450.13 - Control Strip Quality Limits

Quality Characteristic	Target	Specification Limits		Engineering Limits		Acceptance Limit
		LSL	USL	LEL	UEL	
PG Asphalt Binder Grading	Per Binder Grade specified	N/A	N/A	Per AASHTO M320	Per AASHTO M320	N/A
PG Asphalt Binder Content	Per LTMF	Target - 0.3 %	Target + 0.3 %	Target - 0.4 %	Target + 0.4 %	≥ 70 PWL
Volumetrics: Air Voids	4 %	2.7 %	5.3 %	2 %	6 %	≥ 70 PWL
Combined Gradation: Passing #4 (4.75mm) and Larger Sieves	Per LTMF	N/A	N/A	Target - 7%	Target + 7%	N/A
Combined Gradation: Passing #8 (2.36mm) Sieve	Per LTMF	N/A	N/A	Target - 5%	Target + 5%	N/A
Combined Gradation: Passing #16 (1.18mm) to #50 (300um) Sieve	Per LTMF	N/A	N/A	Target - 4%	Target + 4%	N/A
Combined Gradation: Passing #100 (150um) Sieve	Per LTMF	N/A	N/A	Target - 3%	Target + 3%	N/A
Combined Gradation: Passing #200 (75um) Sieve	Per LTMF	N/A	N/A	Target - 1.5%	Target + 1.5%	N/A
In-Place HMA Mat Density (Cores)	95 % of G_{mm}	92.5 % of G_{mm}	97.5 % of G_{mm}	92 % of G_{mm}	98 % of G_{mm}	≥ 70 PWL
Thickness*****: (All Courses 1 inch (25mm) or greater)	Per Plans	- 20 % of Target Thickness	+ 20 % of Target Thickness	- 30 % of Target Thickness	+ 30 % of Target Thickness	≥ 70 PWL
Ride Quality*****: Greater than or equal to	50 in/mile (0.79 m/km)	N/A	70 in/mile (1.10 m/km)	N/A	80 in/mile (1.26 m/km)	≥ 70 PWL

Quality Characteristic	Target	Specification Limits		Engineering Limits		Acceptance Limit
		LSL	USL	LEL	UEL	
55 mph (90 km/hr)						
Ride Quality*: 40mph (65 km/hr) to 55 mph (90 km/hr)	70 in/mile (1.10 m/km)	N/A	100 in/mile (1.58 m/km)	N/A	110 in/mile (1.74 m/km)	>70 PWL

*To be evaluated for applicable pavement courses subject to testing per Subsection 450.65F. The Quality Limits for Ride in Table 450.13 shall only apply to Control Strips for the final pavement course (HMA Surface Course or Friction Course). For pavement courses below the final pavement course that are subject to Ride Quality testing, the Mean IRI for the Control Strip Sublots shall be less than or equal to the Maximum Mean IRI values in Table 450.12.

(5) Verification of Control Strip Lot and LTMF.

In order for a Control Strip Lot and corresponding LTMF to be Verified, the following criteria must be met:

a) All Attributes inspected for each Sublot must meet the specification requirements in Table 450.16.
b) All individual Sublot test results for the Quality Characteristics tested on the Control Strip must be within the Engineering Limits in Table 450.13.
c) If the evaluation of all inspection data and testing data for the Control Strip indicates that the individual Sublots are in conformance with the requirements outlined in Subsection 450.66 B paragraphs (3) and (4) above and the Lot Quality for each applicable Quality Characteristic in Table 450.13 is ≥ 70 PWL, the Control Strip Lot and LTMF shall be declared "Verified". In such event, the LTMF shall become the Job Mix Formula (JMF) for the Lot and the Contractor may proceed with production and placement of the first HMA Lot.
d) If the Control Strip is not Verified, the Contractor shall reassess the LTMF, the production process, and the placement process to determine the apparent cause(s) of nonconformance. The Contractor must submit proposed adjustment(s) to the LTMF and/or the production process and/or placement process. If adjustments to the LTMF are "major" (as defined in Table 1 of AASHTO R 42), the Contractor will be required to submit a new LTMF for laboratory verification by the Engineer per the requirements of Section 450.66A. If proposed adjustment(s) are accepted by the Engineer, the Contractor may proceed with a subsequent Control Strip.

e) If a 2nd or any subsequent Control Strip does not pass all of the inspection and testing requirements, the Contractor must submit proposed adjustment(s) to the LTMF and/or the production process and/or placement process,
f) If the computed PWL for any Quality Characteristic, with the exception of thickness, is < 60 PWL, the Control Strip Lot will be determined rejected and shall be removed. If the mean thickness of the Lot is determined to be greater than the target, it may remain in place, but payment will be based upon the HMA tonnage calculated at the target thickness.
g) For any Control Strip that is not Verified, the Contractor shall prepare a Corrective Action Plan for the nonconforming Control Strip Lot. The corrective method(s) proposed by the Contractor shall be subject to the approval of the Department and shall be performed at the Contractor's expense.

(6) Acceptance and Payment of Control Strips

(a) 1st and 2nd Control Strip

For each Control Strip Lot that has been Verified, payment shall be determined for each individual Quality Characteristic in accordance with the pay adjustment provisions of Subsection 450.92. If the Lot Quality Level for an individual Quality Characteristic is 90 PWL, payment for the Quality Characteristic shall be 100% of the Contractor's bid price for the pay item quantity placed on the Control Strip. If the Lot Quality Level for an individual Quality Characteristic is > 90 PWL, payment for the Quality Characteristic shall be an incentive amount determined in accordance with Subsection 450.92. If the Lot Quality Level for an individual Quality Characteristic is ≥ 60 PWL, but < 90 PWL, payment for the Quality Characteristic shall be a disincentive amount determined in accordance with Subsection 450.92. If the computed Quality Level for an individual Quality Characteristic is < 60 PWL, the Control Strip Lot will be determined rejected and removed in accordance with Subsection 450.66B(5) and shall receive no payment.

(b) 3rd Control Strip

If a 3rd Control Strip Lot is placed and is Verified, payment shall be limited to a maximum of 85% of the Contractor's bid price for the entire pay item quantity placed on the Control Strip, regardless of the actual calculated Quality Level for the Lot. If a 3rd Control Strip Lot is placed and is not Verified, payment shall be limited to a maximum of 80% of the Contractor's bid price for the entire pay item quantity placed on the Control Strip, regardless of the actual calculated Quality Level for the Lot. If the computed Quality Level for an individual Quality Characteristic is < 60 PWL, the Control Strip Lot will be determined rejected and removed in accordance with Subsection 450.66B(5) and shall receive no payment.

(c) 4th or Subsequent Control Strip

If a 4th or subsequent Control Strip Lot is placed and is Verified, payment shall be limited to a maximum of 75% of the Contractor's bid price for the entire pay item quantity placed on the Control Strip, regardless of the actual calculated Quality Level for the Lot. If a 4th or subsequent Control Strip Lot is placed and is not Verified, payment shall be limited to a maximum of 70% of the Contractor's bid price for the entire pay item quantity placed on the Control Strip, regardless of the actual calculated Quality Level for the Lot. If the computed Quality Level for an individual Quality Characteristic is < 60 PWL, the Control Strip Lot will be determined rejected and removed in accordance with Subsection 450.66B(5) and shall receive no payment.

(1) 450.67 Quality Control Documentation and Data Evaluation.

(2) A. QC Inspection Documentation & Evaluation.

The Contractor shall document all QC inspection activity for each HMA Lot Category (Category A, B, or C) produced and placed. All inspection results shall be recorded within 24 hours of inspection on current NETTCP standard Inspection Report Forms (IRFs). The QC Manager shall evaluate inspection results in a timely manner to confirm that production and placement processes are in control. The Contractor shall submit hard copies of all IRFs to the Engineer at the completion of each Lot.

(3) B. QC Sampling and Testing Documentation & Data Analysis.

The Contractor shall document all QC sampling and testing data for each HMA Lot Category (Category A, B, or C) produced and placed. All sampling and testing data shall be recorded within 24 hours of sampling and testing on current NETTCP standard Test Report Forms (TRFs). The QC Manager shall evaluate sampling and testing results in a timely manner, as further outlined below, to confirm that production and placement processes are in control. All QC testing data shall be entered into the Department's MS-Excel QA Data Spreadsheets via the internet (mhdqa.com) within two (2) days after completion of testing. The Contractor shall submit hard copies of all TRFs to the Engineer at the completion of each Lot.

(1) Control Charts.

For each HMA Category A Lot produced and placed, the Contractor shall use Control Charts as part of the QC system to assist in identifying assignable causes affecting the HMA production and placement processes. Control Charts shall be prepared for the Quality Characteristics subject to QC sampling and testing listed in Table 450.10. As a minimum, the Contractor shall plot all QC test results of each Lot on Control Charts for individual Sublot measurements or test values (Run Charts). It is also recommended practice for the Contractor to use Control Charts that plot Subgroups of data (e.g. X-Bar Charts, R Charts). The Contractor shall submit examples

of the Control Charts to be used in the QC Plan. As a minimum, the Control Charts shall identify the Contract number, the Payment Item number, the Lot number, the Quality Characteristic, the Control Chart Target, the Upper and Lower Control Chart Limits, and Sublot or Subgroup numbers.

All Control Charts should be updated within 24 hours after the corresponding testing is completed and documented. Quality Control personnel should use the Control Chart data to monitor and adjust the production and placement processes or suspend operations as determined necessary. Control Charts for Quality Characteristics related to HMA production should be maintained at the HMA production facility. Control Charts for Quality Characteristics related to HMA field placement should be maintained at the project field site. Current Control Charts shall be posted in an accessible location. The Engineer shall be provided access to all Control Charts as part of the Department's monitoring of Contractor QC activity.

(2) Evaluation of Individual Sublot QC Test Results.

The Contractor shall evaluate the individual QC test results for each HMA Lot Category (Category A, B, or C) produced and placed. Each random QC test result shall be evaluated against the applicable Quality Limits within 24 hours of testing. For HMA Category A Lots and Category B Lots, each Sublot test value shall be within the Engineering Limits specified in Table 450.19. For HMA Category C Lots, each Sublot test value shall be within the Specifications Limits indicated in Table 450.19.

If the evaluation of the QC testing data indicates that an individual Sublot is not in conformance with the applicable Quality Limits for the particular HMA Lot Category, the Contractor shall isolate the Sublot and perform selective sampling followed by additional random sampling of the Sublot to quantify the actual quality of the Sublot.

(3) Evaluation of Lot Quality Level.

For HMA Category A Lots and Category B Lots, the Contractor shall use all random QC test results to continuously evaluate the running quality level and determine the percent within limits (PWL) for each Lot during production and placement. The PWL shall be determined through Quality Level Analysis (QLA) for each of the applicable Quality Characteristics listed in Table 450.19 using the corresponding Specification Limits therein. The Contractor shall perform a running QLA using random QC data only at a minimum after each 5 Sublots have been tested and shall plot the cumulative PWL after each 5 Sublot interval. The Engineer shall be provided access to all records documenting the running QLA for each Lot as part of the Department's monitoring of Contractor QC activity.

If the running QLA shows the PWL falling below the Acceptable Quality Level (AQL) of 90 PWL, the Contractor shall initiate appropriate adjustments to the production or placement process or initiate corrective action in accordance with procedures outlined in the approved QC

Plan. If the PWL falls below the Suspension Quality Level (SQL) of 70 PWL, the Contractor shall suspend production and placement of the Lot. The Contractor shall prepare a plan of corrective action for any nonconforming Lot, as further outlined below. If significant adjustment to the JMF or the production or placement process is required, a new Lot will be established. After resuming production and placement, the PWL for the Lot must be back at or above the AQL of 90 PWL.

450.68 Corrective Action.

As part of the Contractor's Quality Control system, the Contractor shall implement corrective action for any part of a Lot that is determined by inspection or testing to not be in conformance with the quality requirements specified in Section 450. If the results of QC inspection identify nonconforming material or workmanship within one or more Sublots, or if the evaluation of the QC testing data indicates that any Sublot is not in conformance with the applicable Quality Limits for the particular HMA Lot Category, the Contractor shall isolate the Sublot(s) and perform additional inspection or testing to further assess the quality of the Sublot. Selective inspection or testing should be used to determine the limits of nonconformance, followed by random inspection or testing to quantify the actual quality of the nonconforming area.

Based on the results of additional inspection or testing, the Contractor shall prepare a plan of corrective action for the nonconforming Sublot(s). The Corrective action plan shall be submitted to and approved by the Engineer prior to initiating corrective action. All corrective action shall be performed at the Contractor's expense.

450.69 Quality Control Records System.

A. Quality Control Daily Diary.

The QC Manager should maintain a Quality Control Daily Diary (QC Daily Diary) to document all major activities or actions related to the Contractor's QC system. The QC Daily Diary serves as a summary record of key actions taken by QC personnel each day. Recommended Information which should be recorded in the QC Daily Diary includes:

- The day's weather or environmental conditions.
- A summary of production or placement activities completed.
- Any non-conforming material or workmanship identified.
- Any corrective actions recommended or taken by QC personnel.
- Discussions held with other Contractor personnel or Department personnel.
- Visitors to the production facility or field placement operation.

B. Quality Control Record Books.

The Contractor shall maintain one or more ringed binders referred to as "Quality Control Record

Books" (QC Record Books) to store all required QC documents. Separate QC Record Books shall be kept at each HMA production facility and at the project field site. Either a separate QC Record Book shall be established for each HMA pavement course or the data for each pavement course may be included in a single QC Record Book provided the data is separated according to pavement course. QC data for each pavement course shall be organized into separate sections by Quality Characteristic and by Lot number.

QC documents to be stored in the QC Record Book(s) include:

- A signed copy of the current approved QC Plan.
- The original signed copies of all completed Inspection Report Forms.
- The original signed copies of all completed Random Sampling location forms.
- The original signed copies of all completed Test Report Forms.
- A current copy or printout of all Control Charts.
- A current copy or printout of all running QLA performed.
- Current summaries of all individual QC test results to date (by Lot & Sublot).
- Summary sheets of material quantities produced or placed (by Lot & Sublot).

Each required record shall be inserted into the corresponding QC Record Book within 24 hours after the document has been completed. All QC Record Books shall be maintained in a suitable location. The Engineer shall be provided access to all QC Record Books as part of the Department's monitoring of Contractor QC activity.

C. Quality Control Records Retention.

All Contractor QC records identified above shall be retained for a minimum of seven (7) years. The records shall be protected from damage or alteration. When requested by any State or Federal Agency for audit or similar purposes, the Contractor shall provide complete access to all QC records.

DEPARTMENT ACCEPTANCE

450.70 General.

The Department is responsible for performing all Acceptance activities and making the final acceptance determination for each HMA Lot produced and placed. The Department's Acceptance system will include monitoring the Contractor's QC activity, performing Acceptance inspection, sampling & testing, and determining the Quality and corresponding payment for each Lot. These activities will be performed for each HMA Lot Category (Lot Category A, B, and C) as outlined further below.

450.71 Acceptance System Approach.

A. Acceptance of Category A Lots.

The Engineer's acceptance determination for each HMA Category A Lot will be based on an evaluation of the Department's Acceptance inspection information and Acceptance testing data. The Engineer will perform Acceptance sampling and testing on a minimum of 25% of the Sublots produced and placed. Contractor QC test data will be included in the Department's acceptance determination for each Category A Lot provided the following requirements are met:

- Split Sample Correlation testing requirements are satisfied.
- The Contractor provides adequate Quality Control per the approved QC Plan.
- All QC test results included are from random samples.
- The QC test results are Validated against the Department's Acceptance test results.

B. Acceptance of Category B Lots.

The Engineer's acceptance determination for each HMA Category B Lot will also be based on an evaluation of the Department's Acceptance inspection information and Acceptance testing data. The Engineer will perform Acceptance sampling and testing on a minimum of 50% of the Sublots produced and placed, but not less than three (3) Sublots. Contractor QC test data will be included in the Department's acceptance determination for each Category B Lot provided the requirements outlined in paragraph A above are satisfied.

C. Acceptance of Category C Lots.

For all HMA Category C Lots, the Engineer's acceptance determination will be based only on the Department's Acceptance inspection information and Acceptance testing data. The Engineer will perform Acceptance sampling and testing on 100% of the Sublots produced and placed. Contractor QC test data will not be included in the Department's acceptance determination for Category C Lots.

450.72 Department Monitoring of Contractor Quality Control.

For projects with HMA Category A Lots or Category B Lots, the Department will monitor the Contractor's Quality Control system to confirm that QC activities are being performed for each Lot in reasonable compliance with the approved QC Plan. Department monitoring of the Contractor's QC system is not intended to evaluate the Quality of the Work. The Engineer will not perform the QC responsibilities of the Contractor or provide constant direction to the Contractor on how to perform Quality Control. The Engineer's monitoring of QC activity will include the following:

- Periodic visual observation of QC inspection, sampling, and testing.
- Reviewing QC documentation and records.

- Providing feedback based on monitoring findings.

The Engineer will document all findings (positive or negative) from any monitoring of the Contractor's QC system on standard Monitoring Report Forms (MRFs). Copies of all MRFs will be provided to the Contractor on a timely basis. When deficiencies in the Contractor's QC system are identified and documented by the Engineer, the Contractor shall take immediate action to address the deficiencies. If the Contractor fails to take appropriate action, the Contractor shall suspend production and placement of the corresponding Lot(s). The Department will withhold payment for the Contractor Quality Control Payment Item (Item No. 450.70) until the Contractor implements satisfactory corrective measures.

450.73 Acceptance Inspection.

The Engineer will perform Acceptance inspection of all work items addressed under Section 450 to ensure that all materials and completed work are in conformance with the contract requirements. Acceptance inspection is intended to visually assess the quality of each HMA Lot produced and placed and will address only the inspection components of Materials and Workmanship in support of the Department's final acceptance determination.

All Acceptance inspection activity by the Department will be performed independent of the Contractor's QC inspection at both the HMA production facility and at the site of HMA field placement. The Engineer will document the results and findings of Acceptance inspection on NETTCP Inspection Report Forms (IRFs). The Engineer will furnish a copy of all Department Acceptance inspection results to the Contractor within five (5) days following the inspection.

A. Acceptance Inspection of Prepared Underlying Surface.

The Department will perform Acceptance inspection of the prepared underlying surface prior to placement of HMA. The items to be inspected and minimum frequency of inspection will be in accordance with the requirements outlined in Table 450.14 and Table 450.15.

Table 450.14 - Department Acceptance Inspection of HMA Patching

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Materials	Mixture Type + PG Binder Grade (Correct Type)	1 per Day	HMA Production Facility	Visual Check + Manufacturer COC
	Rubberized Asphalt Sealant (Correct Type)	1 per Day	At Paving Site	Check Manufacturer COC

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Workmanship	Sawcut Limit Vertical Face	25% of Patched Areas	Sawcut Limits	Visual Check
	Rubberized Asphalt Sealant Application Rate	25% of Patched Areas	Sawcut Limits	Visual Check + Check Measurement
	Cross-Slope & Profile	25% of Patched Areas	Compacted HMA	Check Measurement

Table 450.15 - Department Acceptance Inspection of Tack Coat

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Materials	Asphalt Emulsion (Correct Type)	1 per Day	At Paving Site	Check Manufacturer COC
Workmanship	Asphalt Emulsion Application Rate	Once per 5,000 lane-ft (1,500 lane-m)	Tacked Surface + Tack Distributor System	Visual Check + Check Measurement

B. Acceptance Inspection of HMA Lots.

The Department will perform Acceptance inspection at both the HMA production facility and at the site of HMA field placement. For purposes of Acceptance inspection, the total quantity of each HMA pavement course produced and placed during the same construction season will constitute a Lot. Each in-place HMA Lot will be divided into 500 lane-feet (150 lane-meters) Sublots. The items to be inspected and minimum frequency of inspection will be in accordance with the requirements outlined in Table 450.16.

(1) Wheel Path Deviations.

Each HMA Lot produced and placed will be inspected by the Engineer for Wheel Path Deviations (high points or low points) using a 10 foot (3 meter) standard straightedge in accordance with the procedures outlined in Subsection 450.64B. Acceptance inspection for Wheel Path Deviations applies to all pavement courses (including bridge protective courses and bridge surface courses). The finished surface of each required pavement course will be inspected for all mainline travel lanes, auxiliary lanes, ramps, and side road travel lanes. The Sublot size and minimum frequency of Acceptance inspection for Wheel Path Deviations will be as specified in Table 450.16.

Table 450.16 - Department Acceptance Inspection of HMA Lots

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Materials	HMA Mixture Type, Aggregates & PG Binder (Correct Type)	1 per Day	HMA Production Facility	Visual Check + Manufacturer COC
	Rubberized Asphalt Sealant (Correct Type)	1 per Day	At Paving Site	Check Manufacturer COC
Workmanship	Joint Location & Alignment	50% of Sublots, Once per Joint	At Finished Joint	Visual Check
	Sawcut Joint Vertical Face	50% of Sublots, Once per Joint	Joint Vertical Face	Visual Check
	Rubberized Asphalt Sealant Application Rate	50% of Sublots, Once per Joint	Joint Vertical Face	Visual Check + Check Measurement
	Physical Segregation	50% of Sublots, Once per Lane	Compacted HMA	Visual Check
	Cross-Slope	50% of Sublots, Once per Lane	Compacted HMA	Check Measurement
	Joint Tightness	50% of Sublots, Once per Joint	Compacted HMA	Visual Check
	Joint Surface Deviations	50% of Sublots, Once per Joint	At Finished Joint	10 foot (3 meter) standard straightedge
	Wheel Path Deviations	50% of Sublots, per Wheel Path	Wheel Path	10 foot (3 meter) standard straightedge

450.74 Acceptance Sampling & Testing.

A. Random Sampling.

The Department will utilize stratified random sampling to determine the overall quality of each HMA Lot produced and placed. Random Acceptance sample locations will be determined by the Engineer in accordance with ASTM D 3665 or by electronic random number generator, as

presented by the NETTCP. All random Acceptance sample locations will be documented on NETTCP Standard Test Report Form D3665.

The Contractor shall furnish the Engineer with approved containers for all Acceptance samples. The Engineer will obtain all random Acceptance samples independent of the Contractor's QC samples at the frequencies outlined below.

(1) Sampling HMA Category A Lots.

The Engineer will obtain Acceptance samples from a minimum of 25% of all Sublots in each HMA Category A Lot for all Quality Characteristics specified in Table 450.17, other than PG Asphalt Binder Grading and Ride Quality. Acceptance samples For PG Asphalt Binder Grading and Ride Quality will be obtained from each Sublot as defined in Table 450.17.

(2) Sampling HMA Category B Lots.

The Engineer will obtain Acceptance samples from a minimum of 50% of all Sublots, but not less than three (3) Sublots, in each HMA Category B Lot for all Quality Characteristics specified in Table 450.17, other than PG Asphalt Binder Grading and Ride Quality. Acceptance samples For PG Asphalt Binder Grading and Ride Quality will be obtained from each Sublot as defined in Table 450.17.

(3) Sampling HMA Category C Lots.

The Engineer will obtain Acceptance samples from 100% of all Sublots in each HMA Category C Lot for all Quality Characteristics specified in Table 450.17, other than Ride Quality. Acceptance sampling and testing for Ride Quality will not be performed on Category C Lots.

B. Selective Sampling.

The Department will utilize selective sampling (i.e. non-random samples) as needed to provide supplemental information to assist in quantifying the quality of apparent nonconforming material. When the results of acceptance inspection or random sampling and testing identify material which is not in conformance with the applicable Quality Limits for the particular HMA Lot Category, the Engineer will isolate the corresponding Sublot(s) and perform selective sampling to further assess the quality of the Sublot. Selective inspection or testing will be used to determine the limits of nonconformance, followed by random inspection or testing to quantify the actual quality of the nonconforming area. The test results of selective Acceptance samples will not be combined with random Acceptance sample data in the determination of Lot acceptance using Quality Level Analysis as outlined in Subsection 450.78.

C. Contractor Assistance in Obtaining Acceptance Samples.

The Engineer will obtain all material samples for Acceptance testing by the Department. When requested by the Department, the Contractor shall assist the Engineer in obtaining Acceptance samples in accordance with the following requirements:

- The Acceptance sample location and time will be randomly selected by the Engineer and provided to the Contractor immediately prior to sampling.
- The Contractor's qualified QC personnel will only provide the physical labor to assist the Engineer in obtaining the Acceptance sample.
- The Engineer will be present to direct and monitor the taking of the sample.
- The Engineer will take immediate possession of the Acceptance sample.

Contractor assistance may be requested in obtaining Acceptance samples for PG Asphalt Binder Grading and for In-Place Density and Thickness (HMA cores). The Contractor shall provide adequate traffic control for the Department to obtain cores, regardless of whether the Contractor assists the Engineer in obtaining the Acceptance core samples.

D. Acceptance Sample Identification System.

The Department will use a standard system for the identification of all Acceptance samples. All PG Asphalt Binder samples, HMA loose mixture samples, and core samples will be labeled by the Engineer with the minimum information indicated under Subsection 450.65C. Acceptance sampling data for Ride Quality and Wheel Path Deviations will be identified by the Engineer in accordance with the Department's Standard Operating Procedures (SOPs).

E. Retention of Split Samples.

Qualified Department personnel will obtain all material samples (PGAB samples, HMA loose mix samples, and cores) for Acceptance testing. The Department will retain split samples from each PGAB sample and HMA loose mix sample and provide a split sample to the Contractor if requested. The Department will retain the original core samples after testing to serve as "split samples" and protect them from damage. All split samples will be stored for a period of (30) days, or until tested. These split samples will be utilized if necessary, in the Dispute Resolution process. If mutually agreed upon by the Department and the Contractor, the retained split samples may be discarded prior to the required thirty (30) days.

F. Acceptance Testing of HMA Lots.

The Department will perform Acceptance testing using the random samples obtained in accordance with Subsection 450.74A from the HMA production facility and at the site of HMA field placement. The specific Quality Characteristics subject to Department Acceptance testing are identified in Table 450.17. All Acceptance testing of HMA Lots will be performed by the Engineer in accordance with the AASHTO, ASTM, NETTCP, or Department test methods

specified in Table 450.17 and the procedures outlined below. The Engineer will furnish a copy of all Department Acceptance test results/data to the Contractor within five (5) days following completion of testing.

(1) PG Asphalt Binder Grading.

The Department will review the Supplier's Certificate of Compliance (COC) and corresponding certified AASHTO M320 test results submitted by the Contractor for each Supplier Lot of PGAB from which the HMA Producer's PGAB was obtained. The Engineer will also obtain and test a minimum of one random Acceptance sample of PGAB for each 12,000 ton (11,000 Mg) HMA Sublot, as defined in Table 450.17, to determine conformance with AASHTO M320. A minimum of two 1-quart (1-Liter) containers of PGAB will be obtained for each Acceptance sample from the HMA Producer's tanks in accordance with AASHTO T40. All PGAB Acceptance samples will be split prior to testing and the un-tested portion of the sample will be retained for a minimum of 30 days.

(2) PG Asphalt Binder Content.

The Engineer will test each HMA Lot produced and placed for PG Asphalt Binder Content in accordance with either AASHTO T164 or T308. When AASHTO T164 is used, the test results will be reported prior to ash correction. The Sublot size and minimum frequency of Acceptance testing for PG Asphalt Binder Content will be as specified in Table 450.17. Each material sample for PG Asphalt Binder Content will be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

Table 450.17 - Department Acceptance Sampling and Testing of HMA Lots

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Sampling Method
PG Asphalt Binder Grading	AASHTO M320	12,000 tons (11,000 Mg) of HMA using same PG Grade	1 per Sublot	From Tank Valve at HMA Plant	Random AASHTO T40
PG Asphalt Binder Content	AASHTO T164 or AASHTO T308	600 tons (550 Mg)	1 per Sublot sampled per Subsection 450.74A(1)	From Haul Vehicle at HMA Plant	Random AASHTO T168
Volumetrics: Air Voids	AASHTO T245	600 tons (550 Mg)	1 per Sublot sampled per Subsection 450.74A(1)	From Haul Vehicle at HMA Plant	Random AASHTO T168

Quality Characteristic	Test Method(s)	Sublot Size	Minimum Test Frequency	Point of Sampling	Sampling Method
In-place HMA Mat Density (Cores)	AASHTO T269 AASHTO T230 AASHTO T209 AASHTO T166	600 tons (550 Mg)	1 per Sublot sampled per Subsection 450.74A(1)	From Compacted HMA Course	Random AASHTO T269
In-place HMA Mat Density (Bridge Courses)	ASTM D2950 or AASHTO TP68	150 tons (140 Mg)	1 per Sublot sampled per Subsection 450.74A	From Compacted HMA Course	Random ASTM D2950 or AASHTO TP68
Thickness	AASHTO T269	600 tons (550 Mg)	1 per Sublot sampled per Subsection 450.74A(1)	From Compacted HMA Course	Random AASHTO T269
Ride Quality (IRI)	AASHTO PP52 per Subsection 450.65F(11)	0.1 miles (160 meters) per each Wheel Path	1 Per Sublot	Each Pavement Course per Subsection 450.65F(11)	Random per Subsection 450.65F(11)

(1) In the event that the total daily HMA production is less than one Sublot but greater than 150 tons (140 Mg), a minimum of one random Acceptance sample shall be obtained for the day's production.

(3) Volumetrics (Air Voids).

The Engineer will test each HMA Lot produced and placed for Volumetrics (Air Voids) in accordance with AASHTO T245. The requirement for Volumetric testing of laboratory compacted specimens applies to HMA mixtures for all pavement courses, with the exception of Open Graded Friction Courses and Base Courses. The Sublot size and minimum frequency of Acceptance testing for Volumetrics will be as specified in Table 450.17. Each material sample for Volumetrics will be obtained at the HMA plant from a randomly selected quadrant from the haul vehicle in accordance with ASTM D3665 and AASHTO T168.

(4) In-Place HMA Mat Density.

The Engineer will test each HMA Lot produced and placed for In-place HMA Mat Density. The requirement for In-Place Density testing applies to all pavement courses, with the exception of Open Graded Friction Courses and Leveling Courses, as outlined below.

(a) Testing In-Place Density by Cores. Acceptance testing of HMA pavement courses (other than bridge courses) for In-place Density will be performed using cores in accordance with the

procedures outlined in Subsection 450.65F(8)(b). The Sublot size and minimum frequency of Acceptance testing for In-place Density of HMA pavement courses by core will be as specified in Table 450.17.

(b) Testing In-Place Density by Density Gauge. Acceptance testing of all HMA Bridge Protective Courses and Bridge Surface Courses for In-place Density will be performed using a density gauge in accordance with the procedures outlined in Subsection 450.65F(8)(a). The Sublot size and minimum frequency of Acceptance testing for In-place Density of HMA bridge courses by density gauge will be as specified in Table 450.17.

(5) Thickness.

Each HMA pavement course specified to be placed at a compacted thickness of 1 inch (25mm) or greater, with the exception of the HMA pavement courses identified in Subsection 450.65F(9), will be tested by the Engineer for Thickness using cores. Acceptance sampling and testing for Thickness of the applicable pavement courses shall be in accordance with AASHTO T269. The Sublot size and minimum frequency of Acceptance testing for Thickness will be as specified in Table 450.17.

(6) Ride Quality.

Department Acceptance testing for Ride Quality will be required for all projects having a posted speed equal to or greater than 40 mph (65 km/hr) with HMA Lots falling under Lot Category A or Category B. The Engineer will perform Ride Quality testing on the final HMA pavement course placed (either Surface Course or OGFC-P, when specified) for all mainline travel lanes, auxiliary lanes, ramps, and side road travel lanes using an inertial profiler in accordance with the procedures outlined in Subsection 450.65F(11). Pavement courses and surfaces that are specifically excluded from Acceptance testing for Ride Quality are as specified in Subsection 450.65F(11)(b). The Sublot size and minimum frequency of Acceptance testing for Ride Quality will be as specified in Table 450.17.

The inertial profiler equipment used to perform Acceptance testing will be certified and correlated by the Department in accordance with the requirements and procedures outlined in Subsection 450.65F(11). The Department Acceptance data and Contractor QC data will be correlated and normalized using statistical procedures. The normalization of data will be based on the measurement difference/bias from the Department Reference Profiling Device determined during the device correlation conducted at the Profiling Center by UMass Dartmouth. The Department will provide software and procedures to perform the data normalization. The normalized Acceptance Ride Quality data and QC Ride Quality data will be used to determine the quality level (PWL) and corresponding pay for each Lot.

450.75 Split Sample Correlation.

Split Sample Correlation is an important part of the Department acceptance system for HMA Category A Lots and Category B Lots. Split Sample Correlation shall be performed when Validated Contractor QC test data is to be included in the acceptance determination. The purpose of Split Sample Correlation testing is to identify and eliminate any discrepancies in testing procedures or equipment that could result in significant differences between the Contractor's QC testing results and the Engineer's Acceptance testing results.

Either prior to or on the first day of production and placement of any HMA Category A Lot or Category B Lot, the Contractor and the Department will conduct Split Sample Correlation. The Engineer or the Contractor may also request that Split Sample Correlation be performed at any time during HMA Lot production and placement. Department IA personnel may also test a split of the Correlation samples.

Split Sample Correlation will be performed on split material samples for those Quality Characteristics identified in Table 450.18. Correlation samples for HMA mixture testing shall be either laboratory prepared specimens or plant produced HMA specimens. Samples for HMA Category A Lots may be obtained from the Control Strip Lot. Correlation testing of the Contractor's QC ride quality testing equipment and the Department's Acceptance ride quality testing equipment will be performed in accordance with Subsection 450.65F(11)(c).

Table 450.18 Split Sample Correlation Allowable Differences

Quality Characteristic	**Allowable Difference Between Contractor and Department Split Samples**
Maximum Theoretical Specific Gravity (Gmm)	+/- 0.020
Bulk Specific Gravity (Gmb)	+/- 0.030
PG Asphalt Binder Content	+/- 0.4%
Volumetrics - Air Voids	+/- 1.4%
In-Place HMA Mat Density	+/- 1.4%
Thickness	+/- 10 %
Ride Quality (IRI)	Per Subsection 450.65F(11)(c)

If the Contractor's Split Sample Correlation results differ from the Department's results by more than the allowable differences specified in Table 450.18, then the Contractor and the Department shall determine and resolve the reasons for the differences prior to the start or continuation of HMA Lot production and placement.

450.76 Lot Acceptance Determination Based on Inspection Results.

The Department's Acceptance Inspection results will be used in the final acceptance determination for all HMA Lots (Lot Category A, B, and C). Prior to final acceptance of each HMA Lot produced and placed, the Department will periodically evaluate all Acceptance inspection information for the prepared underlying surface and the Lot. The materials and product workmanship for the completed Work will be evaluated for conformance with the plans and the requirements specified in Subsections 450.53 thru 450.58.

When the Acceptance information identifies deficiencies in either material quality or product workmanship for any underlying surface location or HMA Sublot(s), the location or Sublot(s) will be isolated and further evaluated by the Engineer through additional Acceptance inspection (or sampling and testing, if relevant or possible). Depending upon the findings of the additional Acceptance inspection activity, the Engineer will determine the disposition of the nonconforming Work in accordance with Division I, Subsection 5.03, Conformity with Plans and Specifications.

After each HMA Lot (and corresponding prepared underlying surface) is complete, including any corrective action, the Engineer will evaluate all Acceptance inspection information for the Work. The Department will accept the subject Work if the Engineer's evaluation of all inspection information for the completed Lot (and underlying surface) indicates that the corresponding materials and product workmanship meet the specified requirements (provided the evaluation of all Acceptance testing data for the subject Work per Subsection 450.77 also finds the Work to be acceptable).

450.77 Lot Acceptance Determination Based on Testing Data.

A. Evaluation of Lot Category A Testing Data.

Prior to final acceptance of each HMA Category A Lot produced and placed, the Engineer will periodically evaluate all available Department Acceptance testing data for the Lot.

The Contractor's random QC testing data for each Lot will be included with the Department's random Acceptance testing data in the acceptance determination, provided that the QC data has been Validated in accordance with paragraph (1) below. The Department's Acceptance data and all Validated Contractor QC data will be evaluated using the Quality Limits specified in Table 450.19 and as further outlined below.

(1) Validation of Contractor QC Test Results.

Validation is defined as the mathematical comparison of two independently obtained sets of data to determine whether it can be assumed they came from the same Population. The Validation of each HMA Lot will be performed through a statistical comparison of the Engineer's random Acceptance testing data and the Contractor's random QC testing data for the Lot.

The statistical comparison of testing data will be made using the test result Variances (***F-test***) and the test result Means (***t-test***) at a significance level of 0.01 and in accordance with the procedures contained in Appendix F of the *AASHTO Implementation Manual For Quality Assurance* (February 1996). The Validation worksheet in the Department's MS-Excel QA Data Spreadsheets will be used to perform the Validation of each Lot.

If the Validation results indicate that the Contractor's QC test results and the Department's Acceptance test results can be assumed to be from the same Population, then the Contractor's QC test results will be included with the Department's Acceptance test results in the final acceptance determination for each Lot.

If the Validation results indicate that the Contractor's QC test results and the Department's Acceptance test results cannot be assumed to be from the same Population, then the Department will endeavor to determine the reason for the difference between the two data sets. If a reason for the difference cannot be determined, then only the Department's Acceptance test results will be used in the final acceptance determination for each Lot.

(2) Conformance with Engineering Limits.

The Engineer will evaluate all Department Acceptance testing data and Validated Contractor QC testing data for each Category A Lot to determine conformance with the Engineering Limits in Table 450.19. Each Sublot test value for the Acceptance Quality Characteristics identified in Table 450.19 shall be within the Engineering Limits.

If a Sublot test result is outside of the Engineering Limits, the Engineer will further assess the Sublot quality to determine whether the material in the Sublot can remain in place. The Engineer will isolate the Sublot and perform selective sampling followed by additional random sampling (if possible) within the Sublot to quantify the actual quality of the Sublot. The Engineer will determine the disposition of the Sublot in accordance with Division I, Subsection 5.03, Conformity with Plans and Specifications. If the Engineer's assessment determines that the material quality is sufficient to permit the Sublot to remain in place without corrective action, all random testing data for the Sublot (including the original out of Engineering Limit test result) will be included in the Quality Level Analysis for the Lot in accordance with paragraph (3) below.

When a nonconforming Sublot is corrected or replaced, the Engineer will perform Acceptance testing of the Sublot and evaluate the test results for conformance with the Engineering Limits. The Acceptance test data for the corrected Sublot will replace the original Acceptance test result and will be include in the Quality Level Analysis for the Lot in accordance with paragraph (3) below. Once the above requirements have been met, the Department will accept all completed Sublots, provided that the overall Lot quality is above the Acceptance Limit as further outlined below.

(3) Analysis of Lot Quality Level.

For each HMA Category A Lot, the Engineer will determine the Lot Quality Level, for the applicable Quality Characteristics in Table 450.19, using the Quality Level Analysis (QLA) procedures outlined in Subsection 450.78. The QLA procedure will evaluate all Department Acceptance testing data and Validated Contractor QC testing data using the Specification Limits in Table 450.19. The Department's MS-Excel QA Data Spreadsheets will be used to perform the QLA for each Lot.

All random test results that are within the Engineering Limits will be included in the Quality Level Analysis. Individual Sublot test results that are beyond the Engineering Limits, but for which the corresponding Sublot is permitted to remain in place per paragraph (2) above, will also be included in the Quality Level Analysis.

The QLA procedure will determine the Percent Within Limits (PWL) for each Lot. The Acceptance Limit (Rejectable Quality Level) for each completed Lot is 60 PWL. Each Lot must achieve a final Quality Level of at least 60 PWL in order to be accepted by the Department.

If the final computed Lot Quality Level is at 90 PWL, the Contractor will receive full payment at the unit bid price for the Lot. If the Lot Quality Level is greater than 90 PWL, the Contractor will receive an incentive pay adjustment for the Lot in accordance with Subsection 450.92. If the Lot Quality Level is less than 90 PWL but greater than or equal to 60 PWL, the Contractor will receive a disincentive pay adjustment for the Lot. If the final computed Lot Quality Level is below 60 PWL, the Lot will not be accepted. Payment for the Lot will be withheld and the Contractor shall submit a corrective action plan within 14 days following determination of the Lot PWL. The Engineer will review the corrective action plan and render a decision within 14 days of receipt of the corrective action plan. If the Engineer determines that the Lot or some of the Sublots cannot remain in place, the Contractor shall remove and replace the affected Lot or Sublots. If the Engineer allows the Lot to remain in place, payment will be limited to a maximum of 75% of the bid price for the item.

(4) Final Lot Acceptance Determination.

After each HMA Category A Lot is complete, including any corrective action, the Engineer will perform a final evaluation of all Department Acceptance data and Validated Contractor QC data for the Lot. The Department will accept the subject Lot if the Engineer's evaluation of all testing data for the Lot is in conformance with the applicable Quality Limits as outlined in paragraph (2) and paragraph (3) above.

Table 450.19 - Quality Limits for Acceptance of HMA Lots

Quality Characteristic	Target	Specification Limits		Engineering Limits		Acceptance Limit
		LSL	USL	LEL	UEL	
PG Asphalt Binder Grading	Per Binder Grade specified	N/A	N/A	Per AASHTO M320	Per AASHTO M320	N/A
PG Asphalt Binder Content	Per JMF	Target - 0.3 %	Target + 0.3 %	Target - 0.4 %	Target + 0.4 %	60 PWL
Volumetrics: Air Voids	4 %	2.7 %	5.3 %	2 %	6 %	60 PWL
In-Place HMA Mat Density (Cores)	95 % of G_{mm}	92.5 % of G_{mm}	97.5 % of G_{mm}	92 % of G_{mm}	98 % of G_{mm}	60 PWL
In-Place HMA Mat Density (Bridge Courses)	95 % of G_{mm}	N/A	N/A	90 % of G_{mm}	N/A	N/A
Thickness: (All Courses 1 inch (25mm) or greater)	Per Plans	-20 % of Target Thickness	+20 % of Target Thickness	-30 % of Target Thickness	+30 % of Target Thickness	60 PWL
Ride Quality: Greater than or equal to 55 mph (90 km/hr)	50 in/mile (0.79 m/km)	N/A	70 in/mile (1.10 m/km)	N/A	80 in/mile (1.26 m/km)	60 PWL
Ride Quality: 40mph (65 km/hr) to 55 mph (90 km/hr)	70 in/mile (1.10 m/km)	N/A	100 in/mile (1.58 m/km)	N/A	110 in/mile (1.74 m/km)	60 PWL
Ride Quality: Less than 40 mph (65 km/hr)	Not subject to ride testing					

B. Evaluation of Lot Category B Testing Data.

Prior to final acceptance of each HMA Category B Lot produced and placed, the Engineer will periodically evaluate all available Department Acceptance testing data for the Lot.

The Contractor's random QC testing data for each Lot will be included with the Department's random Acceptance testing data in the acceptance determination, provided that the QC data has

been Validated. The Department's Acceptance data and all Validated Contractor QC data will be evaluated for conformance with Engineering Limits and for Lot Quality Level in accordance with the requirements of Subsection 450.77A above using the applicable Quality Limits specified in Table 450.19.

After each HMA Category B Lot is complete, including any corrective action, the Engineer will perform a final evaluation of all Department Acceptance data and Validated Contractor QC data for the Lot. The Department will accept the subject Lot if the Engineer's evaluation of all testing data for the Lot is in conformance with the applicable Quality Limits.

C. Evaluation of Lot Category C Testing Data.

For each HMA Category C Lot produced and placed, the Engineer will evaluate all Department Acceptance testing data for the Lot entered into the Department's MS-Excel QA Data Spreadsheets after all HMA Sublots are complete in-place. The Contractor's random QC testing data for each Lot will not be included with the Department's random Acceptance testing data in the acceptance determination. The individual Sublot test results for each HMA Category C Lot will be evaluated against the Specification Limits contained in Table 450.19 (Note: the Engineering Limits are not applied since the inherent variability for Minor Lot quantities is expected to be within the Specification Limits). Work under HMA Lot Category C will not be subject to an evaluation of Lot Quality Level using QLA procedures.

If a Sublot test result is outside of the Specification Limits, the Engineer will further assess the Sublot quality in accordance with the requirements of Subsection 450.77A(2). The Engineer will determine the disposition of the Sublot in accordance with Division I, Subsection 5.03, Conformity with Plans and Specifications.

After each HMA Category C Lot is complete, including any corrective action, the Engineer will perform a final evaluation of all Department Acceptance data. The Department will accept the subject Lot if the Engineer's evaluation of the testing data for each Sublot is in conformance with the Specification Limits.

450.78 Quality Level Analysis Procedures.

For each Quality Characteristic subject to analysis of Lot Quality Level, the Quality Level Analysis (QLA) - Standard Deviation Method will be used to determine the percentage of the Lot that is within the Specification Limits. The number of significant figures retained in each step of the QLA calculations and the rounding of all reported values will be as established in the Department's MS Excel QA Data Spreadsheets. The estimated percentage of Work that is within the Specification Limits for a given Lot will be determined as follows:

A. Step 1 – Determine Lot Mean.

The Mean (X) will be determined for each Lot using all random Department Acceptance sample test values and all random Contractor QC sample test values (provided they have been Validated). The Mean is calculated using the following equation:

$$X = \frac{\Sigma x}{n}$$

Where: Σ = summation of

x = individual test value of each material sample

n = total number of material samples tested

B. Step 2 – Determine Lot Standard Deviation.

The Standard Deviation (s) will be determined for each Lot using all random Department Acceptance sample test values and all random Contractor QC sample test values (provided they have been Validated). The Standard Deviation is calculated using the following equation:

$$s = \sqrt{\frac{n\Sigma(x^2) - (\Sigma x)^2}{n(n-1)}}$$

Where: $\Sigma(x^2)$ = summation of the squares of individual test values

$(\Sigma x)^2$ = summation of the individual test values squared

C. Step 3 – Determine Upper Quality Index for Lot.

The Upper Quality Index (Q_U) will be determined for each Lot using the Lot Mean and Lot Standard Deviation calculated in Step 1 and Step 2 above. The Upper Quality Index is calculated using the following equation:

$$Q_u = \frac{USL - X}{s}$$

Where: USL = Upper Specification Limit from Table 450.19

X = The Lot Mean

s = The Lot Standard Deviation

D. Step 4 – Determine Lower Quality Index for Lot.

The Lower Quality Index (Q_L) will be determined for each Lot using the Lot Mean and Lot Standard Deviation calculated in Step 1 and Step 2 above. The Upper Quality Index is calculated using the following equation:

$$Q_L = \frac{X - LSL}{s}$$

Where: LSL = Lower Specification Limit from Table 450.19

X = The Lot Mean

s = The Lot Standard Deviation

E. Step 5 – Determine Percentage of Lot Below Upper Specification Limit.

The estimated percentage of the Lot falling below the Upper Specification Limit (P_U) will be determined using Table 450.20. The P_U value is determined from the table by entering the column for the number of material samples (n) representing the Lot and locating the row that corresponds to the Q_u value determined in Step 3 above. If no USL is specified in Table 450.20, the P_U value is equal to 100.

F. Step 6 – Determine Percentage of Lot Above Lower Specification Limit.

The estimated percentage of the Lot falling above the Lower Specification Limit (P_L) will be determined using Table 450.20. The P_L value is determined from the table by entering the column for the number of material samples (n) representing the Lot and locating the row that corresponds to the Q_L value determined in Step 4 above. If no LSL is specified in Table 450.20, the P_L value is equal to 100.

G. Step 7 – Determine Estimated Percent Within Limits for Lot.

The Lot Quality Level will be determined by estimating the Percent Within Limits (PWL). The PWL is determined using the P_U value from Step 5 and the P_L value from Step 6 above. The Percent Within Limits is calculated using the following equation:

$$PWL = (P_U + P_L) - 100$$

Table 450.20 - Values for Estimating Percent of Lot Within Specification Limits

	Upper Quality Index (Q_U) or Lower Quality Index (Q_L)														
P_U Or P_L (%)*	**n = 3**	**n = 4**	**n = 5**	**N = 6**	**n = 7**	**n = 8**	**n = 9**	**n = 10 to n = 11**	**n = 12 to n = 14**	**n = 15 to n = 18**	**n = 19 to n = 25**	**n = 26 to n = 37**	**n = 38 to n = 69**	**n = 70 to n = 200**	**n = 201 to n = ∞**
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99		1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97		1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95		1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93		1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: If the calculated value of Q_U or Q_L does not correspond exactly to a value in the table, use the next lower value.
If Q_U or Q_L are negative values, P_U or P_L is equal to 100 minus the table value for P_U or P_L.
***** P_U or P_L = Percent Within limits for positive values of Q_U or Q_L

DISPUTE RESOLUTION

450.80 Disputable items

The Contractor or the Department may dispute any of the test values that are utilized in the acceptance determination for a given Lot. The specific Quality Characteristics which may be disputed are as listed in Table 450.21 below. All disputes shall be initiated within the 30 day split sample retention time limit as specified in Subsection 450.82 below.

450.81 Basis for Dispute

Differences from one individual Contractor QC test value to another (or from one individual Department Acceptance test value to another) within a Lot are expected due to inherent variability. Differences are also expected between the QC test values and the Acceptance values for a given Lot as a result of inherent variability. An individual QC test value cannot be directly compared to an individual Acceptance test value since the samples are randomly obtained independent of one another. However, if one or more of the Contractor's random QC test values for a Lot significantly differs from the Department's Acceptance test values for the same Lot, either party may dispute the validity of an individual test value.

450.82 Dispute Resolution Samples

Samples used for Dispute Resolution testing shall be the split samples required to be retained for thirty (30) days by the Contractor and the Department in accordance with Subsection 450.65D and Subsection 450.74E. Original cores are to be retained and shall be protected from damage. If In-place density or thickness is disputed, then the original core, unless damaged, will be used in the Dispute Resolution process. If the original disputed core is damaged, then a new core shall be obtained from within a 2-foot (600mm) radius of the location of the original core by the party whose data is being disputed in the presence of the other party. If ride quality smoothness test data is disputed, then the disputed Sublot(s) shall be re-sampled/retested by the party whose data is being disputed in the presence of the other party.

450.83 Dispute Resolution Steps

The Contractor may dispute the Department's Acceptance results and the Department may dispute the Contractor's Quality Control results by requesting that the dispute resolution split sample be tested. Such a request, either from the Contractor or the Department, must be made in writing within five days after the original sample was obtained. The following shall be provided in the written request:

- Sample reference number, including Lot and Sublot
- The specific Quality Characteristic and test result(s) being disputed
- The complete NETTCP test report form containing the disputed results

A. Step 1 – Split Sample Correlation.

Immediately prior to conducting testing for Dispute Resolution, the Contractor's QC testing personnel, the Department's Acceptance testing personnel (from the District), and a Department Independent Assurance (IA) technician will conduct Split Sample Correlation testing as detailed in Subsection 450.75. Split Sample Correlation testing will be conducted on a separate material sample obtained independent from the original sample and the Dispute Resolution sample.

The purpose of the Split Sample Correlation testing is to determine if testing procedures or equipment utilized by the Contractor or the Department might be the cause of the disputed result(s).

B. Step 2 – Dispute Resolution Sample Testing.

If a Department Acceptance test value is being disputed, the Department's Acceptance testing personnel (from the District) will test the Dispute Resolution split sample. If a Contractor QC test value is being disputed, the Contractor's QC testing personnel will test the Dispute Resolution split sample. In either case, testing of the Dispute Resolution split sample shall be performed by the same Contractor QC testing personnel and Department Acceptance testing personnel that performed the split sample correlation in step 1 above. Testing of the Dispute Resolution split sample shall be performed in the presence of both the Contractor and the Department.

C. Step 3 – Additional Dispute Resolution Testing.

If either the Contractor or the Department believes that the results of the Dispute Resolution split sample testing in Step 2 above do not conclusively resolve the dispute, additional sampling and testing within the disputed Sublot may be requested. In such case, an independent AASHTO accredited laboratory will be utilized to obtain and test three (3) random samples from the disputed Sublot. The Mean of the three test results will be used as the Dispute Resolution test value.

450.84 Final Disposition.

If the difference between the original test value and the Dispute Resolution test value (as determined under either Step 2 or Step 3 above) is within the maximum test difference values listed in Table 450.21, then the original test value will be used in the acceptance determination for the Lot. If the difference between the original test value and the Dispute Resolution test value exceeds the maximum difference values in Table 450.21, then the Dispute Resolution test value will be used in the acceptance determination. In such case, the record of the original test value will be retained (with notation of the outcome of Dispute Resolution); however, it will not be used in calculating the Lot quality level.

Table 450.21 – Dispute Resolution Maximum Test Difference Values

Quality Characteristic	Maximum Test Difference
Maximum Specific Gravity (G_{mm})	+/- 0.020
Bulk Specific Gravity (G_{mm})	+/- 0.030
PG Asphalt Binder Content	+/- 0.4
Volumetrics - Air Voids	+/- 1.4
In-place HMA Mat Density	+/- 1.4
Thickness	+/- 10% of original value
Ride Quality (IRI)	+/- 10% of original value

450.92 Pay Adjustment (PA).

Payment for each HMA Category A Lot and Category B Lot will be determined based on the final Lot Quality Level (PWL) computed in accordance with the QLA procedures contained in Subsection 450.78. Pay adjustments will be determined for each of the Acceptance Quality Characteristics identified in Table 450.22. The relative pay adjustment weight assigned to each of the HMA Quality Characteristics is indicated in Table 450.22.

Table 450.22 - Pay Adjustment Weight Assigned to HMA Quality Characteristics

HMA Quality Characteristics	Pay Adjustment Weight
PG Asphalt Binder Content	10 percent
Volumetrics - Air Voids	25 percent
In-Place HMA Mat Density	25 percent
Thickness	10 percent
Ride Quality (IRI)	30 percent

A. Lot Pay Factor.

A Pay Factor (PF) will be determined for each HMA Lot using the Quality Level (PWL) computed for the Lot and the equation below:

$$PayFactor(PF) = \frac{55 + 0.5(QualityLevel)}{100}$$

The Lot Pay Factor will be used to determine the pay adjustment for each Quality Characteristic as further outlined below.

B. Pay Adjustment for PG Asphalt Binder Content.

Pay adjustment for PG Asphalt Binder Content shall be applied to Pay Item 999.490 at the completion of the HMA Lot. The total Lot pay adjustment for PG Asphalt Binder Content will be determined as follows:

$$PA_{PGAB} = \Sigma(PF_i - 1)\ (Q_i)\ (P_i)\ (0.10)$$

Where: PA_{PGAB} = Pay adjustment in dollars for PG Asphalt Binder Content.

PF_i = Pay factor based on Quality Level (PWL) of PG Asphalt Binder Content for individual Lot (i).

Q_i = Quantity represented by individual Lot (i) in tons (Mg).

P_i = Contract unit price per ton (Mg) for individual Lot (i).

0.10 = Weight given to PG Asphalt Binder Content pay adjustment

C. Pay Adjustment for Volumetrics (Air Voids).

Pay adjustment for Volumetrics (Air Voids) shall be applied to Pay Item 999.491 at the completion of the HMA Lot. The total Lot pay adjustment for Volumetrics (Air Voids) will be determined as follows:

$$PA_{Air\ Voids} = \Sigma(PF_i - 1)\ (Q_i)\ (P_i)\ (0.25)$$

Where: $PA_{Air\ Voids}$ = Pay adjustment in dollars for Volumetrics (Air Voids).

PF_i = Pay factor based on Quality Level (PWL) of Volumetrics (Air Voids) for individual Lot (i).

Q_i = Quantity represented by individual Lot (i) in tons (Mg).

P_i = Contract unit price per ton (Mg) for individual Lot (i).

0.25 = Weight given to Volumetrics (Air Voids) pay adjustment

D. Pay Adjustment for In-Place HMA Mat Density.

Pay adjustment for In-Place HMA Mat Density shall be applied to Pay Item 999.492 at the completion of the HMA Lot. The total Lot pay adjustment for In-Place HMA Mat Density will be determined as follows:

$$PA_{In\text{-}Place\ Density} = \Sigma(PF_i - 1)\ (Q_i)\ (P_i)\ (0.25)$$

Where: $PA_{In\text{-}Place\ Density}$ = Pay adjustment in dollars for In-Place HMA Mat Density.

PF_i = Pay factor based on Quality Level (PWL) of In-Place HMA Mat Density for individual Lot (i).

Q_i = Quantity represented by individual Lot (i) in tons (Mg).

P_i = Contract unit price per ton (Mg) for individual Lot (i).

0.25 = Weight given to In-Place HMA Mat Density pay adjustment

E. Pay Adjustment for Thickness.

Pay adjustment for Thickness shall be applied to Pay Item 999.493 at the completion of the HMA Lot. The total Lot pay adjustment for Thickness will be determined as follows:

$$PA_{Thickness} = \sum (PF_i - 1)\,(Q_i)(P_i)\,(0.10)$$

Where: $PA_{Thickness}$ = Pay adjustment in dollars for Thickness.

PF_i = Pay factor based on Quality Level (PWL) of Thickness for individual Lot (i).

Q_i = Quantity represented by individual Lot (i) in tons (Mg).

P_i = Contract unit price per ton (Mg) for individual Lot (i).

0.10= Weight given to Thickness pay adjustment.

B. Pay Adjustment for Ride Quality.

Pay adjustment for Ride Quality shall be applied to Pay Item 999.494 at the completion of all HMA Lots. Although Ride Quality Acceptance testing will be performed only on the final pavement course, the pay adjustment will be applied to the total quantity of all HMA pavement courses placed. Since each wheel path of the final pavement course represents a Lot for Ride Quality, the quantity for each Lot shall be computed by dividing the total quantity of all pavement courses placed by the number of wheel paths for all lanes tested in the final pavement course. The total Lot pay adjustment for Ride Quality will be determined as follows:

$$PA_{Ride\ Quality} = \sum (PF_i - 1)\,(\sum (Q_{pc})(P_{pc}))/N_{wp}\,(0.30))$$

Where: $PA_{Ride\ Quality}$ = Pay adjustment in dollars for Ride Quality.

PF_i = Pay factor based on Quality Level (PWL) of Ride Quality for individual Lot (i).

Q_{pc} = Quantity represented by individual pavement course (pc) in tons (Mg).

P_{pc} = Contract unit price per ton (Mg) for individual pavement course (pc).

N_{wp} = Total number of wheel paths for all lanes tested.

0.30 = Weight given to Ride Quality pay adjustment.

2008 SUPERPAVE HMA Specifications

SECTION 455

SUPERPAVE HOT MIX ASPHALT PAVEMENT

Section 455 - SUPERPAVE Hot Mix Asphalt Pavement amends Section 450 - Hot Mix Asphalt Pavement. The provisions herein replace the Subsections of Section 450 as indicated.

NOTE: The Pay Adjustment provisions included in Subsection 450.92 will be applied to items under this contract.

DESCRIPTION

Delete Subsection 450.20 - General and replace with the following:

455.20 General.

This work shall consist of producing and placing Hot Mix Asphalt (HMA) pavement. All HMA mixtures shall meet the requirements of the SUPERPAVE volumetric design system. The HMA pavement shall be constructed in courses on the prepared or existing base in accordance with these specifications and in conformance with the lines, grades, compacted thickness and typical cross section as shown on the plans. Each SUPERPAVE HMA pavement course placed shall be comprised of one of the mixture types listed in Table 455.1.

Table 455.1 - SUPERPAVE HMA Pavement Courses & Mixture Types

Pavement Course	Mixture Type	Mixture Designation
Friction Course	• Open-Graded Friction Course - Polymer Modified	OGFC – P
Surface Course	• SUPERPAVE Surface Course - 4.75 • SUPERPAVE Surface Course - 9.5 • SUPERPAVE Surface Course - 12.5 • SUPERPAVE Surface Course - 19.0	SSC - 4.75 SSC - 9.5 SSC - 12.5 SSC - 19.0
Intermediate Course	• SUPERPAVE Intermediate Course - 12.5 • SUPERPAVE Intermediate Course - 19.0	SIC - 12.5 SIC - 19.0
Base Course	• SUPERPAVE Base Course - 25.0 • SUPERPAVE Base Course - 37.5	SBC - 25.0 SBC - 37.5
Leveling Course	• SUPERPAVE Leveling Course - 4.75 • SUPERPAVE Leveling Course - 9.5	SLC - 4.75 SLC - 9.5
Bridge Surface Course	• SUPERPAVE Bridge Surface Course - 9.5 • SUPERPAVE Bridge Surface Course - 12.5	SSC-B - 9.5 SSC-B - 12.5
Bridge Protective Course	• SUPERPAVE Bridge Protective Course - 9.5 • SUPERPAVE Bridge Protective Course - 12.5	SPC-B - 9.5 SPC-B - 12.5

When a SUPERPAVE Surface Course - 19.0 (SSC - 19.0) is specified in the contract, the Laboratory Trial Mix Formula (LTMF) aggregate gradation shall provide a fine-graded HMA mixture as defined in Subsection 455.42F.

MATERIALS

Delete Subsection 450.40 - General and replace with the following:

455.40 General.

SUPERPAVE HMA mixtures shall be composed of the following: Mineral aggregate, mineral filler (if required), Performance Graded Asphalt Binder (PGAB), and as permitted, reclaimed materials (limited to Reclaimed Asphalt Pavement (RAP), Reclaimed Asphalt Shingles (RAS), and Processed Glass Aggregate (PGA)). Materials shall meet the requirements in the following Subsections of Division III, Materials and as otherwise specified herein:

Asphalt Emulsion	M3.03.0
Hot Poured Joint Sealer	M3.05.0
Asphalt Anti-Stripping Additive	M3.10.0
Mineral Aggregate	M3.11.04
Mineral Filler	M3.11.05
Plant Requirements	M3.11.07

Delete Subsection 450.42 - Hot Mix Asphalt Mix Design and replace with the following:

455.42 SUPERPAVE Hot Mix Asphalt Mixture Design.

The Contractor shall be responsible for development of all SUPERPAVE HMA mixture designs. All HMA surface courses, intermediate courses, base courses, leveling courses, bridge surface courses, and bridge protective courses shall be supported by volumetric mixture designs using the SUPERPAVE mixture design system. All SUPERPAVE HMA mixture designs shall be developed in accordance with the following AASHTO standards, as modified herein:

AASHTO M 323
AASHTO R 35
AASHTO T 312

Volumetric mixture designs are not required for OGFC. The aggregate gradation structure and target PG Asphalt Binder content for Open-Graded Friction Course - Polymer Modified (OGFC-P) shall conform to the master ranges in M3.11.03 – Table B.

A. Development of Laboratory Trial Mix Formula (LTMF).

The Contractor shall develop and submit for Department approval, a minimum of forty-five (45) days prior to the start of SUPERPAVE HMA pavement construction, a Laboratory Trial Mix Formula (LTMF) as the proposed Job Mix Formula (JMF) for each SUPERPAVE mixture type to be used on the project. Two or more JMFs per HMA mixture type may be approved for a particular plant, however, only HMA conforming to one JMF is permitted to be produced and placed on any given day.

The following is a general outline of the steps for developing an LTMF and an approved JMF:

1. Estimate Percentage of RAP to be utilized and select PG Asphalt Binder as required by the specifications (Subsection 455.42C.);
2. Evaluate aggregates (and reclaimed materials) for conformance with Consensus Properties (Subsection 455.42D.) and Source Properties (Subsection 455.42E.);
3. Develop trial aggregate blends and estimate PG Asphalt Binder content in accordance with AASHTO R 35. Compact each of the blends. Based on volumetric analysis, select the best trial blend that meets the requirements of M 323 (Subsections 455.42F and 455.42G.);
4. Determine volumetric properties of LTMF and select PG Asphalt Binder content (Subsection 455.42H.);
5. Evaluate Moisture Sensitivity of the mixture (Subsection 455.42I.);
6. LTMF to be verified in the laboratory by the Department (Subsection 455.43);
7. Through production of a Control Strip Lot, verify that LTMF can be produced through the plant. (Subsection 450.66B.). Verification of the LTMF results in an approved JMF;
8. Repeat process for all mixtures to be utilized.

B. Estimated Design Traffic.

The estimated traffic level to be used for SUPERPAVE HMA mixture designs for this contract, expressed in Equivalent Single Axle Loads (ESALs) for the design travel lane over a 20-year period, is **29** Million 18-kip (80-kn) ESALs.

C. Performance Graded Asphalt Binder.

The Asphalt Binder used for all HMA mixtures under this contract shall comply with the requirements of Subsection 450.48. The PGAB Grade selected for this Contract is **PG 64-28**

D. Aggregate Consensus Properties.

Aggregates utilized in SUPERPAVE HMA mixtures, including RAP if used in the mixture, shall be tested for conformance with the following Consensus Property requirements:

- Determining the Percentage of Fractured Particles in Coarse Aggregate (ASTM D 5821)
- Uncompacted Void Content of Fine Aggregate (AASHTO T 304 - Method A)
- Flat or Elongated Particles (ASTM D 4791)

- Clay Content/Sand Equivalent Test (AASHTO T 176)

The Consensus Property test results shall be submitted with the LTMF for each SUPERPAVE HMA mixture. The Contractor shall provide aggregate samples a minimum of forty-five (45) days prior to production for each LTMF to the Department for LTMF verification prior to SUPERPAVE HMA production. The required minimum or maximum criteria for each of the Consensus Property tests for the total aggregate blend are specified below in Table 455.2 below.

Table 455.2 - Aggregate Consensus Property Requirements

Traffic Level	Design ESALs 18-kip (80-kn))	Coarse Aggregate Angularity (1) (2) ASTM D5821 (Percent Minimum)		Fine Aggregate Angularity (1) AASHTO T 304 - Method A (Percent Minimum)		Flat or Elongated Particles (2) ASTM D4791 (Percent Maximum)	Sand Equivalent AASHTO T 176 (Percent Minimum)
-----	(million)	(Depth from final surface) ≤ 4 in (100 mm)	(Depth from final surface) > 4 in (100 mm)	(Depth from final surface) ≤ 4 in (100 mm)	(Depth from final surface) > 4 in (100 mm)	> # 4 (4.75 mm)	----
1	< 0.3	55/--	--/--	--	--	--	40
2	0.3 to < 3.0	75/--	50/--	40	40	10	40
3	3 to < 10	85/80	60/--	45	40	10	45
4	10 to < 30.0	95/90	80/75	45	40	10	45
5	≥ 30.0	100/100	100/100	45	45	10	50
	Design ESALS are the anticipated project traffic level expected on the design lane, projected over a 20 year period, regardless of the actual expected design life of the roadway.	Criteria presented as minimum values. 95/90 denotes that a minimum of 95% of the coarse aggregate, by mass, shall have one fractured face and that a minimum of 90% shall have two fractured faces.		Criteria presented as minimum percent air voids in loosely compacted fine aggregate passing the #8 (2.36 mm) sieve.		Criteria presented as maximum percent by mass of flat or elongated particles of materials retained on the #4 (4.75 mm) sieve, determined at 5:1 ratio.	Criteria presented as minimum values for fine aggregate passing the #4 (4.75 mm) sieve.

Notes:

(1) If less than 25% of a given layer is within 4 inches (100 mm) of the anticipated top surface, the layer may be considered to be below 4 inches (100 mm) for mixture design purposes.

(2) This criterion does not apply to #4 (4.75 mm) nominal maximum size mixtures.

E. Aggregate Source Properties.

The coarse mineral aggregate utilized in SUPERPAVE HMA mixtures shall be clean, crushed rock consisting of the angular fragments obtained by breaking and crushing shattered natural rock. It shall be free from dirt or other objectionable materials. The coarse aggregate, including RAP if used in the mixture, shall be tested for conformance with the following Source Property requirements:

- Toughness as Determined by: Los Angeles Abrasion (AASHTO T 96)
- Soundness as Determined by: Soundness (AASHTO T 104)
- Deleterious Materials as Determined by: Clay Lumps & Friable Particles (AASHTO T 112)
- Specific Gravity (AASHTO T 8)

Testing for each of the Source Properties shall be performed for each SUPERPAVE HMA mixture design developed for the project. The Source Property test results shall be submitted with the LTMF for each SUPERPAVE HMA mixture. The Contractor shall provide samples of each aggregate material from each stock pile, a minimum of forty-five (45) days prior to production for each LTMF to the Department for LTMF verification prior to SUPERPAVE HMA production. The requirements for each of the Source Properties are as indicated in Table 455.3 below.

Table 455.3 - Aggregate Source Property Requirements

Source Property Test	Limit
Toughness (AASHTO T 96)	Maximum Loss < 30 %
Soundness (AASHTO T 104)	Maximum Loss < 10 %
Deleterious Materials (AASHTO T 112)	Maximum Permissible < 0.5 %

F. SUPERPAVE Aggregate Gradation and Specific Gravity Requirements.

The combined aggregate blend for each SUPERPAVE HMA mixture shall conform to the Gradation Control Point requirements specified in Table 455.6 below. The results of the selected optimum Design Aggregate Structure shall be plotted on a 0.45 Power Chart and included with the LTMF.

The combined aggregate gradation shall be classified as coarse-graded when it passes below the Primary Control Sieve (PCS) control point as defined in Table 455.4. All other gradations shall be classified as fine graded.

The specific gravity of each coarse and fine aggregate component shall be determined in accordance with AASHTO T 85 and T 84 respectively, and the specific gravity of the mineral

filler shall be determined in accordance with AASHTO T 100. The individual aggregate specific gravities shall be included with the LTMF. The Contractor shall provide samples of each aggregate material a minimum of forty-five (45) days prior to production for each LTMF to the Department for verification of the selected optimum Design Aggregate Structure and specific gravity of each stock pile.

Table 455.4 - Gradation Classification

PCS Control Point for Mixture Nominal Maximum Aggregate Size					
	% Passing				
Nominal Maximum Aggregate Size	1-1/2” (37.5 mm)	1” (25.0 mm)	3/4” (19.0 mm)	1/2” (12.5 mm)	3/8” (9.5 mm)
Primary Control Sieve	3/8” (9.5 mm)	#4 (4.75 mm)	#4 (4.75 mm)	#8 (2.36 mm)	#8 (2.36 mm)
PCS Control point (% Passing)	47	40	47	39	47

G. Gyratory Compaction Criteria.

Each SUPERPAVE HMA mixture shall be designed and controlled during production using an approved Gyratory Compactor which meets the requirements of AASHTO T 312. Compaction shall be in accordance with the requirements of AASHTO T 312. The density of each SUPERPAVE HMA mixture shall be evaluated at the initial number of gyrations ($N_{initial}$), the design number of gyrations (N_{design}), and the maximum number of gyrations (N_{max}). The gyratory-compacted specimens for each LTMF shall meet the density requirements specified in Table 455.5 below.

H. Volumetric Design Requirements.

Each SUPERPAVE HMA mixture shall be designed in accordance with the volumetric mixture design specifications contained in AASHTO M 323 and procedures contained in AASHTO R 35, as modified herein. Each HMA mixture LTMF shall be tested for conformance with the following volumetric properties:

- Air Voids at N_{design} (V_a)
- Voids in the Mineral Aggregate at N_{design} (VMA)
- Voids Filled with Asphalt at N_{design} (VFA)
- Fines to Effective Asphalt Ratio ($P_{0.075}$ / P_{be})

The volumetric property test results shall be submitted with the LTMF for each SUPERPAVE HMA mixture. The required minimum or maximum criteria for each of the volumetric property tests are specified in Table 455.6 below.

Table 455.5 - SUPERPAVE HMA Design Requirements

Traffic Level	Design ESALs	Number of Gyrations by Superpave Gyratory Compactor			Percent Density of Gmm from HMA Specimen			Voids Filled with Asphalt (VFA)* Based on Nominal Maximum Aggregate Size					
	(million)	Nini	Ndes	Nmax	Nini	Ndes	Nmax	#4 (4.75 mm)	3/8" (9.5 mm)	1/2" (12.5 mm)	3/4" (19.0 mm)	1" (25.0 mm)	1-1/2" (37.5 mm)
1	< 0.3	6	50	75	≤ 91.5	96.0	≤ 98.0	70 – 80	70 – 80	70 – 80	70 – 80	67 – 80	64 – 80
2	0.3 to < 3.0	7	75	115	≤ 90.5	96.0	≤ 98.0	65 – 78	65 – 78	65 – 78	65 – 78	65 – 78	64 – 78
3	3.0 to < 10	8	100	160	≤ 89.0	96.0	≤ 98.0	75 – 78	73 – 76	65 – 75	65 – 75	65 – 75	64 – 75
4	10 to < 30.0	8	100	160	≤ 89.0	96.0	≤ 98.0	75 – 78	73 – 76	65 – 75	65 – 75	65 – 75	64 – 75
5	≥ 30.0	9	125	205	≤ 89.0	96.0	≤ 98.0	75 – 78	73 – 76	65 – 75	65 – 75	65 – 75	64 – 75

*The VFA values contained in Table 455.5 have been modified from AASHTO M 323 to ensure adequate PG Asphalt Binder content in each SUPERPAVE HMA mixture.

Table 455.6 - Gradation and Volumetric Requirements

	SUPERPAVE HMA Mixture Nominal Maximum Aggregate Size												LTMF Verification Limits
Sieve	#4 (4.75 mm)		3/8" ((9.5 mm)		1/2" (12.5 mm)		3/4" (19.0 mm)		1" (25.0 mm)		1-1/2" (37.5 mm)		
	CONTROL POINTS		CONTROL POINTS		CONTROL POINTS		CONTROL POINTS (5)		CONTROL POINTS		CONTROL POINTS		Target ±
Inches	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	
2	-	-	-	-	-	-	-	-	-	-	100	-	**6.0**
1.5	-	-	-	-	-	-	-	-	100	-	90	100	**6.0**
1	-	-	-	-	-	-	100	-	90	100	-	90	**6.0**
¾	-	-	-	-	100	-	90	100	-	90	-	-	**6.0**
½	100	-	100	-	90	100	-	90	-	-	-	-	**6.0**
3/8	95	100	90	100	-	90	-	-	-	-	-	-	**6.0**
#4	90	100	-	90	-	-	-	-	-	-	-	-	**6.0**
#8	-	-	35	67	31	58	26	49	19	45	15	41	**5.0**
#16	30	60	-	-	-	-	-	-	-	-	-	-	**3.0**
#30	-	-	-	-	-	-	-	-	-	-	-	-	**3.0**
#50	-	-	-	-	-	-	-	-	-	-	-	-	**3.0**
#100	-	-	-	-	-	-	-	-	-	-	-	-	**2.0**
#200	6	12	2	10	2	10	2	8	1	7	0	6	**1.0**
PB	-		-	-	-	-	-	-	-	-	-	-	**0.3**
VMA (3)	17.0		16.0		15.0		14.0		13.0		12.0		1.0
Va (%)	4.0		4.0		4.0		4.0		4.0		4.0		1.0
VFA	Per Table 455.5 ± 5 off LTMF		Per Table 455.5 ± 5 off LTMF		Per Table 455.5 ± 5 off LTMF		Per Table 455.5 ± 5 off LTMF		Per Table 455.5 ± 5 off LTMF		Per Table 455.5 ± 5 off LTMF		
Gse	LTMF value		LTMF value		LTMF value		LTMF value		LTMF value		LTMF value		0.02
Gmm	LTMF value		LTMF value		LTMF value		LTMF value		LTMF value		LTMF value		0.02
Dust/Pbe(2)	0.9 – 2.0		0.6 - 1.2		0.6 - 1.2		0.6 - 1.2		0.6 - 1.2		0.6 - 1.2		
Mixture Temp	265 - 325F(1)		265 - 325F (1)		265 - 325F (1)		265 - 325F (1)		265 - 325F (1)		265 - 325F (1)		
PCS (4)			Sieve #8	47	Sieve #8	39	Sieve #4	47	Sieve #4	40	Sieve 3/8"	47	

(1) Based on the final design PG Asphalt Binder certification. (2) Dust is considered to be the percent of material passing the #200 (75 µm) sieve. The calculated effective asphalt content (Pbe) shall be used for this calculation. (3) Voids in Mineral Aggregates shall be computed as specified by AASHTO R 35. (4) If the aggregate gradation passes beneath the PCS Control Point specified in Table 455.4, the dust-to-binder ratio range may be increased from 0.6-1.2 to 0.8-1.6 at the Engineer's discretion. (5) When used as a Surface Course under OGFC the Min % for the #8 (2.36 mm) Sieve should be 40.

I. Evaluation of Moisture Sensitivity.

Each SUPERPAVE HMA mixture shall be tested by the Contractor for Moisture Sensitivity in accordance with the requirements of AASHTO T 283. The compacted specimens for each LTMF shall exhibit a minimum tensile strength ratio of 80% as determined by AASHTO T 283. A minimum tensile strength ratio of 80% is required. The use of approved anti-stripping agents (either liquid or mineral) can be used to meet this requirement. If an anti-strip agent is required, it shall be included in the Contractor's cost.

The Moisture Sensitivity test results shall be submitted with the LTMF for each SUPERPAVE HMA mixture. The Department will perform testing of the Moisture Sensitivity prior to SUPERPAVE HMA production as part of the verification of each LTMF.

Delete Subsection 450.66A. - Laboratory Verification of HMA Mix Design and replace with the following:

455.43 Verification of Laboratory Trial Mix Formula (LTMF)

The Contractor shall submit a LTMF with supporting documentation, a minimum of forty-five (45) days prior to production, to the Engineer with samples of blended aggregate material and PG Asphalt Binder. An adequate amount of the blended aggregate material and PG Asphalt Binder shall be supplied in order to verify the LTMF selected for production (proposed JMF).

If the Engineer is unable to verify the Contractor's LTMF in accordance with the LTMF Verification Limits in Table 455.7, then the Engineer will work with the Contractor to resolve the verification issue(s). **The Contractor shall not proceed with production and placement of the Control Strip (Section 450.66B.) until the LTMF is verified by the Engineer.**

Table 455.7 - SUPERPAVE HMA LTMF Verification Limits

Properties	LTMF Verification Limit
Asphalt Binder Content (P_b)	Target ± 0.3 percent
Gradation Passing #4 (4.75 mm) and Larger Sieves	Target ± 6.0 percent
Gradation Passing #8 (2.36 mm) Sieve	Target ± 5.0 percent
Gradation Passing #16 (1.18 mm) to #50 (0.30 mm) Sieve	Target ± 3.0 percent
Gradation Passing #100 (0.15 mm) Sieve	Target ± 2.0 percent
Gradation Passing #200 (75 µm) Sieve	Target ± 1.0 percent
Max. Theo. Specific Gravity (G_{mm})	Target ± 0.02

Properties	LTMF Verification Limit
Air Voids (V_a)	Target ± 1.0 percent
Voids in Mineral Aggregate (VMA)	Target ± 1.0 percent
Voids Filled With Asphalt (VFA)	Target ± 5.0 percent
Bulk Specific Gravity (G_{mb})	Target ± 0.022

CONSTRUCTION PROCEDURES

Delete Subsection 450.53F. - Tack Coat and replace with the following:

G. Tack Coat.

A tack coat of asphalt emulsion, grade RS-1 shall be uniformly applied to existing or new pavement surfaces prior to placing pavement courses as specified below. The existing surface shall be swept clean of all foreign matter and loose material using a mechanical sweeper and shall be dry before the tack coat is applied.

(1) Tack Distributor System.

A pressure distributor shall be used to apply the tack coat. The tack distributor system shall be equipped with the following to control and monitor the application:

(e) System for heating the asphalt emulsion uniformly to specified temperature.
(f) Thermometer for measuring the asphalt emulsion temperature.
(g) Adjustable full circulation spray bar.
(h) Positive controls including tachometer, pressure gauge, and volume measuring device.

(2) Tack Application Requirements.

The tack coat material shall be applied by a pressure distributor. All nozzles on the distributor shall be open and functioning. All nozzles shall be turned at the same angle to the spray bar. Proper nozzle angle shall be as determined by the manufacturer of the distributor spray bar. The spray bar shall be adjusted so that it is at the proper height above the pavement surface to provide a double overlap spray for a uniform coverage of the pavement surface. A double lap application requires that the nozzle spray patterns overlap one another such that every portion of the pavement receives spray from exactly two nozzles.

When an HMA pavement course is placed on an existing tight smooth pavement surface, a tack coat shall be applied at the rate of 1/20 gal/s.y. (0.20 liters/square meter). All existing surfaces subjected to

milling shall receive a tack coat at the rate of 1/15 gal/s.y. (0.28 liters/square meter). Tack coat shall be applied to cover approximately 90% of the pavement surface.

Any new HMA pavement course that has been open to traffic, or that was placed 30 days prior to placement of the subsequent pavement course, shall receive a tack coat at an application rate of 1/20 gal/s.y. (0.20 liters/square meter).

When the surface of a new HMA pavement course is in a condition which in the Engineer's judgment is unsatisfactory for the direct placement of the subsequent pavement course, a tack coat shall be applied at the applicable rate specified above for the particular pavement surface condition.

In addition to the requirements above, all vertical surfaces of curbs, edging, utilities, and drainage structures shall receive a thorough tack coat application immediately prior to placing each HMA pavement course.

(3) Tack Inspection.

The asphalt emulsion temperature and application rate shall be periodically measured and properly recorded by the Contractor on NETTCP Inspection Report Forms. If the temperature or application rate is determined to not be in conformance with the specification requirements above, the Contractor shall make appropriate adjustments to the tack application operations.

COMPENSATION

The Pay Adjustment provisions included in Subsection 450.92 - Pay Adjustment shall be applied to items under this contract.

Delete Subsection 450.91D. - Hot Mix Asphalt and replace with the following:

D. Hot Mix Asphalt.

Each Hot Mix Asphalt pavement course will be paid for at the contract unit price per ton (Megagram) of in-place mixture under the HMA Pay Items specified in Subsection 455.93. Payment shall include sweeping the underlying surface, transportation, delivery, placement including providing a Material Transfer Vehicle (MTV), and compaction of each HMA pavement course in accordance with Subsection 450.54 through Subsection 450.58.

All sawcutting required for transverse joints or longitudinal joints in accordance with Subsection 450.57 shall also be included in the contract unit price for each HMA pavement course.

ITEM 482.3 SAWING ASPHALT PAVEMENT

The work under this item includes sawing existing bituminous concrete pavement at the locations shown on the plans, as described hereunder and as directed by the Resident Engineer.

Sawcut locations shall be marked on the pavement prior to sawcutting. Sawcut locations shall be in reasonably straight lines and be accessible to sawing tools. Sawcuts shall be made at trenches, excavation limits for structures, limits of work and other existing pavement locations where sawcuts are noted on the plans or as directed by the Resident Engineer.

Saw cuts which have been damaged and/or undermined due to the Contractor's operations shall be re-sawn as directed by the Resident Engineer.

Sawcuts shall be neatly made to the full depth of the proposed adjacent pavement section. The sawcutting tool shall be of a type specifically made for sawing pavement.

ITEM 504.2 GRANITE CURB TYPE VA4 – SPLAYED END

The work shall conform to the relevant provisions of Section 501 and the following:

Splayed ends shall be furnished and installed at locations shown on the plans and shall be a minimum length of six foot six inches. The curb shall be sawcut to match into the proposed adjacent curb and/or berm.

ITEM 635. HIGHWAY GUARD REMOVED AND STACKED

The work to be done under this item shall consist of removing and stacking guardrail of any kind or type within the project limits designated as remove and stack. The work under this item shall conform to the relevant provisions of Section 630 of the Standard Specifications and the following:

The work to be done shall consist of removing and stacking guardrail including posts, end sections, offset brackets, and hardware as indicated on the Contract Drawings. Items to be removed and stacked shall be done so at Contractor staging areas. Removed guardrail materials may be reused on future phases of this project by the Contractor as approved by the Resident Engineer. Any materials/ hardware lost or damaged which is scheduled to be reused shall be replaced by the Contractor at their own expense.

All guardrail materials which are in poor condition and cannot be used on the project shall be legally disposed of by the Contractor.

ITEM 697.1 SILT SACK

The work under this item includes furnishing, installing, maintaining and removing silt sacks at all existing and proposed catch basins within the limits of work of the project during construction.

Silt sacks shall be made of non-woven polypropylene and shall fit freely suspended inside the catch basin. The filter shall have a polypropylene boot at the top on which the grate rests to hold it in

place. A manufactured overflow opening shall be provided near the top of the filter, below the boot. The filter shall have the following properties:

Construction Material	Non-woven polypropylene
Maximum overflow rate:	>200 GPM
Maximum filtration rate:	>50 GPM (Type - S)
Absorbent material:	Polypropylene
Maximum filtration rate:	>5-8 GPM (Type – O)
Boot adapter dimensions:	36” x 36”
Nominal depth:	18”

Silt sack shall be Siltsack by ACF Environmental or approved equivalent.

Silt sacks shall be installed prior to construction, at the same time that other erosion controls are installed. Silt sacks shall be inspected after each rain event and damaged sacks shall be replaced as approved by the Owner. Sacks that have filled with debris but remain functional shall be cleaned and reset into the catch basin.

When work is being conducted on the catch basin the silt sack shall be removed, cleaned, and temporarily stored until the drainage structure work has been completed, at which time the silt sack shall be either reset or removed, as applicable to the finished function of the structure.

Silt sacks shall be removed and disposed at the conclusion of the work on the project or as directed by the Resident Engineer.

ITEM 756. NPDES STORM WATER POLLUTION PREVENTION PLAN

This Item addresses the preparation and implementation of a Storm Water Pollution Prevention Plan required by the National Pollutant Discharge Elimination System (NPDES) and applicable Construction General Permit.

Pursuant to the Federal Clean Water Act, effective March 10, 2003, construction activities which disturb one acre or more are required to apply to the U.S. Environmental Protection Agency (EPA) for coverage under the NPDES General Permit for Storm Water Discharges From Construction Activities. On July 1, 2003 (68 FR 39087), EPA published the final NPDES construction general permit for construction activity. On August 4, 2003 (68 FR 45817), EPA reissued the General Permit for the Commonwealth of Massachusetts and included state specific requirements.

The NPDES General Permit requires the submission of a Notice of Intent (NOI) to the U.S. EPA prior to the start of construction (defined as any activity which disturbs land, including clearing and grubbing). There is a seven (7) day review period commencing from the date on which EPA enters the Notice into their database. The Contractor is advised that, based on the review of the NOI, EPA may require additional information, including but not limited to, the submission of the Storm Water

Pollution Prevention Plan for review. Work may not commence on the project until final authorization has been granted by EPA.

In addition, if the project discharges to an Outstanding Resource Water, vernal pool, or is within a coastal ACEC as identified by the Massachusetts Department of Environmental Protection (DEP), a separate notification to DEP is required. DEP may also require submission of the Storm Water Pollution Prevention Plan for review and approval. Filing fees associated with the notification and, if required, the SWPPP filing to DEP shall be paid by the Contractor.

The owner, MassDOT, and the operator, the Contractor, must submit separate NOIs. In cases where the municipality or other party has control over the plans and specifications or day-to-day site operations, said party must also submit a NOI.

The General Permit also requires the preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the aforementioned statutes and regulations. The Plan will include the General Permit conditions and detailed descriptions of controls of erosion and sedimentation to be implemented during construction. It is the responsibility of the Contractor to prepare the SWPPP to meet the requirements of the most recently issued CGP. The Contractor shall submit the Plan to the Engineer for approval. It is the responsibility of the Contractor to be familiar with the General Permit conditions and the conditions of any state Wetlands Protection Act Order, Water Quality Certification, Corps of Engineers Section 404 Permit and other environmental permits applicable to this project and to include in the Stormwater Pollution Prevention Plan the methods and means necessary to comply with applicable conditions of said permits.

It is the responsibility of the Contractor to complete the SWPPP in accordance with the EPA Construction General Permit, provide all information required, and obtain certifications as required by the Construction General Permit. Any amendments to the SWPPP required by site conditions, schedule changes, revised work, construction methodologies, and the like are the responsibility of the Contractor. Amendments will require the approval of the Engineer prior to implementation.

Included in the General Permit conditions is the requirement for inspection of all erosion controls and site conditions on a weekly basis as well as after each incidence of rainfall exceeding 0.5 inches in twenty-four hours. The Contractor shall choose a qualified individual who will be on-site during construction to perform these inspections. The Engineer must approve the contractor's inspector. In addition, if the Engineer determines at any time that the inspector's performance is inadequate, the Contractor shall provide an alternate inspector. Written weekly inspection forms, storm event inspection forms, and Monthly Summary Reports must be completed and provided to the Engineer. Monthly Summary Reports must include a summary of construction activities undertaken during the reporting period, general site conditions, erosion control maintenance and corrective actions taken, the anticipated schedule of construction activities for the next reporting period, any SWPPP amendments, and representative photographs.

The Contractor is responsible for preparation of the Plan, all SWPPP certifications, inspections, reports and any and all corrective actions necessary to comply with the provisions of the General Permit. Work associated with performance of inspections is not included under this Item. The Standard Specifications require adequate erosion control for the duration of the Contract. Inspection

of these controls is considered incidental to the applicable items. This Item addresses acceptable completion of the SWPPP, any revisions/amendments required during construction, and preparation of monthly reports. In addition, any erosion controls beyond those specified in bid items elsewhere in this contract which are selected by the Contractor to facilitate and/or address the Contractor's schedule, methods and prosecution of the work shall be considered incidental to this item.

The CGP requires the submission of a Notice of Termination (NOT) from all operators when final stabilization has been achieved.

ITEM 767.7 FIBER ROLL

The work under this item shall consist of furnishing, installing, maintaining, and removing erosion control straw wattles for erosion and sedimentation control in conformance with the requirements of the approved project Stormwater Pollution Prevention Plan.

Fiber rolls shall be 9" diameter, tubular sediment control devices comprised of weed-free agricultural straw fibers encased in durable netting. Each length of fiber roll shall be 25 feet in length weighing 50 pounds with a density of 4.53 lbs/cubic foot.

Fiber roll shall be placed in accordance with manufacturer's recommendations and the details shown on the plans. Maintenance of these devices and removal of accumulated sediment shall conform to the requirements of the NPDES SWPPP. Following establishment of permanent slope stabilization the fiber rolls shall be removed and the area disturbed by initial installation shall be restored.

ITEM 811.27 SECURE ELECTRICAL HANDHOLE FRAME AND COVER

The work of this item shall conform to the relevant provisions of Sections 801 and 820 of the Standard Specifications and the following:

The work shall include the furnishing and installation of electrical handhole frames and covers for the highway lighting system, and all other materials, labor, equipment and incidental costs required for the work, as shown on the plans and as directed by the Engineer. The work shall also entail removing and resetting handhole frames and covers to meet with final grade, and as directed by the Engineer.

Handhole frames and covers shall be secured using bolts to prevent accidental removal.

Each handhole casting shall be equipped with a bolt down and gasketed cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow the cleanout of sand, dirt, and other debris.

Frames and covers shall be classified as heavy duty and shall meet the requirements of AASHTO M306.

Handhole covers shall be approximately 14" x 14". Frames shall have a clear opening of 12" x 12".

Handhole covers shall have a non-skid surface with letters cast in the depression on the top. Each letter shall be raised 0.2". The legends shall be italic and shall read "*MassDOT*" (9" width x 1.3" height) with the MassDOT division (i.e. street lighting, traffic) embossed directly below.

Shop Drawings

Within 30 days following execution of the Contract, the Contractor shall submit shop drawings for handholes, frames/covers, and manufacturer's equipment specifications to the Engineer in accordance with the relevant provisions of Section 815.20.

No work shall be commenced by the Contractor until approval of the shop drawings and manufacturer's data has been received in writing from the Engineer. Approval of these drawings will be general in character and shall not relieve the Contractor from the responsibility of, or the necessity of, furnishing materials and workmanship conforming to the plans and specifications.

The Contractor shall deliver to the Engineer a certificate of compliance with the manufacturer for all materials purchased from the manufacturer.

ITEM 811.331 HEAVY DUTY PULL BOX

ITEM 812.11 LIGHT STANDARD FOUNDATION SD3.011

ITEM 823.70 HIGHWAY LIGHTING POLE AND LUMINAIRE REMOVED AND RESET

The work under these items shall conform to the relevant provisions of Sections of 800 and 820 of the Standard Specifications and the following:

The work under these items shall consist of dismantling, removing, storing, and resetting of existing light poles, luminaries and related hardware within the I-93 project as described on the plans. The Contractor shall not be responsible to supply new poles or luminaries. Any new poles and luminaries that require installation by the Contractor shall be furnished by others.

Several existing street lights shall be removed and reset as they fall within the median crossover areas located within the project limits. The Contractor shall coordinate with the electric company for removal of the existing street light poles. The Contractor shall remove the foundation and furnish and install a new heavy duty pull box at that location. The new pull box shall be a heavy duty structure and include a heavy duty frame and secured cover. The pull box and frame and cover shall meet HS-20 loading requirements. The Contractor shall coordinate with the electric company for light poles within the public way for all wiring and service connections.

The Contractor shall exercise extreme care in the dismantling, removal, storage and resetting of the existing poles and luminaires. The pole, or related equipment, damaged through carelessness or

lack of protection by the Contractor shall be replaced at no additional cost.

New light pole foundations shall be furnished and installed at the new light pole location shown on the plans and as required by the Engineer. New foundation dimensions shall match the existing dimensions of the foundations removed. The existing foundations shall be removed and replaced with heavy duty pull boxes. The Contractor shall furnish and install additional conduit to the new light pole location as required.

New conduit shall be furnished and installed from the new pull box location to the relocated street light foundation location.

For light poles within the I-93 work zone, the wiring in the existing pole shall be disconnected and the pole removed. The existing wiring shall be pulled out of the conduit and the conduit shall be disconnected at the existing pole foundation conduit sweep.

All electrical work shall be performed by an experienced licensed electrician and such work shall meet all state and local electrical codes.

The Contractor shall backfill the existing foundation removal excavation with gravel borrow or suitable material, as required by the Engineer.

ITEM 812.16 REPAIR/EXTENSION OF LIGHT POLE FOUNDATION

Work under this item shall conform to the relevant provisions of Section 820 of the Standard Specifications and the following:

This item shall consist of repairing and/or extending existing light pole foundations to meet the requirements of the project.

Materials required to be furnished and installed as part of this work are as noted on the plans. Bonding agent shall meet the requirements of section M4.05.5 of the standard specifications.

The work required at each existing foundation is noted on Table A below. All work shall be performed so as to avoid damage to existing reinforcing, anchor bolts and conduit to remain. The final top of foundation elevations are noted in Table A. The final top of foundation elevation is set at 1 inch above the elevation of the top of the highest final median barrier at the foundation location. Contractor to field verify all existing and proposed elevations.

Each new or reset light pole shall not be placed on a foundation until new concrete placed as part of the work has reached its design strength.

TABLE A

Crossing	Station	Exist Top of Fdn Elev.	Prop Top of Fdn Elev.	Treatment
Rte 16	55+00	36.3+/-	37.82	Extend only
	51+20.0	30.1+/-	31.44	Extend only
Mystic River	20+20.1	19.2+/-	20.32	Extend only
	16+92.4	29.1+/-	30.12	Extend only
Riverside Ave	14+11.1	36.3+/-	37.29	Repair/Extend
Salem St EB	96+44.5	43.3+/-	44.76	Extend only
Salem St WB	103+55.5	36.7+/-	37.84	Extend only
Valley St	123+40.2	47.5+/-	48.82	Extend only

ITEM 820.14 MARINE NAVIGATION LIGHTING

Work under this item shall conform to the relevant provisions of Section 820 of the Standard Specifications and the following:

This item of work shall consist of furnishing and installing the marine navigation lighting systems as specified for the replacement of I-93 Northbound and Southbound bridges over the Mystic River. It shall include the furnishing, installation and testing of electrical and structural components incidental to construction of a fully operational navigation lighting system for the bridge. The navigation lighting shall be light-emitting diode type (LED).

Codes and Standards: All equipment, materials, installation and workmanship shall be in accordance with applicable requirements of the latest editions of the following organizations and codes:

US Coast Guard (USCG) Publication No. M16590.5, Section 118 USCG Bridge Administration

33 CFR 118.65

American Association of State Highway Transportation Officials (AASHTO)

National Electrical Manufacturers, Association (NEMA).

American National Standards Institute (ANSI).

National Electrical Code (NEC) (2008).

Underwriters Laboratories (UL).

Occupational Safety and Health Act (OSHA).

National Fire Protection Association (NFPA).

Institute of Electrical and Electronic Engineers (IEEE).

National Electrical Safety Code (NESC).

Quality Assurance: Electrical Equipment and material to be furnished under this specification shall be new and approved by the Engineer. The Engineer's determination of an acceptable equivalent to those products identified is final.

Materials

Materials required to be furnished and installed as part of this work are noted on the plans. All materials shall be produced to the highest standards of workmanship and in conformance with best industry practice by manufacturer(s) who can document experience with production of the material qualities necessary in the quantities required.

All structural steel for lamp support shall be AASHTO M270 Grade 50W/Bolts to attach structural steel shall be AASHOTO M164 Type 3.Connection bolts used to mount the navigation lights shall conform to ASTM A325 and be hot-dipped galvanized in accordance with ASTM A153 except where otherwise stipulated.

Navigation Lights LED-Type

General:

Navigational Lights shall be provided to properly mark the width of the waterway to approaching marine traffic. Each light shall consist of a fixture (marine lantern), internal assembly, and mountings, all as described herein. Each light shall meet or exceed the USCG requirements for this location.

Light Requirement: A total of four (4) red and two (2) green 180 degrees axis lights are required. The navigation lights shall show through a vertical angle of at least 20 degrees and conform to the Chromatic Standards for USCG Marine Signal Lanterns. Each light shall shine horizontally through an arc of 180 degrees minimum. The navigation lights shall have a color-corrected intensity of 50 candelas.

Fixture: Lantern housing shall consist of heavy-duty, copper-free cast aluminum structural components, anodized with a polyurethane coating, stainless steel hardware and a precision-molded, color-impregnated single-piece glass 200 millimeters Fresnel lens. The lenses shall be red or green as required and conform to the chromaticity standards for United States Coast Guard marine signal lanterns. Lantern shall be hinged for easy access to the lamp and internal assembly. Closure of the lantern shall be by captive toggle bolts and a watertight gasket. Lantern shall meet IEC Enclosure Classification IP-55 Standards. The lantern top shall remain physically connected to the lantern base when opened for servicing. The Lantern shall have stainless steel lens

protection rods (astragals) angled to minimize shadowing of the light beam at all viewing angles. Vertical lens rods are not acceptable.

Internal Assembly: An array of 1 or more light emitting diodes (LEDs) shall be symmetrically arranged around the lens focal point to optically couple the LEDs and the lens. The LED array shall be contained within a cylindrical diffuser to maximize horizontal uniformity of the light beam. LED life shall exceed 50,000 hours or 5 years for 24 hour continuous burning. Array is to be mounted on an internal shock and vibration isolator assembly. **Construction Methods**

The recommended routing of the conduits and cables to power the lights is indicated on the plans. If the contractor desires to use different routing or layout of the proposed conduits and cables the contractors routing shall be submitted for review. No work shall proceed until the submitted routing is approved.

Unless shown otherwise, the Contractor shall install PVC Schedule 80 conduit and PVC waterproof fittings. Remove burrs from, clean, dry and brush joints in PVC conduit with solvent cement before installation of coupling.

Conduits shall be securely clamped and supported at intervals not exceeding 5 feet in length. Use PVC coated fittings and tools on all PVC conduit runs.At any point where a conduit crosses an expansion joint longitudinally, or where movement between adjacent sections of conduit can be expected, conduit expansion fittings shall be installed. Junction and pull boxes shall be installed so that covers are readily accessible.

820.15 TEMPORARY HIGHWAY LIGHTING – UNDERPASS

The work under this item shall consist of furnishing and installing a temporary underpass lighting system below the following I-93 bridges: Riverside Ave., Salem St. EB, Salem St. WB, Rte. 16, Valley St., and Webster St. The work under this item shall conform to the relevant provisions of Section 820 and the following:

Existing underpass light fixtures shall be removed and stacked and the temporary underpass lighting system shall be in place and functional prior to the start of work on the bridge superstructure. Following bridge replacement all components of the existing underpass lighting system shall be restored to their preconstruction conditions. Components of the existing light system damaged by the Contractor shall be replaced in kind.

Handholes supplied as part of this item shall be equipped with a heavy duty frame and bolt down and gasketed cover. The threaded hole that receives the cover lock-down bolt shall be open at the bottom to allow cleanout of sand, dirt and other debris. Frames and covers shall meet the requirements of AASHTO M305. Covers shall be approximately 14” x14”. Frames shall have a clear opening of 12” x 12”.

All electrical work shall be performed by an experienced licensed electrician and such work shall meet all state and local electrical codes.

ITEM 853.22 TEMPORARY CONCRETE BARRIER – RESTRAINED

Work under this item shall conform to the relevant provisions of Section 850 of the Standard Specifications and the following:

Restrained barrier shall be installed in locations shown on the drawings. Barrier furnished and installation procedures shall be in accordance with New York State Department of Transportation Engineering Bulletin EB 10-034 dated August 31, 2010. This bulletin has been included in the package and is located in Appendix A.

Contractor's attention is directed to the plans for additional notes related to the restrained concrete barriers.

ITEM 853.3 MOVEABLE PRECAST CONCRETE BARRIER

ITEM 853.31 MOVEABLE PRECAST CONCRETE BARRIER REMOVE AND RESET

The work under this item shall conform to the relevant provisions of Section 850 of the Standard Specifications and the following:

General

Moveable Precast Concrete Barrier (MCTB) work shall consist of furnishing, transporting, installing along I-93 southbound median, removal and resetting along the I-93 northbound median, maintenance throughout construction period and final removal and transport of MCTB system upon completion of the superstructure replacement as shown the plans, or as directed by the Engineer .

Moveable Precast Concrete Barrier Remove and Reset shall consist of the relocating and adjusting the MCTB system laterally and longitudinally utilizing the self propelled barrier transfer machine as described herein and as directed by the Engineer.

Materials

MCTB System - The MCTB system shall meet the testing requirements of "National Cooperative Highway Research Program, Report 350" (NCHRP 350), Test Level 3, and be approved by the Federal Highway Administration (FHWA).

Prior to using a new MCTB system, the Contractor shall submit to the Engineer a materials certificate for each system supplied and a copy of the FHWA Letter of Acceptance issued to the manufacturer that the device conforms to NCHRP Report 350 (TL-3).

The MCTB system shall be comprised of an array of units. Each unit of these units shall meet the following minimum requirements:

- Weight: 425 lbs./ft.
- Approx. Dimensions: 32" H x 24" W x 37" L
- Shape: "New Jersey" shape w/ modified T-shape head
- Concrete: 4,000 psi, 28-day

Barrier Reflector Markers and Paint – The MCTB system shall be furnished with yellow barrier reflector markers and paint in accordance with the barrier manufacturers recommendations. Place barrier reflectors every 20 feet along the MCTB system. The barrier reflectors shall be attached per the (barrier reflector) manufacturer's recommendation. Barrier reflector markers shall be placed in the following configurations:

- On each side of the barrier in accordance with the barrier manufacturer's recommendations.

Bi-directional barrier reflectors on top of the barrier in accordance with the barrier manufacturer's recommendations. These barrier reflectors must stay in place to accommodate to 2-inch height clearance for operation of the barrier transfer machine.

The bottom portion of each side of the MCTBs shall be painted yellow in accordance with the barrier manufacturer's recommendations.

Barrier Transfer Machine – The Contractor shall furnish and operate two (2) self propelled barrier transfer machines to move the MCTB system. The barrier transfer machines must be in good working condition and equipped and operable as follows:

- Capable of lateral transfer of continuous lengths of the MCTB system at a maximum working speed of up to 5 mph, while lifting the barrier to accommodate differences in roadway elevation up to 12 inches. When transferring lateral distances of more than 16 feet the maximum working speed shall be 3 mph.

- Able to move the MCTB system 12 feet in either direction from a neutral 1800 foot radius curve without disassembly.

- Attain a maximum speed of 5 mph when transporting sections of the MCTB system down the roadway.

- Operate under all of the restrictions of the contract and site conditions (i.e. rough pavement).

- Employ a capstan system to maintain the MCTB system in a neutral longitudinal position when transferred on certain grades and curves.

- Able to transfer the MCTB system laterally up to 9 feet or more without causing any part of the

equipment or barrier to extend into traffic.

- Equipped with a tow fitting at each end to allow the barrier transfer machine to be towed while continuing to make the necessary lateral transfer of the MCTB system, in the event of power plant malfunction or failure.

- Equipped with an engine block heater.

MCTB End Protection – The Contractor shall furnish and install two (2), non-redirective crash cushion systems and place one at each end of the MCTB system. The crash cushion systems shall be of the same size and shape as the MCTB system and shall be attached to the MCTB system per the manufacturer's recommendations. Contractor shall furnish and install non-directive cushions system on the approved drawings.

Construction

The entire MCTB system must be available for installation at the time of project need (per the progress schedule). No extension of time will be granted for the lack of availability of the MCTB system. Deletion of the MCTB is not an option that will be considered.

The Engineer shall inspect the MCTB system upon delivery to the project site and periodically throughout the life of the project. Any barrier components delivered to the project site having damage or defects that will affect the performance of the system, as determined by the Engineer, must be replaced with a suitable unit. Any MCTB system that is damaged or rendered unsuitable by the Contractor's operations or adjacent traffic during the life of the project, as determined by the Engineer, must be replaced with a suitable unit. All costs associated with removing damaged or defective barrier sections (caused by the Contractor) and replacing them as specified in this paragraph will be borne by the Contractor.

Place the MCTB system at the location(s) as shown on the plans, or as directed by the Engineer. Connect the individual units of the MCTB system, as specified by the manufacturer, to form a continuous chain to facilitate the required lateral and longitudinal movement by the barrier transfer machine.

Place the MCTB system before diverting traffic or beginning the associated construction work.

During installation of the MCTB system, protect traffic by the use or installation of standard warning and channelizing devices.

Place the MCTB system in the direction of traffic flow as possible or as approved by the Engineer.

When the MCTB is placed on pavement, clean the pavement of all material (sand, gravel, dirt, ice, snow, etc.) that would reduce the friction between the MCTB system and the underlying pavement. During each movement of the MCTB system, remove debris accumulated next to the wall, which

may hinder traffic, once the MCTB system is moved. Dispose of all debris as required by the standard specifications.

All incomplete MCTB system installations or removals which result in barrier blunt ends exposed to traffic inside the clear zone are to be made crash-safe by the Contractor.

When the MCTB system is relocated, adjusted, or placed back in operation, or as directed by the Engineer, clean and replace all damaged reflector markers and paint. Completely remove barrier markers damaged after the MCTB system has been placed in initial operation and replace with new markers. Position the replacement markers directly in front of the damaged marker. All costs associated with replacing markers damaged by the Contractor's equipment (including the barrier transfer machine) will be borne by the Contractor.

Identify a storage area for the barrier transfer machine and that is acceptable to the Engineer. Perform all maintenance operations recommended by the manufacture of the barrier transfer machine. Complete repairs expeditiously to ensure the barrier transfer machine is available for use on the project as required. Furnish and maintain a sufficient supply of spare parts and trained personnel to ensure that the specified lane configurations are available at the required times.
Before the MCTB system is put into use on the project, the Engineer will determine the schedule that the MCTB system is to be moved each week.

Store the barrier transfer machine in a location approved by the Engineer.

ITEM 853.403 MOVEABLE IMPACT ATTENUATOR

The work under this item shall conform to the relevant provisions of Section 850 of the Standard Specification and shall consist of furnishing a moveable impact attenuator (MIA) equipped with a flashing arrow panel. The impact attenuator can be either a truck mounted or a tow-behind unit. In either case, the unit and the accompanying truck are considered one unit when considering compensation.

The moveable impact attenuator shall be equipped with all required brake lights, tail lights, and turn signals and have Federal Highway Administration (FHWA) and Department approval.

The impact attenuator shall meet the testing requirements of "National Cooperative Highway Research Program, Report 350" (NCHRP 350), and be approved by the Federal Highway Administration.

Documentation of FHWA approval shall be supplied to the Engineer. Most approvals are conditional; therefore, any associated issues (including model variations, modifications, proper installation (truck mounting) and/or tow-vehicle specifications) shall be resolved before use in the field.

In addition to the FHWA approval, the Contractor shall provide documentation, as necessary, to enable the Engineer to determine the appropriate effectiveness of the system for the conditions anticipated. The submitted information shall include estimated displacement characteristics for a variety of impacts (assumptions regarding both impacting vehicle weight and speed) so that proper traffic management set-ups can be undertaken in the field.

INSTALLATION - The impact attenuator unit shall be utilized as shown on the plans or as directed by the Engineer. The impact attenuator unit shall be utilized at the proper orientation and height above the paved surface for all applications.

MAINTENANCE - A damaged impact attenuator unit shall not be used on this project at any time until it is repaired to the satisfaction of the Engineer (a statement from the product manufacturer may be required). Any work that becomes delayed due to the lack of a properly functioning impact attenuator unit will not constitute justification for an extension of time.

FLASHING ARROW PANEL - The truck and/or tow-behind unit shall be equipped with a flashing arrow panel conforming to the requirements of Section 850.46 of the Standard Specifications.

ITEM 853.41 TEMP. IMP. ATTENUATOR FOR SHOULDER INCAPABLE OF REDIRECTION

ITEM 853.411 TEMP. IMP. ATTENUATOR FOR SHOULDER INCAPABLE OF REDIRECTION R&R

Work under these items shall conform to the relevant provisions of Section 850 of the Standard Specifications and the following:

These items shall consist of furnishing, installing, and removing temporary impact attenuators in conformance with the manufacturer's specifications and in conformance with the location, lines and grades shown on the Plans and/or designated in the Special Provisions. This work also includes maintaining, removing and reinstalling temporary impact attenuators where indicated on the Plans, or as directed by the Resident Engineer.

All materials used in the foundation and anchorage of temporary impact attenuators shall meet the requirements of Division III, materials and manufacturer's recommendations. The temporary impact attenuator may be any impact attenuator which meets the requirements of the National Cooperative Highway Research Program, Report 350, Test Level 3 and its subsequent revisions, and has been accepted by the Federal Highway Administration for general use in the location intended. The temporary impact attenuator shall be designed for 65 miles per hour. The temporary impact attenuator shall be compatible with the barrier or other device it is attached to.

The Contractor shall submit shop drawings of the temporary impact attenuator for approval prior to installation.

ITEM 853.8 TEMPORARY ILLUMINATION FOR NIGHTTIME WORK

All work shall conform to the relevant provisions of Section 850 and the following: the work under this Item shall consist of illuminating the work areas at the specified locations for the purpose of conducting nighttime work and other areas as designated by the Resident Engineer. Nighttime work will occur at all locations where operations during daytime hours will unduly hamper and delay the motoring public, as listed elsewhere in this Contract.

Illumination Standards for Work Area.

The work area shall be illuminated to conform to pertinent OSHA Safety Standards. Any area where all phases of the work are completed need not be illuminated except for safety. All lighting units shall be placed in such a manner as to avoid shadows on the work area or the travel area and to prevent excessive glare to the motorist.

The entire work area shall be illuminated to a minimum average of one-hundred (105) lux measured on a horizontal plane 6 inches above the work surface. A uniformity ratio (average to minimum) of 4 to 1 or better shall be maintained at all times in the work area. This shall apply to the work areas only. Any area where all phases of the work are completed need not be illuminated.

All portable lighting shall be located off the traveled way opposite the channelizing devices (i.e., when closing the left or high speed lanes all lighting should be placed on the right side of the roadway). All lighting shall be aimed in such a manner as to avoid shadows on the traveled way and to prevent excessive glare to the motorist. All floodlights shall have a flat tempered glass or polycarbonate lenses securely fastened to the housing to prevent personal injury in the event of lamp breakage. Floodlights shall be mounted on portable or fixed poles, trailer units, tripods or staging of the contractor's choice in a location off the traveled way.

The lighting staging area shall be roped off to all personnel except the lighting technicians. All generators and wiring shall be within the restricted area and shall conform to the Massachusetts Electrical Code and pertinent OSHA Safety Standards.

Power Sources

The contractor shall provide generators of type, size, and wattage output required to adequately energize the lighting equipment specified. Generator placement and wiring shall be in compliance with the Massachusetts Electrical Code and pertinent OSHA safety standards. It shall be the contractor's responsibility to ensure that lighting fixture and generator electrical rating are compatible.

ITEM 853.9 TEMPORARY ILLUMINATION FOR NIGHT PAVING & PLANING OPERATIONS

The following illumination standards shall be maintained at all times during night paving operations.

Lane Drops

The traveled way within the lane drop areas and all cones, barrels, or other physical barriers placed on the roadway for the purpose of channelizing or restricting vehicular traffic shall be illuminated to a minimum average of 21.5 lux measured on both the horizontal and vertical planes 6" (150 mm) above the surface in question.

The lane drop area to be illuminated shall be defined as beginning at the first cone, barrel or other channelizing device, continuing through the full roadway width transition area, and ending where the traveled way attains the constant width which will be maintained through the construction area. A uniformity ratio (average to minimum) of 4 to 1 or better shall be maintained at all times within the illuminated transition area.

All portable lighting shall be located off the traveled way opposite the channelizing devices (i.e., when closing the left or high speed lanes all lighting should be placed on the right side of the roadway). All lighting shall be aimed in such a manner as to avoid shadows on the traveled way and to prevent excessive glare to the motorist. Illumination of the lane drop areas shall be accomplished using 250 watt, 400 watt, 1000 watt and 1500 watt metal halide floodlights in any combination and any number necessary to achieve the lux levels and uniformity ratios specified above.

All floodlights shall have a flat tempered glass or polycarbonate lenses securely fastened to the housing to prevent personal injury in the event of lamp breakage. Floodlights shall be mounted on portable or fixed poles, tripods or staging of the contractor's choice in a location off the traveled way. The lighting staging area shall be roped off to all personnel except the lighting technicians. All generators and wiring shall be within the restricted area and shall conform to the Massachusetts Electrical Code and pertinent OSHA Safety Standards.

Equipment Lighting

Rollers

Each roller shall be equipped with a two (2) unit light cluster on both the front and back. A single cluster with two units (one wide beam and one narrow beam) aimed towards the front and two (one wide beam and one narrow beam) towards the back may be used.

All floodlights shall be securely mounted to minimize vibrations during roller operations. Floodlights should be mounted on steel bullhorn style brackets with 2" (50 mm) tenons and a 3-foot (900 mm) spread. Mounting height shall be a minimum of 8.2 feet (2.5 meters) above the top platform surface of the roller (provided the overall height from ground level does not exceed 15 feet (4.5 meters)). Mounting height and placement shall be designed to allow the operator to run the roller from a standing position without blocking the lighting beams onto the roadway. Floodlights for the roller shall be 250 watt metal halide fixtures as described below.

Trucks

The Contractor shall provide two pickup trucks equipped with floodlights. One truck shall provide illumination at the end of the actual work area behind the last roller and shall move forward as the paving operation progresses along the roadway. The second truck shall be used for traffic control operations and for fill-in lighting wherever required.

Each truck shall have a minimum of three (one wide beam and 2 narrow beams) 250-watt metal halide floodlights mounted on supports on the pickup truck bed. The floodlights shall be aimed in a forward direction over the truck cab but shall also have the capability of being adjusted and aimed in any direction, if required. Floodlights for truck mounting shall be as described below.

Pavers

Single width 12 feet (3.6 meters nominal) and double width 24 feet (7.2 meters nominal) pavers shall be equipped with a continuous twin lamp fluorescent bar consisting of enclosed 4 feet (1.2 meter) fluorescent fixtures mounted end to end across the full width of the screed area. Fixtures shall be adjustable so that they may be tilted toward the work area. A minimum of 110 lux must be provided at the screed area and in the area (min. 15 feet (4.5 meters)) immediately behind the screed where manual raking operations are taking place. Two auxiliary floodlights (narrow beam) shall be provided, one to illuminate the guide line and one to illuminate the auger area.

Care shall be taken in the placement of these floodlights to avoid aiming of the lights into the line of sight or into the mirrors of trucks backing into the auger/hopper area to unload bituminous concrete.

Floodlights for pavers shall be as described below.

Planing Machines

The work area for the planing operation shall be illuminated for a minimum of 20 feet (6 meters) to the front and to the rear of the planer. Illumination shall be a minimum of 55 lux in the required area. Floodlights providing the illumination may be remote mounted rather than being on the planer to avoid excessive vibrations. Floodlights shall conform to the specifications for 250-watt metal halide floodlights described hereinafter.

Floodlighting Equipment

All floodlights for both the lane drop areas and the equipment-mounted lighting shall have cut-off type light distribution and shall have a die-cast aluminum housing with integrally cast heavy-duty hinges. Fixture housing door shall be closed with two or more captive screws and shall have positive gasketing to ensure water tightness and dust tightness. The housing shall have no weep holes. The reflector shall be high purity anodized aluminum with a secondary internal reflector element to reflect high angle rays back into the beam to achieve high beam utilization and meet IES definition of cut-off distribution.

Lamp socket shall be pre-wired grip type mogul base with additional support on the glass end of the lamp to minimize vibration. Lens shall be tempered clear glass gasketed to the fixture housing. Ballast shall be pre-wired regulating type designed for –20.2 degree F (-29 degrees C). Starting with an operating lamp current crest factor not exceeding 1.65. Mounting shall be accomplished with a die-cast aluminum slip fitter designed for a 2-inch (50 mm) tenon. Surface mounting brackets shall be provided for alternate mounting at the contractor's option. Fixture shall be U.L. listed. Lamps shall be metal halide of the wattage specified.

Fluorescent fixtures shall be twin lamp 4-foot long (1.22 meters) fixtures utilizing two (2) high output cool white fluorescent lamps (F48T12/CW/HO). Housing shall be extruded aluminum or stainless steel.

Reflector shall be die formed aluminum with high gloss baked white enamel finish. Lens shall be either

tempered glass, polycarbonate or virgin acrylic and shall be fully framed and gasketed. Lens frame shall be hinged or captive latched on one side and shall be toggle-latched on the other side with a stainless steel spring-loaded bail to apply constant pressure between the lens and the fixture housing. All fasteners shall be stainless steel. The lamp holder shall be self-sealing, self-aligning and spring loaded. Lens unlatching and lamp removal shall be accomplished without the use of special tools. The fixtures shall have integral, high power factor ballasts capable of starting to –20.2 °F (-29 °C).

Fixtures shall have fittings for standard continuous row mounting and shall have top mounting brackets for additional support.

Lighting Equipment Mounting

Mounting shall be designed and constructed by the Contractor, at his option, to suit the configuration of the equipment to which the lighting is attached.

Mounting heights, placement and aiming shall be as hereinbefore described. Mounting shall be secure to prevent excessive vibration and to ensure there is no hazard to equipment operators or

other personnel. Care shall be exercised to ensure that fixture mounting will clear all overhead structures.

Lighting configurations for the equipment lighting may, with the concurrence of the Engineer, vary from those specified herein provided that the specified light output is adhered to. All equipment lighting shall be aimed in such a manner as to maximize the illumination on each individual task.

The Contractor shall maintain an inventory of spare lamps and spare fixtures on the job site, and all lamp or fixture failures shall be repaired or replaced immediately.

Power Sources

The Contractor shall provide generators of type, size, and wattage output required to adequately energize the lighting equipment specified. Generator placement and wiring shall be in compliance with the Massachusetts Electrical Code and pertinent OSHA safety standards. It shall be the Contractor's responsibility to ensure that lighting fixture and generator electrical rating are compatible.

Lighting Equipment Schedule

Location	# of Fixtures	Size	Type	Remarks
Lane Drop Area Varies	Varies	Varies	Metal Halide	Min. 10 fc
Rollers	4	250 watt	Metal Halide	Aim 2 forward & 2 back
Pick-up Trucks	3	250 watt	Metal Halide	Variable aiming
Pavers	3	1.2 m	Twin Lamp Fluorescent	Screed Area
(Single Width)	2	250 watt	Metal Halide	Auger & Guide Line
Pavers	6	1.2 m	Twin Lamp Fluorescent	Screed Area
(Double Width) 2		250 watt	Metal Halide	Auger & Guide Line

The illumination on the project shall be monitored at random intervals for conformance to the specifications set forth herein. Substandard illumination in any area (traveled way, work area or equipment lighting) may be sufficient reason for the Engineer to direct stoppage of all work until the substandard situation is corrected.

If there are sufficient non-compliance incidents relating to the illumination of the work area and the lane drops (e.g. failure to maintain the minimum light levels and the uniformity ratios specified, as determined by field tests) or if the finished roadway surface is unsatisfactory in any way, or if safety considerations dictate, the Engineer, at his discretion, may revoke the nighttime paving operation from the contract.

ITEM 901.2 SUBSTRUCTURE REPAIR CONCRETE

In cases where schedule dictates, the contractor may, at his expense and option perform additional production testing to determine concrete strength prior to 28 days and shorten the time elapsed between placement and the introduction of load to the structure.

Production testing of the mix shall commence per the following:

1. **Field Cure Cylinders:**

   The contractor will simulate actual field conditions by placing the samples as close to the structure they represent as possible, protected from direct sun and other damage, and shall be cured similarly including the use of blankets and other curing methods used for the in - place concrete. Cylinder breaks shall be performed on (3) 7 day, (3) 10 day, and (3) 28 day. Field cured cylinders shall be left with the structure and in the curing molds until the date they are broken. Samples shall be cast in molds according to the size determined by the trial batch results for the two different molds, the size shall be determined by agreement between the resident and contractor shall be made prior to the casting of the molds. Additional field cure cylinders may be taken at the contractor's option for additional testing to be used in determining the availability of loading the structure. All acceptance test and cylinders shall be performed by MassDOT personnel. Field cured cylinders shall be tested at the contractor's independent testing laboratory.

2. **Standard Cure Cylinders:**

   MassDOT will cure cylinders in standard curing conditions in accordance with ACI. Cylinder breaks shall be performed on (3) 7 day and (3) 28 day samples. Samples shall be cast in molds according to the size determined by the trial batch results for the two different molds. Agreement between the resident and contractor shall be made prior to the casting of the molds.

Where this concrete is used in an area critical to the structure, loading of the structure may not take place until one of the following has happened:

1. A representative field cured cylinder has achieved the required 28 day strength as determined by breaks by the contractor's independent laboratory. This may be a scheduled break, or if the contractor has cast additional cylinders, they may be broken at a non-standard time in order to achieve the required break results.

2. The design engineer has been contacted and an analysis of the loading conditions has taken place, and the designer has determined the strength of the field cured cylinders as determined by breaks at the contractor's independent laboratory to be of sufficient strength to accommodate the proposed loads. Documentation of such analysis will be provided to the Resident Engineer for his use and disposition.

Production Curing Methods

Curing is typically required for the initial ¼ of the specified design strength time. Due to the accelerated rate of Hydration and cure for the mix, wet curing for this 4000 3/8" is a minimum of 3days. Alternate curing methods shall be submitted and approved prior to their use.

ITEM 904.11 RAPID-SETTING GYPSUM CONCRETE

The work to be done under this Item shall consist of partial depth and/or full depth, concrete deck repairs. Full depth repairs must always be done between the centerlines of two adjacent stringers so that the deck acts as a structural slab between the stringers.

The material shall be a rapid-setting gypsum concrete patching compound, which will develop a minimum compressive strength of 2000 psi within two (2) hours.

Prior approval by the Department will be required of the material before it can be incorporated into the work.

The compound shall have the following properties:

Description	**Job Aggregated-100%**	**Job Aggregated-200%**
Recommended Mix Design	**100 lb compound:**	**100 lb compound:**
	100 lb of sand:	**100 lb sand:**
		100 lb stone 3/8-inch size
Setting time, mins.	20-35	20-35
Yield, cubic yard/ 100 lbs bag	0.04	0.06
Setting Expansion, %	0.09	0.05
Net Exp. after drying, %	0.04	0.01
Wet Compressive strength in psi, (psi, 2 inch cube molds, moist cured)		
1 hour after set	3300	3190
3 hours after set	3300	3180
6 hours after set	3700	3600
1 day	6200	6100
3 days	6900	6900
28 days	8800	8500

Flexural Strength, per ASTM C-78-84

1 Part compound; 1 Part sand (100% Extension)

Time	Flexural Strength, psi
1 day	730
3 days	850
28 days	1060

1 Part compound; 1 Part Sand; 1 Part Stone 3/8-inch Size (200% Expansion)

Time	Flexural Strength, psi
1 day	610
3 days	740
28 days	850

The compound shall be expanded by adding aggregates of the size and quality recommended by the manufacturer of the material to the following proportions:

1. Two (2) parts gypsum cement.
2. Two (2) parts fine aggregate conforming to the requirements of Subsection M4.02.02.
3. One (1) part course aggregate not to exceed ½ inch in diameter.

Prior to placing the compound, the patch area shall be flushed with clean water to remove all dust and then blasted with compressed air to remove all standing water.

When temperatures are at or below the freezing point, the following steps shall be taken to ensure proper setting action:

1. Use warm mixing water, warm aggregate and warm gypsum cement.
2. Pre-heat the excavated area to be patched.
3. Protect the mixture from freezing after placement until after hydration takes place.

The Contractor shall be required to mix and place the cement by using three (3) eight (8) cubic foot (minimum) rubber-blade mobile mixers, two (2) of which shall be used and one (1) of which must be a standby. Sufficient mixing and placing equipment shall be provided on the construction site by the Contractor to insure that a breakdown of equipment will not cause significant delays in completing the scheduled work shift.

Placement of the compound into the bridge deck area to be patched shall be completed by 2:30 AM at the latest so that the required minimum compressive strength of 2000 psi is attained before the area is opened up to traffic at 5:00 A.M.

Method of Measurement and Basis of Payment

Work will be measured and paid for at the contract CY price of $1,000.00 for each CY of Rapid Setting Gypsum Concrete installed and accepted by the Resident Engineer.

ITEM 905. 4000 PSI, 3/8", 660 CEMENT CONCRETE

The work shall conform to the applicable requirements of Section 901, supplemented by the following:

Description
The work includes preparing surfaces and placing cement concrete in repairs to the abutments, wingwalls, pier columns and pier caps of the bridges covered under this contract. The 4000 psi, 3/8", 660 Cement Concrete shall be used to repair or patch deteriorated concrete areas that are greater than 2" deep as directed by the Engineer.

Construction Methods
Areas to be repaired must be clean, sound, and free of contaminants. All loose and deteriorated concrete shall be removed by mechanical means. Mechanically prepare the concrete substrate to obtain a surface profile ± 1/16" with a new exposed aggregate surface.

If reinforcing steel is exposed, then clean by mechanical means and high pressure washing with water that does not contain detergents or any bond inhibiting chemicals. Where active corrosion has occurred that would inhibit bonding, sandblast steel to white metal finish.

After removal and edge conditioning are complete, remove bond inhibiting materials (dirt, grease, loosely bonded aggregate) by abrasion blasting or high pressure washing with water that does not contain detergents or any bond inhibiting chemicals. Check the concrete surfaces after cleaning to insure that the surface is free from additional loose aggregate or that additional delaminations are not present.

Epoxy Bonding Compound
Use Sika Armitec 110 Epocem or approved equal. Field installation and application shall be in accordance with the Manufacturer's recommendations.

Curing shall conform to Subsection 901.65 Curing and Finishing of the Supplemental Specifications. All cement used under Item 905. shall be Type II Portland Cement. No change from Type II shall be permitted unless approved by the Engineer.

Reinforcing steel required to replace existing deteriorated reinforcing steel in areas of repairs shall be provided under Item 910.1. Reinforcing steel to be used shall be epoxy coated.

Method of Measurement and Basis of Payment

Work will be measured and paid for at the Contract SF price of $ 75.00 for each SF repaired and accepted by the Resident Engineer.

ITEM 909.2 CEMENTITIOUS MORTAR FOR PATCHING

The Work to be done under this Item shall consist of chipping away deteriorated concrete and placing a two-compound polymer modified cementitious patching compound to areas of existing concrete in abutments, wingwalls, pier columns and pier caps for the bridges covered under this contract . This item is for the repair of deteriorated or spalled areas that are no more than 2 inches in depth for horizontal and vertical applications and 3" for overhead applications.

The procedure to be used to repair deteriorated or spalled concrete shall be as follows:

The Contractor shall remove all deteriorated or spalled concrete in the areas as shown on the Plans or as designated by the Engineer.

The Contractor shall have the approval of the Engineer certifying that all spalled and deteriorated concrete has been removed prior to repairing the deteriorated areas.

Concrete at the edges of all areas to be patched using Cementitious Mortar for Patching shall be removed to a minimum depth of 1/2" prior to the application of the mortar.

The mortar shall be applied by workmen who, in the judgment of the Engineer, are sufficiently experienced and skilled in this class of work.

Products to be used for this item shall be on the MassDOT Qualified Products List and approved by the Engineer before the Contractor begins his/her operations.

Materials

1. The polymer modified cementitious system shall consist of a 2-component system whose components conform to the following requirements:

2. Component A shall be a liquid polymer emulsion of an acrylic copolymer base and additives. This acrylic copolymer shall have the following properties:

ph	4.5 - 6.5
Minimum film forming temp.	Approx. 20 deg. C (68 deg. F)
Tear Strength	Approx. 6.8 – 990-1420 psi
Elongation at break	500-900%
Particle Size Range	Less than 0.1 micron

3. Component B shall be a blend of selected Portland Cements, specially graded aggregates, organic accelerator, and admixtures for controlling setting time, water reducers for workability and a corrosion inhibitor.

4. The component ratio A:B shall be 1:5.2 by weight. The system shall not contain chlorides, nitrates, added gypsum, added lime, or high alumina cements. The system shall be non-combustible, either before or after cure.

5. For applications greater than 1 in. in depth, the mortar may have to be extended with an aggregate in accordance with Manufacturer's recommendations. The aggregate shall be 1/2" to 3/8" clean, well-graded, saturated surface dry aggregate having low absorption and high density. Aggregate shall conform to ASTM C-33 and must be approved for use by the Engineer.

Typical Properties of Mixed Components

1.	Application Time (Working Time)	15 mins. after combining comps.
2.	Finishing Time	20-60 mins. after combining components
3.	Color	Concrete Gray

Typical Properties of Cured Materials

1.	Abrasion Resistance	6 times than of controlled concrete
2.	Bond Strength (Pull Off Method)	100% concrete substrate failure
3.	Modulus of Elasticity	4,500,000 psi
4.	Surface Scaling (Deicing salt solution freeze/thaw)	No deterioration after 120 cycles
5.	Compressive Strength (2 hours 50% RH)	150 psi minimum
6.	Compressive Strength (28 day 50% RH)	5,500 psi minimum
7.	Flexural Strength (28 day 50% RH)	2,000 psi minimum

8. This system shall conform with EPA/USPHS Standards for surface contact with Potable water.

9. This system shall not produce a vapor barrier.

10. This system shall be thermally compatible with concrete.

Certification
The Contractor shall furnish notarized certification that all materials conform to the above requirements. In addition, samples of all materials proposed for use shall be submitted to the Department's Research and Materials Section. To allow sufficient time for testing, these samples must be submitted at least six weeks prior to scheduled use.

Construction Methods

Surface Preparation
Surface to be prepared in accordance with the mortar manufacturer's written recommendations.

Areas to be patched must be clean and sound. All loose and disintegrated concrete shall be removed by means of chipping or an equivalent method to a depth where sound concrete is exposed. Minimum patch depth at edges of patch = 1/2". Sandblast or high pressure water blast existing concrete to remove all contaminants prior to applying mortar. Chipping methods to be approved in advance by the Resident Engineer.

Mixing
Mix manually or mechanically in accordance with the mortar manufacturer's written recommendations. Manual mix in a wheel barrow or mortar box. Mechanically mix in appropriate sized mortar mixer or with electric drill and paddle.

1. Mixing Procedure: MORTAR

   Shake Component A before using. Then pour approximately 4/5 Component A into mixing container. Add Component B slowly while continuing to mix. Mix to a uniform consistency maximum 3 min. Add remaining A Component to mix if a more loose consistency is desired.

2. If manual mixing takes more than 3 min., mix smaller quantities. Should smaller quantities be necessary, be sure components are dosed in correct ratio and Component B is mixed before dosing. The mortar shall be prepared in accordance with the manufacturer's instructions.

Application and Finish
1. At time of application, surfaces should be damp (saturated surface dry) with no glistening water. Mortar must be worked into substrate filling all pores and voids. Force material against edge of repair, working toward center. After filling, consolidate, then screed.

2. Maximum thickness of application in one pass shall be 1". If the depth of patch exceeds 1", mortar shall be placed in multiple passes of approximately equal thickness to reach the maximum thickness of 2" for horizontal and vertical applications and the maximum thickness

of 3" for overhead applications. Before the first pass has achieved an initial set, the surface shall be prepared for the second pass by scratching with a trowel to form a grid of deformation on the surface.

3. Then prime and work mix into substrate, filling all pores and voids. Avoid puddling of primer on horizontal substrates.

   Priming is not always required but when the surface is porous or the mix stiff, use remaining A Component as a prime coat. A stiff mix is required for vertical or overhead surfaces.

   Brush mix over the substrate just before placing the repair. Do not prime until ready to patch. Mortar must be placed while prime coat is wet. Dried prime coat must be removed by mechanical means.

Curing

1. Use fine mist spray of water, wet burlap, or non solvent approved curing compound if ambient conditions might cause premature surface drying by high temperatures, low humidity and strong winds.

   If necessary, protect newly applied mortar from rain. To prevent freezing, cover with insulating material.

Limitation

1. Mortar minimum application thickness 1/8".
2. Minimum ambient and surface temperatures 45 deg. F and rising at time of application.
3. Store A and B Components at 65 to 80 deg. F.
4. Apply only on clean, sound substrate. Surface should be damp but free from standing water (saturated surface dry).
5. Mortar must be mixed to a uniform consistency - no lumps; do not overmix (3 min. maximum).
6. Do not use solvent-type curing compound.
7. Caution: Contains cement and a polymer which may, in certain cases, cause skin irritation. Cleanliness is required. In case of skin contact or contact with eyes, wash thoroughly with water. If eye contact, consult nearest doctor.

ITEM 910.1 STEEL REINFORCEMENT FOR STRUCTURES EPOXY COATED ITEM 912. DRILLING AND GROUTING DOWELS

The work to be done under these items shall conform to the relevant provisions of Section 901 and the following:

Description
The limits of work shall be as identified on the plans for the bridges covered under this contract. This item shall also include replacement of deteriorated reinforcing steel discovered during the concrete excavation for abutments, wingwalls, pier columns and pier cap.

General
The work to be done under these items shall also consist of drilling and grouting holes in the existing structure for steel reinforcing dowels necessary for the replacement of deteriorated existing reinforcing steel, which is intended to be retained, or for the addition of new steel to provide long term bonding for large repairs. The limits of work shall be determined by the Engineer in the field.

Steel reinforcing for structures, coated, shall be used to replace existing deteriorated reinforcing steel, which is intended to be retained, or provide new steel in areas of new concrete.

Materials
The grout to be used for these dowels shall be HILTI HIT-RE 500SD Epoxy or approved equal. Field installation and application shall be in accordance with the Manufacturer's recommendations.

All materials shall be delivered in original, unopened containers with the manufacturer's name, labels, product identification and batch numbers. Damaged material must be removed from the site immediately. All materials shall be stored off the ground and protected from rain, freezing or excessive heat until ready for use.

The grout, drilled hole diameter and embedment depth shall be field tested, as specified below, prior to approval for use on this project.

One test dowel bar, at each substructure unit, of each dowel size shall be installed in the existing concrete and tested by the Contractor for pull-out. The pull-out force shall correspond to 90% of the yield strength of the bar. If any of the tested bars pull out or if the surrounding concrete shows signs of cracking, the Contractor must adjust the hole diameter, embedment, length and/or grouting material to meet this test requirement. All testing of the drilled and grouted dowels shall be performed by the Contractor and is incidental to the work under this heading. The method of applying the tension test load to the dowels shall conform to ASTM E488.

Details of the testing equipment used and the locations and details of the test dowels shall be submitted to the Engineer for approval. The Contractor shall perform this test as soon as possible in order to eliminate delays in construction due to the approval process. Dowels shall not be ordered until the embedment lengths have been approved by the Engineer.

Reinforcing steel dowels shall meet requirements of AASHTO M31, Grade 60 (ASTM A615 Grade 60) and shall be epoxy-coated.

Construction Methods
All dowel holes shall be percussion drilled. Should percussion drilling adversely damage the existing concrete the holes shall be diamond drilled. The inner surfaces of the core holes shall be

scored to develop sufficient keying action. The method of scoring the hole's inner surface shall be subject to the approval of the engineer.

The diameter and embedment of the drilled dowel holes shall be in accordance with the recommendations of the grout manufacturer and the following minimum dimensions:

Diameter: minimum 1/8" larger than the diameter of the rebar, providing a minimum 1/16" annular spacing.

Embedment: as indicated on Plans.

Drilled dowel hole diameter and embedment is based on the requirements specified under this item, the strength of the existing concrete, and the layout of dowels on the existing structure.

The holes shall be blown clear of any debris and shall have the approval of the Engineer prior to the placement of any grout material.

The drilling operation shall be performed without damage to any existing reinforcing or portion of the structure that is to remain in place. Any damage to the existing concrete that is to remain in place shall be repaired to a condition equal to or better than that existing prior to the beginning of the Contractor's operations and shall be repaired at his/her expense.

The Contractor shall strictly follow the recommendations of the manufacturer for mixing and placing the grout material prior to the placement of the dowels.

ITEM 992.1 ALTERATIONS TO BRIDGE NO. M12025; M12027; M12028; M12029; M12030; M12036; M12039

The work to be done under this Item shall conform to the relevant provisions of Section 995 and the specific requirements stipulated for component parts of this Item. For those component parts where no specific requirement is stipulated, the Standard Specifications shall apply except for payment.

Description

The work includes the removal and replacement of the existing superstructures for the bridges covered under this contract, according to the plans for each bridge and these specifications.

Structural Steel

The work under these headings shall conform to the applicable provisions of Section 960 of the Standard Specifications and the following.

All welding and the preparation and assembly of material for welding shall conform to the current editions of the Standard Specification for Highways and Bridges, the AASHTO Standard Specifications for Highway Bridges, and the AASHTO/AWS Bridge Welding Code (ANSI/AASHTO/AWS D1.5).

Charpy V-Notch Tests are not required for the following secondary members: stiffener plates and angles, filler plates and utility supports.

Incidental to this item is any work necessary to conduct a field investigation in order to determine all measurements and details necessary for the completion of the work prior to the preparation of shop drawings.

Demolition and work involving painted steel shall conform to the General Requirements for Demolition and Work Involving Painted Steel and the requirements of Section 961 of the Specifications.

4000 PSI – 1½" – 565 CEMENT CONCRETE
4000 PSI – 3/4" – 585 HIGH PERFORMANCE CEMENT CONCRETE
5000 PSI – 3/4" – 685 HIGH PERFORMANCE CEMENT CONCRETE

High Early Strength Concrete

The work under these headings shall conform to the applicable provisions of Section 901 of the Standard Specifications with the following additions:

The following concrete mixes are to be used:

4000 PSI – 1½" – 565 LB/CY: Highway Guardrail Transition Bases

4000 PSI – 3/4" – 585 LB/CY High Performance: Deck and End Diaphragm Encasement at Abutments

5000 PSI – ¾" – 685 LB/CY High Performance (HP): Highway Guard Transition and CF-PL3 Barriers

High Early Strength Concrete: Longitudinal and Transverse Closure Pours

High Early Strength Concrete

The work to be done under this item shall conform to the relevant provisions of Section 901 of the Standard Specifications and the following:

The Contractor shall develop a high early strength concrete mix design for use in the longitudinal and transverse closure pours. This high early strength concrete may also be used in the cast in place concrete work for the modifications to the approach slabs.

The high early strength concrete shall conform to the requirements of M4.00.00, M4.01. and M4.02. and the following criteria:

1. Use Portland cement conforming to AASHTO M 85 with compatible admixtures and air entraining agent.
2. Water-cementitious material ratio shall not exceed 0.4 by weight, including water in the admixture solution and based on saturated surface dry condition of aggregates.

3. Use a maximum size coarse aggregate of ¾".
4. The amount of entrained air shall be 6.0 +/- 1.5%.
5. A slump test shall be developed as part of the QC plan and shall address changing environmental conditions.
6. High early strength concrete shall achieve a minimum compressive strength of 2,000 psi at 4 hours after the final set. The minimum 28-day compressive strength shall be 4000 psi.
7. A shrinkage reducing admixture shall be added to the concrete mix according to the manufacturer's recommendation such that there will be no cracks at 14 days in the sample tested in AASHTO T334 (see below). A shrinkage reducing admixture shall be tested by an approved testing lab and meet the requirements of ASTM C494-10 Type S, except that in Table 1 length change shall be measured as: Length Change (percent of control) shall be a minimum of 35% less than that of the control. Table 1 Length Change (increase over control) shall not apply. Shrinkage reducing admixtures shall not contain expansive metallic materials.
8. The maximum allowable total chloride content in concrete shall not exceed 0.1% by weight of cement.

Mix Design Requirements

The concrete mix design shall be mitigated per Subsection M4.02.00. Proposed mix design (overdesign factor of 120% of the design strength) with data sheets and trial batches shall be submitted within 15 days from the date of Notice to Proceed to the Research and Materials Section for review and approval. The Engineer shall be notified at least 48 hours prior to the test batching and shall be present to witness the testing.

All tests necessary to demonstrate the adequacy of the concrete mix shall be performed by the Contractor, including, but not limited to: slump, air content, temperature, initial set and final set (AASHTO T197). Compressive strength tests shall be determined on field cured cylinders (6" X 12" cylinders) at 9 hours, 12 hours, 15 hours, 18 hours, 24 hours, 30 hours, 36 hours, 42 hours, 2 days and 3 days, and standard cured cylinders at 7 days and 28 days. Additionally, a confined shrinkage test as outlined in the AASHTO T334 - Practice for Estimating the Crack Tendency of Concrete shall be performed by an independent testing company.

In addition, a trial placement shall be done a minimum of (90) ninety days before the intended date of the initial closure pour placement. The Contractor will be required to demonstrate proper mix design, batching, placement, finishing and curing of the high early strength concrete. The trial placement shall simulate the actual job conditions in all respects including plant conditions, transit equipment, travel conditions, admixtures, forming, the use of bonding compounds, restraint of adjacent concrete, placement equipment, and personnel.
The details for the trial placement configuration are shown in Figure 1.

Acceptance criteria for the trial placement shall be as follows:

- The trial placement concrete shall not exhibit cracking or separation from the test panel in excess of 0.016 inches wide
- There shall be no more than one transverse crack in excess of 0.010 inches wide in the 10

foot long pour.

- The evaluation of the trial placement shall take place 14 days after placement.

If the trial placement fails these criteria, the Contractor will be required to submit a corrective action plan on how repairs of these crack sizes will be performed. The Engineer may require the Contractor to conduct more trial batches and trial placements. The requirement for multiple test placements shall not be cause for a time extension.

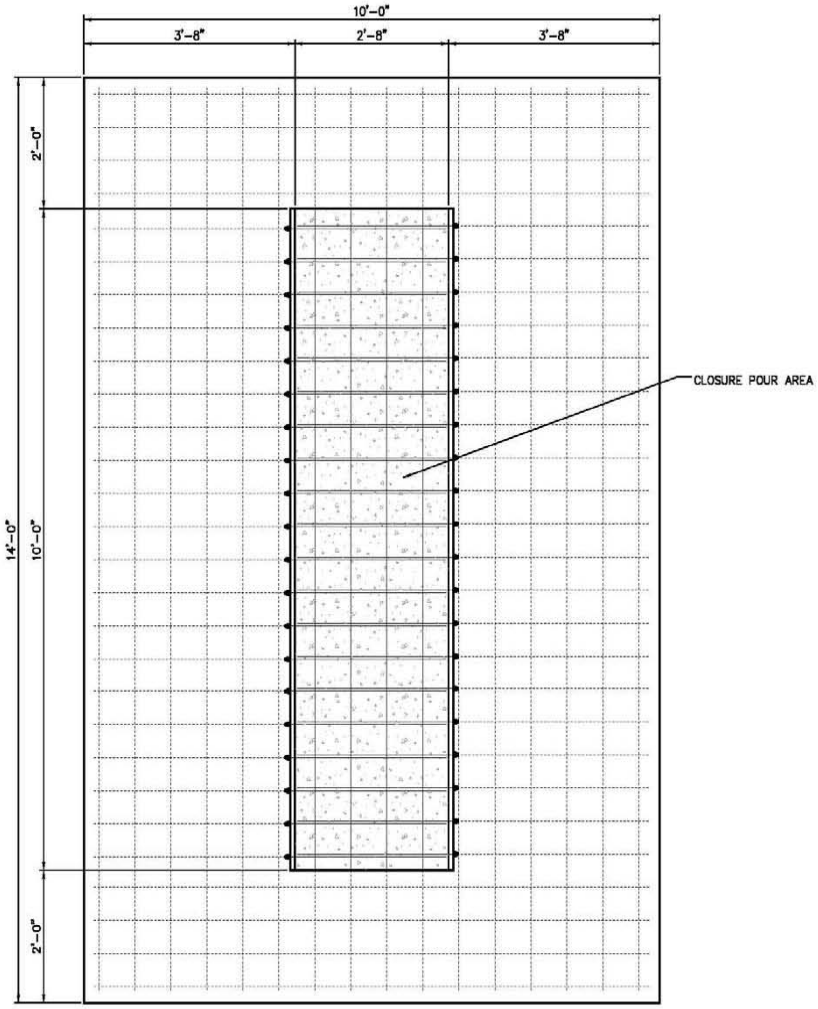


FIGURE 1 – TRIAL PLACEMENT TEST SET-UP

The Contractor shall engage an AASHTO accredited laboratory to provide on-site mobile testing facilities which are qualified laboratories under the NETTCP program to perform all Quality Control field testing. All personnel performing tests shall be qualified NETTCP Concrete Technicians and certified ACI Concrete Laboratory Technicians. Anytime the Contractor moves the laboratory, all associated equipment shall be recalibrated. The onsite laboratories should be located and calibrated at each bridge location. On weekends where more than one bridge is being constructed, additional on site laboratories shall be provided so that there is one for each bridge being constructed. This requirement is intended to minimize the movement of test cylinders.

The Contractor is required to perform initial set and final set tests (AASHTO T197) in addition to slump, air content and temperature on concrete from each concrete truck used in the placing of this High Early Strength Concrete. Field cured cylinders (6" X 12" cylinders) will be made from the first and last concrete trucks. A set of three (3) field-cured cylinders shall be made for each informational test associated with early structural loading. The Contractor is advised to fabricate adequate sets of cylinders to allow multiple tests to verify field concrete strength. The Engineer shall be allowed to witness the test and comment on all the tests performed by the Contractor. The Contractor must have a contingency plan established and approved in case compressive strength and other requirements are not met. The Contractor shall not open the roadway to traffic until all of the following conditions have been met:

- At least four hours has elapsed from the last final set time recorded for any concrete. Final set is achieved when the penetration resistance measures 4000 psi by AASHTO T197.
- Field cured cylinder breaks have achieved at least 2000 psi.
- The Engineer has directed that the roadway can be opened to traffic.

All testing and equipment shall conform to AASHTO T-22, and the making and curing of concrete cylinders shall conform to AASHTO T23. All costs associated with the on-site mobile testing facilities, personnel and field testing, equipment calibration and verification to demonstrate the field concrete strength shall be incidental to Item 904.XX.

Verification tests will be performed by MassDOT on field cured cylinders at 3 days and on standard cured cylinders at 7 days and 28 days. Cylinder breaks at 3 days and 7 days must be at least 10% above the approved trial batch results. The Contractor will be notified of any verification tests that do not meet these requirements and will be required to develop a contingency corrective action plan incase final strength is not achieved. Concrete will be accepted based on meeting the 28-day strength requirement of 4000 psi.

Curing Methods

The concrete curing methods shall be developed by the Contractor as part of the QC plan. The curing methods used in the production placements shall be the same as the curing methods used for the trial placement.

High Early Strength Concrete Crack Inspection

The Contractor shall document the location and frequency of cracks on the closure pours (number of cracks per square foot). Cracks greater than 0.016 inches in width shall be repaired as required by

the membrane waterproofing manufacturer The Contractor shall develop repair procedures as part of the QC plan.

The work completed under this Item will be paid for at the contract price per actual number of cubic yards of high early strength concrete that is measured complete in place. Payment under this Item includes full compensation for all testing and approval of the mix design.

SPRAY APPLIED MEMBRANE WATERPROOFING

Description of Work

The work under this Item shall conform to applicable sections of Section 965 of the Standard Specifications and the following:

The work to be performed shall consist of the furnishing and application of an approved cold liquid spray applied, seamless methylmethacrylate or polyurea membrane system and all concrete surface preparation work necessary to install the membrane system. The membrane system shall consist of the primer, the membrane, aggregated keycoat layer, and tack coat.

General

Membrane application shall be in accordance with the manufacturer's instructions. The Manufacturer's representative shall be present during the entire application and shall oversee surface preparation, installation and quality control testing. The handling, mixing, and addition of membrane components shall be performed in a safe manner to achieve the desired results in accordance with the manufacturer's recommendations. All open flames and spark producing equipment shall be removed from the work area prior to commencement of application. No smoking signs shall be posted at the entrances to the work. The Applicator shall be responsible for the protection of equipment and adjacent areas from overspray or other contamination.

The Contractor and the Applicator shall agree upon a schedule for coordination between trades working in the areas that are to receive the membrane system. Before beginning the application, the Contractor shall schedule and conduct a meeting at the site to review the approved submittals, and other pertinent matters related to the application including the schedule for coordination between trades. Present, as a minimum, shall be the Contractor, the Applicator, the Manufacturer's Field Representative and the Engineer.

All components of the membrane system shall be delivered to the site in the manufacturer's original packaging, clearly identified with the products type and batch number. The Contractor shall provide the Applicator with a storage area for all components. The area shall be cool, dry, out of direct sunlight, and complies with relevant health and safety regulations. Copies of material safety data sheets for all components shall be kept on site at the Contractor's field office.

Only products pre-approved by MassDOT will be accepted for use. Product approval shall require the demonstration by the manufacturer that the membrane system meets the material specifications and that the entire membrane system is designed and tested as waterproofing for use on bridge deck

applications. The manufacturer shall demonstrate through testing prior to approval that the system meets material properties and performance requirements stated herein.

Submittals

The Contractor shall submit to the Engineer for approval the membrane system material specifications, installation procedure, application equipment and testing as well as product performance data, storage and protection instructions, handling and mixing instructions, material safety data sheets (MSDS) for all components. An 8 inch square sample of the proposed membrane representing in color, texture and thickness satisfactory field application shall be provided to the Engineer. All submittals shall be certified to be in conformance with the manufacturer's instructions.

Materials

The waterproofing membrane shall consist of a one or two coat rapid curing liquid spray applied methylmethacrylate or polyurea for a total minimum membrane thickness of 100 mils measured over peaks. The membrane shall easily accommodate the need for day joints and patch repairs. The membrane shall be able to bridge live cracks up to 1/8 inch in width and shall conform to the following requirements:

The primer shall promote adhesion of the membrane to the concrete surface. The chemical composition of the primer, membrane, aggregate keycoat and tack coat that make up the membrane system shall conform to the manufacturer's specifications for the material and shall be approved by the manufacture as being compatible for use with the specified membrane. Cleaning solvents shall also be as approved by the manufacturer for use with
membrane.

Applicator

The system shall be applied by an Applicator who is approved by the membrane system manufacturer. The Applicator installing the membrane shall have at least 2 years of experience on membrane installation with applicator certified by the membrane manufacturer. The Engineer shall receive manufacturer's written approval of the Applicator's qualifications at least seven days prior to the application of any system component. This approval shall apply only to the named individuals performing the application.

PROPERTY	TEST	REQUIREMENTS
Minimum Thickness		100 mils minimum measured over peaks
Water Vapor Transmission	ASTM E 96-00 Method A	$<1.66 \times 10^{-3}$ lb/ft^2/day
Adhesion to concrete	ASTM D 4541	100 psi minimum. Failure in concrete will require additional concrete preparation
Tensile	ASTM D 638 Method A, Die C	> 1,700 psi

PROPERTY	TEST	REQUIREMENTS
Elongation at Break	ASTM D 638 Method A, Die C	130 % Typical
Crack Bridging	ASTM C 836- 00	Pass 10 cycles at -14.8 °F no failure at 1/8 inch

Application Procedure

The application procedure shall consist of concrete surface preparation, applying primer, applying membrane, applying aggregated keycoat layer, applying Polymer Modified tack coat. Special attention shall be paid to the bridge deck surface preparation prior to the membrane system application. A representative from the membrane manufacturing company shall be present for the entire duration of the membrane application. The manufacturer's representative shall be responsible for the field testing, required documentation and reporting.

The membrane system shall not be applied in either wet, damp or foggy weather, or when the ambient temperature is 40° F or below or is forecast to fall below 40° F during the application period.

The membrane waterproofing on bridge decks shall not be placed until the Contractor is ready to follow within 24 hours with the first layer of Hot Mix Asphalt pavement; a longer period of time will be allowed only with the approval of the Engineer.

Where the areas to be waterproofed are bound by a vertical surface including, but not limited to, a curb or a wall, the membrane system shall be continued up the vertical as necessary. A neat finish with well defined boundaries and straight edges shall be provided.

1. CONCRETE SURFACE PREPARATION: Concrete surfaces which are to be waterproofed shall be screeded to the true cross section, sounded and all spalls and depressions shall be repaired prior to the application of the prime coat. Depressions shall be filled to a smooth flush surface with 1:2 mortar (1 part cement to two parts sand) or an approved rapid setting patching mortar that is compatible with the waterproofing system. Other surfaces shall be trimmed free of rough spots, projections or other defects which might cause puncture of the membrane so that the surface profile of the prepared concrete surface shall not exceed a ¼ inch amplitude, peak to valley.

The use of resin or wax-based deck curing membranes is not acceptable.

Immediately prior to the application of the primer, the concrete to which the membrane is to be applied shall be cleaned of all existing bond inhibiting materials using an abrasive blast. Dust or loose particles shall be removed using clean, dry oil-free compressed air or industrial vacuums. The surface preparation shall insure that the concrete surface shall be free of bituminous product, surface laitance, oil staining, soiling, and dust and produce a clean dry surface.

Random tests for adequate tensile bond strength of the membrane shall be conducted on the concrete in accordance with ASTM D 4541 using the membrane manufacturer's primer and

membrane to achieve minimum bond strength of 100 psi with failure in the concrete. Additional preparation of the concrete shall be required if a bond strength of a least 100 psi is not demonstrated in the concrete-membrane interface.

2. APPLYING PRIMER: The primer shall only be applied when the temperature of the concrete deck surface exceeds the dew point and when the concrete deck surface has moisture content of 5.5% or less as confirmed by a portable electronic surface moisture meter supplied by the Contractor. The primer shall be applied to ensure full coverage. The concrete to which the membrane is to be applied shall have cured a minimum of 7 days prior to the application of the primer. A second coat of primer shall be required if first coat of primer is absorbed by the concrete. The primer shall be over sprayed with the membrane for up to the manufacture allowed re-coat drying time but in no case it shall exceed 24 hours. Beyond this period, the surface shall be prepared again and re-primed following the manufacturer's recommendations prior to membrane application.

3. APPLYING MEMBRANE: The waterproofing membrane shall be applied in a methodical manner. The Applicator shall follow the approved mixing and application procedure. Unless approved by the Engineer, the membrane shall be spray applied, with the mixing of the two components taking place at the nozzle, and shall be applied to the primed deck in accordance with the manufacturer's instructions. The spray equipment shall be computer controlled, monitoring mixing ratios and quantities applied, and the latter allowing coverage rates to be checked. Following the application of membrane system and before holiday testing, the cured surface shall be visually inspected. If any defects or pinholes are found, an appropriate quantity of membrane shall be mixed by hand and repairs effected by touch-in with a putty-knife hand tool, ensuring in all cases that the thickness of the repair is sufficient to bring the area up to the specified thickness and that the thickness of the repair patch is a minimum 100 mils.

4. APPLYING AGGREGATED KEYCOAT: Following the membrane application, a layer of resin, compatible with the membrane shall be spray applied to a thickness of 30 to 40 mils into which a crushed basalt aggregate approved by the membrane manufacturer shall be broadcast ensuring minimum 80% coverage.

5. APPLYING POLYMER MODIFIED TACK COAT: The manufacturer's tack coat shall be applied in accordance with the membrane manufacturer's recommendations after a minimum of three hours from initial membrane application. Polymer modified tack coat shall be heated and melted in a kettle at a temperature between 375°F-400°F and applied at a coverage rate of between 25-35 Square Feet/Gallon. The Tack Coat shall be allowed to cool for a minimum of 1 hour prior to the application of the hot rolled asphalt.

During paving, a light soap spray should be applied to the paving equipment wheels to prevent removal of the tack coat

6. REPAIRS: If an area of membrane requires repair or if the membrane becomes damaged, a patch repair shall be carried out to restore the integrity of the membrane system. The damaged area shall be cut back to sound materials and wiped with a solvent up to a width of at least 6 inches

beyond the periphery of the damaged area, removing contaminants. The concrete shall be primed as necessary, followed by the application of the membrane. A continuous layer shall be obtained over the concrete with a 6 inch overlap onto the existing membrane. The solvent shall be as approved by the membrane waterproofing manufacturer. Repairs shall comply with the manufacturer's guidelines for any over-coating times.

Where the membrane is to be joined to existing cured material and at day joints, the new application shall overlap the existing membrane/day joint by at least 4 inch. The existing membrane/day joint shall be cleaned of all contamination including tack coat material or dirt to an edge distance of a least 6 inch and wiped with a solvent as approved by the membrane waterproofing manufacturer.

7. FIELD QUALITY CONTROL: The following tests shall be conducted by the manufacturer's representative and recorded on a test report form to be submitted to the Engineer. All test reports shall be submitted to the Engineer within 5 working days of the test completion.
a. Temperature and Moisture: Concrete deck temperature and dew point readings shall be taken prior to commencing the primer application. Air temperature shall be recorded every 4 hours during the application process.

b. Film Thickness: Wet film thickness shall be checked every 300 square feet using a gauge pin or standard comb type thickness gauge or a magnetic gauge. Film thickness checks shall be carried throughout the application process. During the Final Review, the cured membrane film thickness shall be checked by a dial thickness gauge.

c. Pin Hole/Holidays: The entire surface of the membrane shall be holiday tested in accordance with ASTM D 4787 using an approved holiday tester. All holidays shall be located, marked for repair, documented, and repaired in accordance with the approved repair procedure. The holiday testing equipment shall be independently calibrated with valid certification. The spark tester shall be adjusted to suit the conductivity of the in-place concrete substrate prior to testing in accordance with ASTM D-4787. Tester certification shall be provided to the Engineer prior to commencing the application process. The Engineer shall oversee the holiday testing.

d. Adhesion Tensile Bond: Random tests for adequate tensile bond strength shall be conducted in accordance with ASTM D 4541 using the membrane manufacture's primer and membrane. The test shall be conducted using the membrane as the adhesive to the test dolly. Minimum bond strength of 100 psi will be required for acceptance. Failure in the concrete will require additional surface preparation of the concrete. Tester Model 106, or approved similar equipment shall be used. A frequency of 1 test per 5,000 square feet or fraction thereof shall be conducted. Areas smaller than 5,000 square feet shall receive a minimum of 3 tests.

e. Visual inspections shall be conducted throughout the application process. The Manufacturer's Field Representative shall take progress photos for incorporation with his final review report to the Engineer.

Final Review
The final review visual inspection shall be conducted jointly by the Applicator, Contractor, Manufacturer's Field Representative and Engineer. Irregularities or other items that do not meet the

requirements of the Special Provisions and the Plans shall be addressed/repaired at this time, at no additional cost to the MassDOT.

Strip Seal Bridge Joint System

The work under this heading shall conform to the applicable provisions of Section 960 and 972 of the Specification with the following additions:

Supplying and installing materials for the strip seal bridge joint system, including, steel extrusions, strip seals, headed anchors, and expansion anchor bolts for leveling, shall be included under this heading.

Shop drawings shall be prepared in accordance with the applicable requirements of Subsection 960.60. The joints shall be fabricated with the proper skews and cross slope of the deck.

Concrete Coating for Existing Substructures

After all substructure repairs have been completed a colored protective coating will be applied, color to be determined by MassDOT, over the entire above grade substructure of each bridge. The material shall be either Conpro Lastic by Conproco Corporation, Sikaguard 550W Elastocolor by Sika Corporation and Thorolastic by BASF

APPENDIX A

NEW YORK STATE ENGINEERING BULLETIN EB 10-034

To:		*New York State Department of Transportation* **ENGINEERING BULLETIN**	**EB 10-034**
			Expires one year after issue unless replaced sooner

Title: **BOX BEAM STIFFENING OF TEMPORARY CONCRETE BARRIER**

Distribution:		Approved:	
☒ Manufacturers (18)	☐ Surveyors (33)		
☒ Local Govt. (31)	☒ Consultants (34)	/s/J.F. Tynan	8-31-10
☒ Agencies (32)	☒ Contractors (39)	James F. Tynan, P.E.	Date
	☐ _____( )	Deputy Chief Engineer (Construction)	

ADMINISTRATIVE INFORMATION:

- This Engineering Bulletin (EB) is effective beginning with projects submitted for the letting of 01/06/11.
- This EB does not supersede any previous issuances.
- This standard sheet will be incorporated into the next complete printing of the Standard Sheets.

PURPOSE:

The purpose of this EB is to issue Standard Sheets *619-01 Temporary Concrete Barrier (Sheet 3 of 3)* and *M619-72 Box Beam Stiffening of Temporary Concrete Barrier*.

TECHNICAL INFORMATION:

- Box Beam Stiffening of Temporary Concrete Barrier is an option to limit the deflection of temporary concrete barrier to 2.2 feet for standard impact conditions (5000# pickup impacting at 62 mph and a 25° angle). Without box beam stiffening, the deflection was 3.3 feet. With all segments pinned and no box beam stiffening, the deflection was 0.7 feet.
- Standard Specification Section 619 will subsequently be modified to include construction details and separate payment items for Box Beam Stiffened Temporary Concrete Barrier. In the interim, if a designer plans to use this detail, he/she must submit a special specification to the Design Quality Assurance Bureau, Specification and Standards Section for approval. Contact Terry Hale at terry.hale@dot.state.ny.us or (518) 485-7009 for assistance.
- Standard Sheets 619-01, 1 of 2 and 2 of 2 will be renumbered to 1 of 3 and 2 of 3 on the website, but will not be reissued.

TRANSMITTED MATERIALS:

Standard Sheets *619-01 Temporary Concrete Barrier (Sheet 3 of 3)* and *M619-72 Box Beam Stiffening of Temporary Concrete Barrier* are available on the IntraDOT and the Department's website at: https://www.nysdot.gov/main/business-center/engineering/cadd-info/drawings

BACKGROUND:

In 2007, research was conducted on a concept to reduce the deflection of TCB without the need to pin units into the pavement or a bridge deck. The concept involved bolting 12 foot lengths of 6" x 6" box beam on the back side of the TCB, spanning across the joints.

CONTACT:

For additional information contact Terry Hale of the Design Quality Assurance Bureau at (518) 485-7009, thale@dot.state.ny.us or Tom Melander of the Office of Construction at (518) 457-6472, tmelander@dot.state.ny.us.

crossovers, lane shifts and closures, and other traffic patterns associated with construction activities. Interim pavement markings are intended for use for a given phase or season, for a maximum of 1 year.

619-1.08 Temporary Rumble Strips. Work shall consist of installing, maintaining, and removing temporary rumble strips at the locations shown in the contract documents or as directed by the Engineer.

619-1.09 Interim Tubular Markers. Work shall consist of furnishing, installing, moving, and maintaining interim tubular markers attached to the pavement as shown in the contract documents or as directed by the Engineer. Interim tubular markers are typically used for 2-way, 2-lane freeway work zones and long-term closures where available width is limited.

619-1.10 Portable Variable Message Signs (PVMS). Work shall consist of furnishing, installing, operating, maintaining, relocating, and removing PVMSs as shown in the contract documents or as directed by the Engineer. The number, general locations and duration of use of PVMSs will be specified in the contract documents under the Special Note Requirements for Portable Variable Message Signs (PVMS). PVMSs are intended to supplement other traffic control devices by displaying symbolic or word messages, but are not to be used alone to replace conventional traffic control devices.

619-1.11 Type III Construction Barricades. Work shall consist of furnishing, installing, moving, maintaining, and removing Type III construction barricades, with warning lights where specified, as shown in the contract documents or as directed by the Engineer.

619-1.12 Temporary Concrete Barrier. Work shall consist of furnishing, installing, moving, maintaining, and removing temporary concrete barrier, including barrier warning lights where specified, as shown in the contract documents or as directed by the Engineer.

619-1.13 Temporary Glare Screen. Work shall consist of furnishing, installing, moving, maintaining, and removing modular glare screen mounted on a concrete barrier as shown in the contract documents or as directed by the Engineer.

619-1.14 Temporary Impact Attenuator. Work shall consist of furnishing, installing, maintaining, repairing, moving and removing temporary impact attenuators as shown in the contract documents or as directed by the Engineer.

619-1.15 Temporary Sand Barrel Arrays. Work shall consist of furnishing, installing, maintaining, relocating and removing temporary sand barrel arrays as shown in the contract documents or as directed by the Engineer.

619-1.16 Vehicle Arresting Barrier. Work shall consist of providing vehicle arresting barriers (net-type) and their anchorages as shown on the Standard Sheets to prevent errant vehicles from entering a closed work area as shown in the contract documents or as directed by the Engineer.

619-1.17 Maintain or Modify Traffic Signal Equipment. Work shall consist of modifying or maintaining in proper operation, existing, relocated, modified, or newly installed traffic signals as shown in the contract documents or as directed by the Engineer.

619-1.18 Temporary Traffic Signals. Work shall consist of furnishing, installing, moving, maintaining, and removing temporary traffic signals and necessary components as shown in the contract documents or as directed by the Engineer. Temporary signals shall be installed only on a highway designated as a Restricted Highway.

619-1.19 Nighttime Operations. Work shall consist of developing a Nighttime Operations and Lighting Plan, and furnishing, installing, operating, maintaining, moving and removing lighting equipment for nighttime construction operations as shown in the contract documents or as directed by the Engineer.

619-2.08 Temporary Rumble Strips.

A. Raised Asphalt Rumble Strips. Raised asphalt rumble strips shall be formed from a 6.3 or a 9.5 hot mix asphalt. Asphalt Emulsion Tack Coat shall be used to adhere the rumble strip to the existing pavement.

B. Raised, Removable-Tape Rumble Strips. Removable-tape rumble strips shall be formed from black, non-reflectorized, removable pavement-marking tape. Raised, removable-tape rumble strips shall have a minimum width measured in the direction of traffic of 6 inch, with sufficient layers of tape such that each finished rumble strip has a thickness of 3/8 inch ± 1/8 inch.

C. Raised, Preformed Rumble Strips. Raised, preformed rumble strips shall be manufactured specifically as temporary rumble strips. Raised, preformed rumble strips shall have a minimum width measured in the direction of traffic of 4 inches, with a thickness of between 1/4 inch and 1/2 inch.

D. Saw-Cut Rumble Strips. Saw-cut rumble strips shall have a width measured in the direction of traffic of 4 inches ± 1/2 inch. The depressions shall have a rectangular cross section with a depth of 3/8 inch ± 1/8 inch.

E. Milled-in Rumble Strips. Milled-in rumble strips shall have a nominal width measured in the direction of traffic of 6 inches. The depressions shall have a semicircular, concave cross section with a depth of 3/8 inch ± 1/8 inch.

F. Removing Temporary Rumble Strips. Rumble strip depressions shall be filled in with a 6.3 or a 9.5 hot mix asphalt meeting the requirements of Section 402, Hot Mix Asphalt (HMA) Pavements.

619-2.09 Interim Tubular Markers. Interim tubular markers shall be in accordance with §729-03 Temporary Tubular Markers.

619-2.10 Portable Variable-Message Signs (PVMS). Portable Variable-Message Signs shall be in accordance with §729-16 Portable Variable-Message Signs (PVMS).

619-2.11 Type III Construction Barricades. Type III construction barricades shall be fabricated in accordance with §729-08 Type III Construction Barricades. All barricades used at night shall be equipped with warning lights in accordance with §729-18 Warning Lights.

619-2.12 Temporary Concrete Barrier. Temporary concrete barrier segments shall be precast concrete units in accordance with the Standard Sheets or approved Materials Details. All temporary concrete barrier supplied after January 1, 2015 shall be produced in accordance with the requirements of §704-05 Precast Concrete Barrier, and shall have a legible permanent marking. Temporary concrete barrier supplied prior to January 1, 2015 which was not produced in accordance with the requirements of §704-05 Precast Concrete Barrier, shall be material certified in accordance with specific Standard Sheets or Materials Details used for fabrication.

Warning lights for temporary concrete barrier with warning lights shall be in accordance with §729-18 Warning Lights. Where warning lights are not required, each temporary concrete barrier segment shall be delineated using reflective panels covered with ASTM Type IX sheeting, approximately 3 x 6 inches, having a minimum area of 18 square inches. Where warning lights are required, segments shall not be delineated with panels. Reflective pavement marking materials applied to the face of the barrier shall not, by themselves, be considered acceptable delineation.

619-2.13 Temporary Glare Screen. Temporary glare screen shall be in accordance with §729-17 Temporary Glare Screens.

619-2.14 Temporary Impact Attenuator. Temporary impact attenuators shall be in accordance with §729-10 Temporary Impact Attenuators - Redirective or §729-11 Temporary Impact Attenuators - Gating.

slope downward toward each side starting at the center. Where no passage is intended or permitted, the stripes shall slope downward toward the center of the barricade or barricades.

At night, each Type III construction barricade used to close a roadway, a segment of a roadway or a sidewalk shall be equipped with one flashing warning light.

619-3.12 Temporary Concrete Barrier. The Engineer will inspect temporary concrete barrier sections upon delivery to the contract. Any barrier section having damage and/or defects in the concrete and/or joint connections will be rejected if the performance of the barrier may be affected.

When temporary glare screen is attached to the barrier, temporary delineation shall be mounted such that its visibility is not blocked by the glare screen.

Temporary concrete barrier sections shall be fastened together to form a continuous chain. After placement, each successive unit shall be pulled longitudinally to remove the slack in the joint between units. When joined together, the barrier sections shall form a smooth and continuous barrier. Any sections damaged or misaligned while in service shall be corrected or replaced.

TABLE 619-4 FLARE RATES FOR POSITIVE BARRIER

POSTED SPEED LIMIT (mph)	30	40	50	55	65
TEMPORARY CONCRETE BARRIER	8:1	11:1	14:1	16:1	20:1
BOX BEAM OR HEAVY POST CORRUGATED BEAM	7:1	9:1	11:1	12:1	15:1

TABLE 619-5
GUIDE RAIL & CONCRETE BARRIER STANDARD* DEFLECTION DISTANCES

BARRIER TYPE	POST SPACING (ft)	DEFLECTION DISTANCES (ft)
CABLE GUIDE RAIL	16	11.0
	12	9.5
	8	8.0
	4	7.0
CORRUGATED W-BEAM (WEAK POST) GUIDE RAIL	12.5	8.0
	6.25	6.0
	4.16	5.0
CORRUGATED W-BEAM (HEAVY POST BLOCKED OUT)	6.25	4.0
	3.12	2.0
BOX BEAM GUIDE RAIL	6.0	5.0
	3.0	4.0
CORRUGATED W-BEAM (WEAK POST) MEDIAN BARRIER	12.5	7.0
	6.25	5.0
CORRUGATED W-BEAM (HEAVY POST) MEDIAN BARRIER	6.25	2.0
BOX BEAM MEDIAN BARRIER	6.0	3.0
CONCRETE BARRIER	Not Applicable	1.25
Grouted		0.9
Grouted & Pinned		0.25

* Note: Standard Deflection is caused by a 4500 lb test vehicle traveling 60 mph impacting the barrier at a 25° angle.

Where space is available, approach ends of the barrier shall be flared at the taper rate shown in Table 619-4 Flare Rates for Positive Barrier and terminated in a tapered concrete end section, embedded in a slope, or otherwise protected against impact by errant vehicles. Tapered concrete end sections shall not be used in traversable medians, gores, and other areas where impacts on a tapered concrete end section could allow vehicles to penetrate into opposing or adjacent lanes of traffic. Where the posted speed limit is 45

mph or higher, a temporary impact attenuator or temporary sand barrel array shall be provided on approach ends of temporary concrete barrier when the offset from the edge of the traveled way to end of the full section barrier is less than 12 feet, and will be paid for separately.

In order to reduce movement of the barrier on structures and in areas where limited deflection is desired, the Contractor shall pin temporary concrete barrier where shown in the contract documents. Each pinned segment shall be pinned using a minimum of four (4) pins, two (2) on each side, in non-adjacent anchor recesses. Pins shall not project above the top surface of the anchor recess, and shall have the following minimum pin embedment lengths:

- Bridge Decks and Cement Concrete Pavement 5 in
- Flexible Pavement 18 in
- Unpaved Areas 30 in

After removal of the barrier, holes in the surface created to pin the barrier shall be filled, unless that area will be further disturbed. Holes in flexible pavement or unpaved areas shall be filled with material consistent with the subbase, base and surface material. Holes in portland cement concrete pavement or structural decks shall be filled with material meeting the requirements of §701-05 Concrete Grout Material or §721-03 Epoxy Polysulfide Grout.

A. Barrier Without Warning Lights. Where warning lights for temporary concrete barrier are not required, the Contractor shall provide and maintain delineation on the temporary concrete barrier. The delineation shall be maintained visible and free of dirt and snow, including during shutdown periods. The maximum spacing of delineation shall be 40 feet in tangents and 20 feet in curves with radii less than 2,800 feet.

B. Barrier With Warning Lights. Type C warning lights shall be provided on temporary concrete barrier with warning lights. The maximum spacing of warning lights shall be 40 feet in tangents and 20 feet in curves with radii less than 2,800 feet. Warning lights shall be attached to the barrier so that the lights remain securely in place and so that the attachment minimizes damage to the barrier.

All warning lights shall be kept clean, properly aligned and in operating condition. Batteries shall be replaced as necessary to maintain adequate visibility of the warning lights at night.

Where channelizing devices with Type B flashing warning lights are not provided immediately preceding a run of barrier to be marked with warning lights, the first warning light on that run of barrier shall be a Type B warning light.

619-3.13 Temporary Glare Screen. Temporary glare screen shall be installed in accordance with the manufacturer's instructions. All components of the glare screen shall be maintained in a safe and functional condition. Damaged components shall be repaired or replaced.

If blades are utilized, the blades shall be spaced and angled to provide approximately a 22° headlight cutoff angle. The screen shall not overhang the face of the barrier and shall not cover delineation or lights. The screen shall be kept plumb and properly positioned on the barrier, with reflectorization securely affixed to the screen. Cleaning of the reflectorization shall be by a method that does not damage the paddles, reflectorization or barrier, and is not hazardous to traffic.

The Contractor shall remove and dispose of the temporary glare screen upon completion of the contract or when it is no longer required. Upon removal of the temporary glare screen, there shall be no protrusions remaining on the top face of the barrier. Bolt holes or other damage to permanent barrier from glare screen installation shall be repaired by the Contractor at no additional cost to the State.

619-3.14 Temporary Impact Attenuator. The Contractor shall install temporary impact attenuators in accordance with the contract documents, the manufacturer's instructions and materials details. The Contractor shall provide the Engineer a copy of the manufacturer's materials details and installation instructions a minimum of 5 work days prior to use, to allow verification of the attenuator supplied and proper installation. The selection of the manufacturer and model of temporary impact attenuator shall be at the Contractor's option, provided the attenuator supplied is of the type indicated, gating or redirective; shields the hazard; and fits in the location without encroachment into travel lanes or required offsets.

xx = Material
01= Traffic Paint, 03= Removable Tape,
04= Removable Wet Reflective Tape,

619.1001xx	Interim Pavement Markings, Stripes	Feet
619.1002xx	Interim Pavement Markings, Symbols	Each
619.1003xx	Interim Pavement Markings, Letters	Each

xx = Material
01= Traffic Paint, 02= Epoxy Paint, 03= Removable Tape,
04= Removable Wet Reflective Tape,
05= Traffic Paint Supplemented with Raised Markers

619.1101xx	Portable, Variable Message Sign (PVMS) (Hybrid Flip Disk)	Each
619.1102xx	Portable, Variable Message Sign (PVMS) (LED)	Each
619.1103xx	Portable, Variable Message Sign (PVMS) (Hybrid Flip Disk)	Week
619.1104xx	Portable, Variable Message Sign (PVMS) (LED)	Week

xx = Options
01= None, 02= Cellular Communications
03= Radar, 04= Cellular Communications and Radar

619.12	Temporary Glare Screen	Feet
619.13nn	Temporary Traffic Signals	Each Location
619.1611	Maintain Traffic Signal Equipment (Requirement A)	Intersection Month
619.1612	Maintain Traffic Signal Equipment (Requirement B)	Intersection Month
619.1613	Maintain Traffic Signal Equipment (Requirement C)	Intersection Month
619.1614nn	Modify Existing Traffic Signal Equipment (Temporary)	Each Location
619.1701	Temporary Concrete Barrier (Unpinned)	Feet
619.1702	Temporary Concrete Barrier (Unpinned) with Warning Lights	Feet
619.1703	Temporary Concrete Barrier (Pinned)	Feet
619.1704	Temporary Concrete Barrier (Pinned) with Warning Lights	Feet
619.1802	Temporary Impact Attenuator - Redirective (Test Level 2)	Each
619.1803	Temporary Impact Attenuator - Redirective (Test Level 3)	Each
619.1812	Temporary Impact Attenuator - Gating (Test Level 2)	Each
619.1813	Temporary Impact Attenuator - Gating (Test Level 3)	Each
619.20	Interim Tubular Markers	Each
619.21	Temporary Sand Barrel Module	Each
619.22	Temporary Rumble Strips	Feet
619.23	Vehicle Arresting Barrier	Each
619.24	Nighttime Operations	Lump Sum
619.25	Traffic Control Supervisor	Month
619.26	Pavement Patching, Winter	Cubic Yards
619.27	Mailboxes	Each

SECTION 620 - BANK AND CHANNEL PROTECTION

620-1 DESCRIPTION. This work shall consist of furnishing all plant, labor, equipment, and materials to place a protective covering of erosion-resistant material on embankment slopes, streambanks, at culvert inlets or outlets on bottoms and side slopes of channels, at structure foundations, and at other locations shown on the plans or as directed by the Engineer. The work shall be done in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical sections shown on the plans or established by the Engineer.

620-1.01 Stone Filling. Stone filling shall consist of well graded stone placed as protective material on stream-banks, in channels and elsewhere, as required.

620-1.02 Dry Rip-Rap. Dry rip-rap shall consist of stone fitted and placed on streambanks or in channels in order to provide protection against erosion.

required for compression testing. A minimum of five samples, prepared by the manufacturer in accordance with ASTM C1262, will be required for freeze/thaw testing.

Samples will be tested for compressive strength in accordance with ASTM C140. Samples will be tested for freeze/thaw durability in accordance with ASTM C1262.

BASIS OF ACCEPTANCE. Concrete block will be accepted on the basis of the manufacturer's name and location appearing on the Department's Approved List and a material certification that specifies the product conforms to this specification.

704-05 PRECAST CONCRETE BARRIER

SCOPE. This specification covers the material and quality requirements for precast concrete barrier used in highway applications, precast concrete barrier for structures, and precast temporary concrete barrier.

MATERIAL REQUIREMENTS. The Material Requirements contained in §704-03 Precast Concrete - General shall apply except as noted herein.

Concrete mixtures used under this specification shall have a maximum cement content of 750 lbs per cubic yard. Unless noted otherwise in the contract documents or approved fabrication drawings, the compressive strength of concrete used in precast concrete barrier shall be as follows:

Concrete Barrier	3,000 psi (minimum) @ 28 days
Concrete Barrier for Structures	5,000 psi (minimum) @ 28 days
Temporary Concrete Barrier	3,000 psi (minimum) @ 28 days

All reinforcing steel for Concrete Barrier and Concrete Barrier For Structures shall be epoxy coated meeting the requirements of §709-04 Epoxy Coated Bar Reinforcement, Grade 60. All reinforcing steel for Temporary Concrete Barrier shall meet the requirements of §709-01 Bar Reinforcement, Grade 60.

DRAWINGS. The drawing requirements contained in §704-03 Precast Concrete - General shall apply except as noted herein.

Concrete Barrier and Temporary Concrete Barrier shall use dimensions as shown on the Standard Sheets. Concrete Barrier for Structures shall use dimensions as shown on the Bridge Design (BD) Sheets.

FABRICATION. The fabrication requirements contained in §704-03 Precast Concrete - General, as well as the following shall apply.

- Cross-sectional dimensions shall not vary from the dimensions shown by more than 1/4 inch.
- Barrier shall not be out of plumb by more than 1/4 inch.
- Longitudinal dimensions shall not vary from the dimensions shown by more than 1/4 inch per 10 feet of barrier.
- When checked with a 10 foot straight edge, irregularities shall not exceed 1/4 inch.

SAMPLING AND TESTING. The Sampling and Testing requirements contained in §704-03 Precast Concrete - General shall apply.

MARKING. The Marking requirements contained in §704-03 Precast Concrete - General shall apply except as noted herein.

Concrete Barrier and Concrete Barrier For Structures shall be marked on one end of each barrier segment such that they will not be exposed to view after installation.

Temporary Concrete Barrier shall be marked with "NYSDOT" in place of a Department contract number. In addition, each Temporary Concrete Barrier segment shall be permanently marked with a manufacturer's identification and a date of manufacture in a manner that will remain legible throughout its service life. The date, at a minimum, shall contain the month and year. Permanent markings shall be placed in a consistent location on the top, bottom, or one end of each segment. Imprinting the required information a minimum of 1/4 inch into the concrete surface will be considered an acceptable permanent

marking. Paint will not be considered a permanent marking. If permanent markings are located on the bottom of the segment, paint markings matching the permanent markings shall be placed on one end of each segment to facilitate field inspection.

FINAL PRODUCTION INSPECTION. The Final Production Inspection requirements contained in §704-03 Precast Concrete - General shall apply.

SHIPPING. The Shipping requirements in §704-03 Precast Concrete - General shall apply.

BASIS OF APPROVAL. Concrete Barrier designs other than those shown on the Standard Sheets will not be approved.

Concrete Barrier For Structures designs may be proposed, and if found acceptable, they will be placed on the approved list. Evidence shall be provided that the proposed anchorage system has been successfully tested in accordance with the procedural directives issued by the DCES.

Temporary Concrete Barrier designs other than those shown on the Standard Sheets may be proposed, and if found acceptable, they will be placed on the approved list. Evidence shall be provided that the temporary concrete barrier, with the proposed joint system, is NCHRP 350 approved.

BASIS OF ACCEPTANCE. The Basis of Acceptance requirements contained in §704-03 Precast Concrete - General shall apply.

704-06 PRECAST CONCRETE CRIBBING

SCOPE. This specification covers the material and fabrication requirements for precast concrete cribbing.

MATERIAL REQUIREMENTS. The Material Requirements contained in §704-03 shall apply.

DRAWINGS. The Drawing requirements contained in §704-03 shall apply.

FABRICATION. The Fabrication requirements contained in §704-03 shall apply.

SAMPLING AND TESTING. The Sampling And Testing requirements contained in §704-03 shall apply.

MARKING. The Marking requirements contained in §704-03 shall apply.

FINAL PRODUCTION INSPECTION. The Final Production Inspection requirements contained in §704-03 shall apply.

SHIPPING. The Shipping requirements contained in §704-03 shall apply.

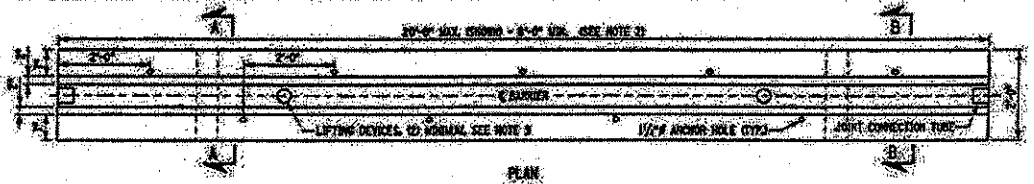
BASIS OF ACCEPTANCE. The Basis Of Acceptance requirements contained in §704-03 shall apply.

704-07 SEGMENTAL RETAINING WALL BLOCKS

SCOPE. This specification covers the material details and quality requirements for segmental retaining wall blocks.

MATERIAL REQUIREMENTS. Provide segmental retaining wall block meeting the style and color requirements in the contract documents. Use materials, meeting the following requirements, in the manufacture of segmental retaining wall blocks:

Portland Cement	701-01
Coarse Aggregate	703-02
Mortar Sand	703-03



NOTES:

1. TEMPORARY CONCRETE BARRIER SHALL BE PRECAST IN ACCORDANCE WITH THE REQUIREMENTS OF D704-05 PRECAST CONCRETE BARRIER.
2. TEMPORARY CONCRETE BARRIER SHALL BE PRECAST UNITS OF ONE OF THE FOLLOWING NOMINAL LENGTHS: 4', 10', 12', 14', 16', 18', 20'.
3. STEEL PLATE REINFORCEMENT SHALL BE ASTM A709, ASTM A36, GRADE 345 STEEL. TUBE REINFORCEMENT SHALL BE ASTM A500, GRADE B OR C. ALL REINFORCING BARS SHALL BE ASTM A615, GRADE 420. EPOXY BARS ARE NOT REQUIRED.
4. ALL WELDING SHALL BE PERFORMED BY A WELDER QUALIFIED IN ACCORDANCE WITH SECTION 8 OF THE NYS STEEL CONSTRUCTION MANUAL.
5. SURFACES TO BE WELDED SHALL BE FREE OF SLAG, RUST, MOISTURE, GREASE OR ANY OTHER MATERIAL THAT WILL PREVENT PROPER WELDING OR PRODUCE OBJECTIONABLE FUMES.
6. WELDING SHALL BE SHIELDED METAL ARC WELDING (SMAW) PERFORMED WITH E70XX ELECTRODES CONFORMING TO THE REQUIREMENTS OF SECTION 3 OF THE NYS STEEL CONSTRUCTION MANUAL.
7. THE NUMBER AND PLACEMENT OF THE #3A AND #3B BARS WILL VARY WITH THE LENGTH OF THE BARRIER SEGMENT.
8. CONCRETE CLEAR COVER FOR REINFORCING BARS SHALL BE 1½" MINIMUM UNLESS OTHERWISE SPECIFIED.
9. A MINIMUM OF (2) TWO RECESSED LIFTING DEVICES, EACH WITH THE CAPACITY TO LIFT A MASS OF 5 TONS MINIMUM, SHALL BE INSTALLED ON EACH SEGMENT. SEGMENT MASS IS APPROXIMATELY 400 LBS/FT.
10. ONE DRAINAGE POCKET SHALL BE INCLUDED IN THE CENTER OF 9'-0" AND 10'-0" SEGMENTS. TWO DRAINAGE POCKETS IN ALL OTHER SEGMENTS.
11. CONNECTION KEY COVER PLATE SHALL BE INSTALLED FLUSH WITH THE BARRIER TOP.
12. 1½" ASTM A307 ANCHOR PINS SHALL BE PLACED IN FOUR ANCHOR HOLES OF EACH SEGMENT TO BE PINNED.
13. BASED ON SEGMENT LENGTH AND MAXIMUM JOINT ROTATION, TEMPORARY CONCRETE BARRIER CAN ONLY BE INSTALLED TO THE FOLLOWING MINIMUM RADII: 4' = 90', 10' = 115', 12' = 130', 14' = 145', 16' = 164', 18' = 201', 20' = 230'.

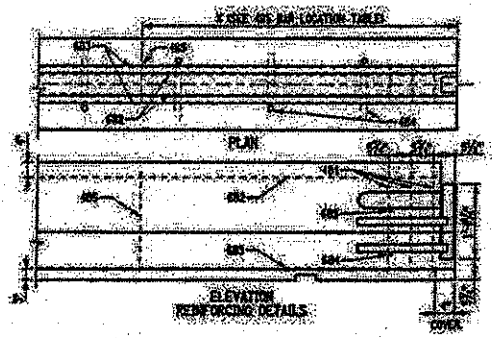
FULL SECTION BAR LIST

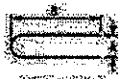
MARK	SIZE	NUMBER PER SECTION	LENGTH	TYPE	A	B	C	LOCATION
401	4	6	4'-11"		1"	5"	28"	12"	STIRRUPS
404	4	SEE TABLE	3'-1"		3"	15½"			ANCHOR RECESS HOOPS
405	4	1 PER RECESS	4'-11"		10"	3"	28"	3"	STIRRUPS
483	4	2	SEE NOTE 7	STR.					LONGITUDINAL TOP
483	4	2	SEE NOTE 7	STR.					LONGITUDINAL BOTTOM
484	4	2	1'-2"	STR.					TRANSVERSE BOTTOM
485	4	2	4"	STR.					TRANSVERSE STOP

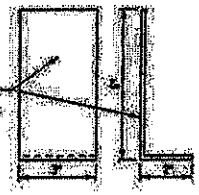
485 BAR LOCATION TABLE

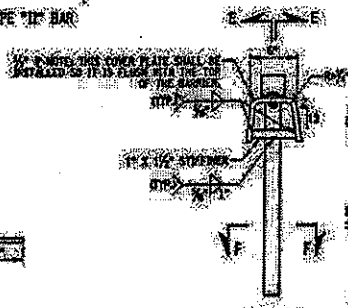
NOMINAL LENGTH OF BARRIER UNIT	X	NO. EACH SECTION
20'	4'-3"	3
18'	3'-9"	3
16'	3'-11"	3
14'	3"	3
12'	2"	3
10'	2"	3
4'	1'-9½"	3

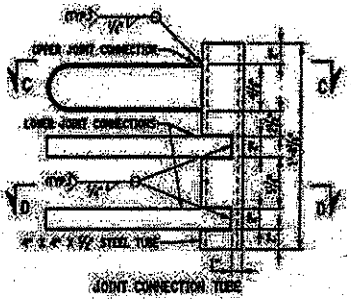
"X" DISTANCE FROM END OF BARRIER TO 485 BAR

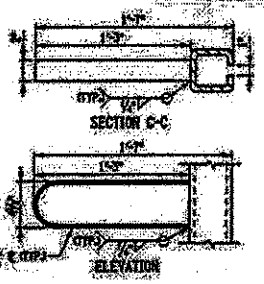


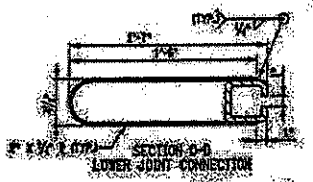


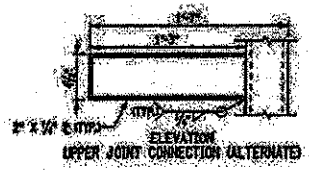


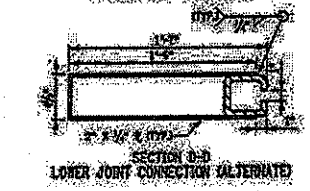


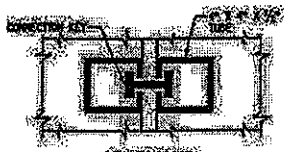












STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

D.O. CUSTOMARY STANDARD SHEET

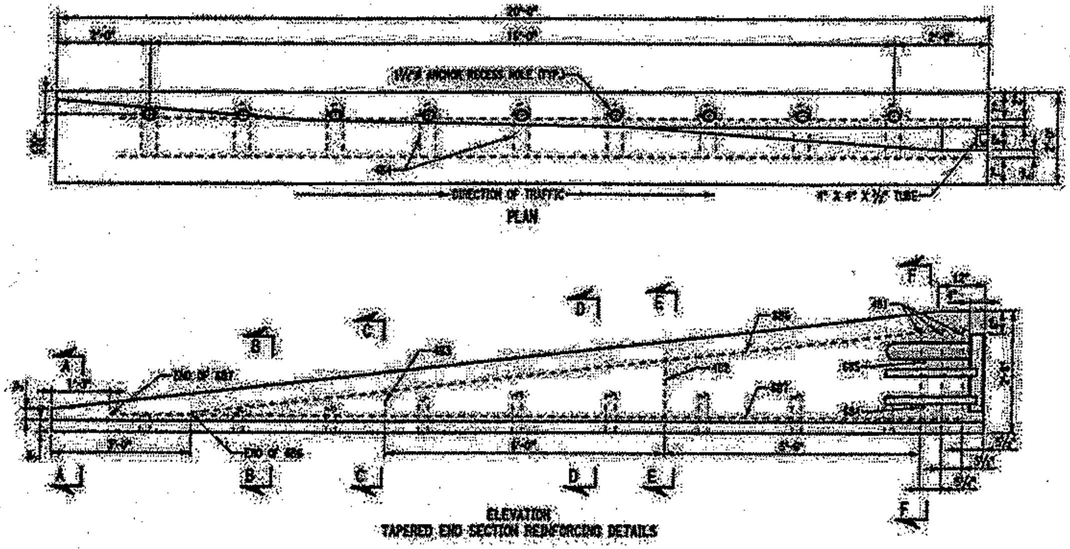
TEMPORARY CONCRETE BARRIER
(SHEET 1 OF 3)

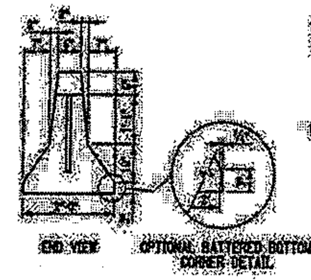
APPROVED SEPTEMBER 30, 2009
/S/ A.P. THAU, P.E.
DEPUTY CHIEF ENGINEER
CONSTRUCTION

ISSUED UNDER EB 09-025

619-01

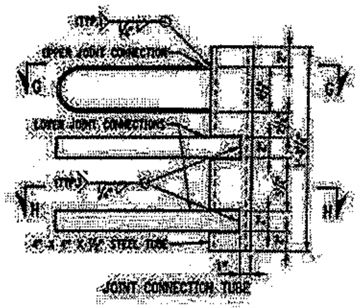
EFFECTIVE DATE: 01/01/10

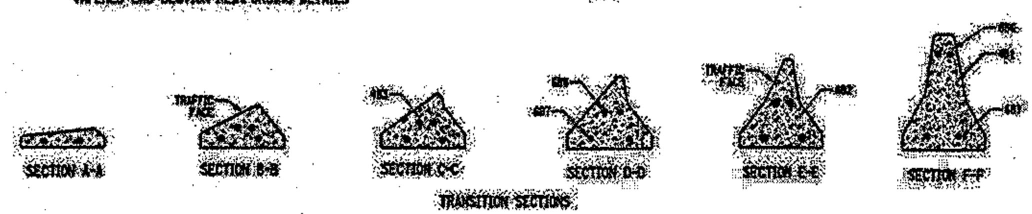


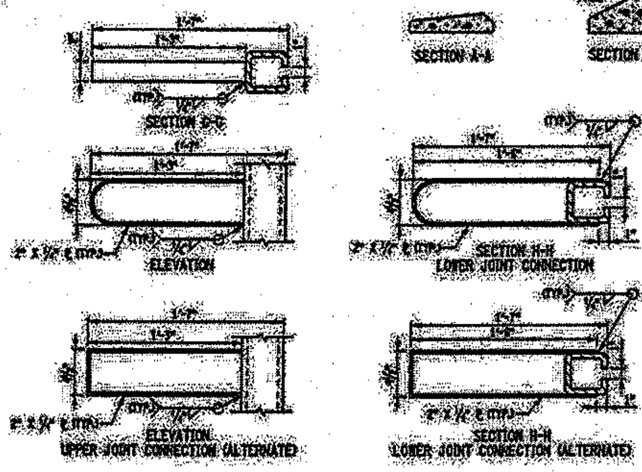


NOTES:

1. TEMPORARY CONCRETE BARRIER SHALL BE PRECAST IN ACCORDANCE WITH THE REQUIREMENTS OF §704-05, PRECAST CONCRETE BARRIER.
2. STEEL PLATE SHALL BE ASTM A36M, ASTM A709M, GRADE 345, TUBE STEEL SHALL BE ASTM A500 GRADE B OR C, AND REINFORCING BARS SHALL BE ASTM GRADE 420.
3. ALL WELDING SHALL BE PERFORMED BY A QUALIFIED WELDER IN ACCORDANCE WITH SECTION 8 OF THE NYS STEEL CONSTRUCTION MANUAL.
4. SURFACES TO BE WELDED SHALL BE FREE OF SLAG, RUST, MOISTURE, GREASE OR ANY OTHER MATERIAL THAT WILL PREVENT PROPER WELDING OR PRODUCE OBJECTIONABLE FUMES.
5. WELDING SHALL BE SHIELDED METAL ARC WELDING USING PROPERLY DRIED 5/32" Ø E7018 ELECTRODES CONFORMING TO THE REQUIREMENTS OF SECTION 7 OF THE NYS STEEL CONSTRUCTION MANUAL.
6. CONCRETE CLEAR COVER FOR REINFORCING BARS SHALL BE 1½" (MIN) EXCEPT WHERE OTHERWISE SPECIFIED.
7. A MINIMUM OF (2) TWO RECESSED LIFTING DEVICES, WITH THE CAPACITY TO LIFT A MASS OF 6 TONS MINIMUM SHALL BE INSTALLED ON EACH SEGMENT.
8. 1" Ø ASTM A36M ANCHOR RODS SHALL BE PLACED IN FOUR RECESSES OF EACH SEGMENT TO BE PINNED.
9. CONNECTION KEY COVER PLATE SHALL BE INSTALLED FLUSH WITH THE BARRIER TOP.
10. THE DETAILS SHOWN FOR THE END SECTIONS ON THIS SHEET ARE FOR APPROACH ENDS WHICH ARE TO BE LOCATED TO THE LEFT OF THE TRAFFIC FLOW ON ONE-WAY OPERATIONS OR BETWEEN OPPOSING FLOWS OF TRAFFIC ON TWO-WAY OPERATIONS. WHEN AN APPROACH END IS TO BE LOCATED TO THE RIGHT OF THE TRAFFIC FLOW, THE END SEGMENT SHALL BE CONSTRUCTED SO THAT IT IS OPPOSITE-HAND REVERSED IN ALL CONFIGURATIONS, ANCHOR HOLE LOCATIONS AND REINFORCEMENTS.
11. ALL CORNERS ON THE TOP OF THE SEGMENT SHALL BE ROUNDED TO A 1" RADIUS. THE SEGMENT SHALL HAVE A SMOOTH TRANSITION TO A 6" END-OF-SECTION HEIGHT. ALL END SECTIONS SHALL BE PINNED UNLESS OTHERWISE NOTED.







TAPERED END SECTION BAR LIST								
MARK	SIZE	NUMBER PER SECTION	LENGTH	TYPE	A	B	C	LOCATION
401	13	3	4'-11"	1	5"	26"	1"	STIRRUPS
402	13	1	3'-5"	1	5"	18"	1"	STIRRUPS
403	13	1	1'-9"	1	5"	8"	1"	STIRRUPS
404	13	9	3'-1"	11	4"	15½"		HOOPS
604	19	1	1'-2"	STR.				
605	19	1	[illegible]	STR.				
606	19	2	16'-7"	STR.				TRANSVERSE (TOP)
607	19	2	16'-2"	STR.				TRANSVERSE (BOTTOM)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

U.S. CUSTOMARY STANDARD SHEET

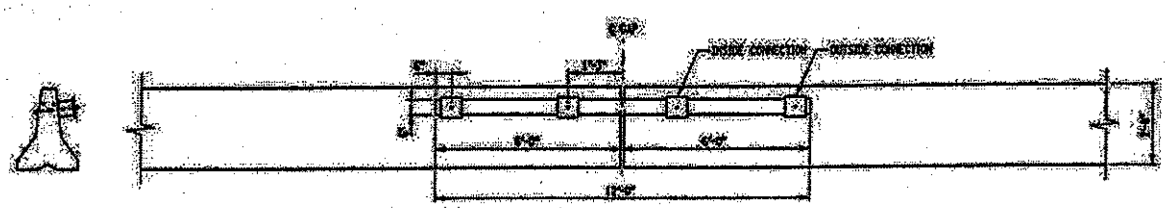
TEMPORARY CONCRETE BARRIER
(SHEET 2 OF 3)

APPROVED SEPTEMBER 30, 2009 /S/ A. P. TYRAN, P.E. DEPUTY CHIEF ENGINEER CONSTRUCTION

ISSUED UNDER EB 09-025

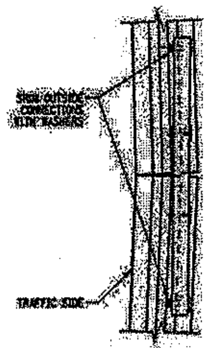
619-01

EFFECTIVE DATE: 01/07/10

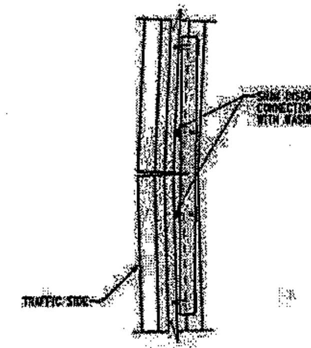


SIDE VIEW
(CONSTRUCTION SIDE)

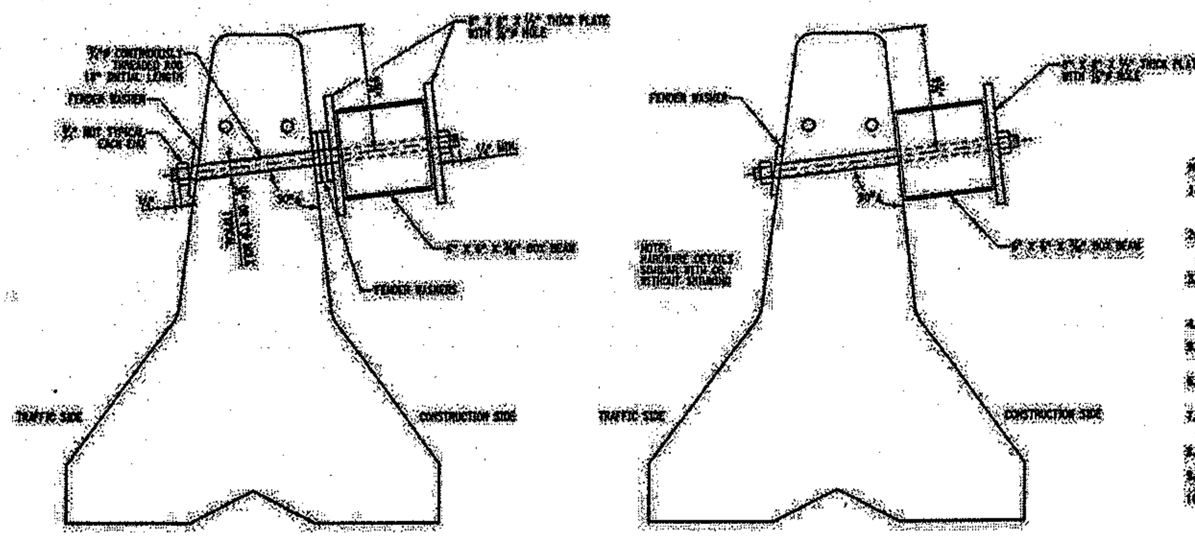
BOX BEAM GUIDE RAIL
HOLE LAYOUT DETAIL



PLAN VIEW
TCB CURVING
TOWARD TRAFFIC



PLAN VIEW
TCB CURVING
AWAY FROM TRAFFIC



SECTION WITH SHIMMING

SECTION WITHOUT SHIMMING

BOX BEAM STIFFENING OF TEMPORARY CONCRETE BARRIER

NOTES:

1. TEMPORARY CONCRETE BARRIER (TCB) SHALL BE PRECAST IN ACCORDANCE WITH THE REQUIREMENTS OF §619-03 PRECAST CONCRETE BARRIER AND STANDARD SHEET TITLED "TEMPORARY CONCRETE BARRIER - SHEET 1 OF 3" AND "TEMPORARY CONCRETE BARRIER - SHEET 2 OF 3".
2. BOX BEAM SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF §710-21, BOX BEAM RAILING AND MEDIAN BARRIER, RAILS.
   A. HOWEVER, THE BOX BEAM NEED NOT BE NEW.
   B. THE GALVANIZING REMAINING ON THE OLD PIECES SHALL BE SUFFICIENT TO ENSURE THE STEEL IS STRUCTURALLY INTACT.
3. TCB WITH BOX BEAM STIFFENER SHALL BEGIN AT LEAST 50'-0" PRIOR TO, BE CONTINUOUS THROUGH AND EXTEND AT LEAST 50'-0" BEYOND THE AREA REQUIRING LIMITED DEFLECTIONS. WHERE SPACE LIMITS SUCH EXTENSIONS, THE FIRST/LAST TCB SEGMENT SHOULD BE PINNED WITH 4 PINS ON THE CONSTRUCTION SIDE.
4. TEMPORARY CONCRETE BARRIER WITH BOX BEAM STIFFENER MAY ONLY BE USED WITH TCB SEGMENTS 14'-0" OR LONGER.
5. TEMPORARY CONCRETE BARRIER MAY ONLY BE INSTALLED TO THE FOLLOWING MINIMUM RADII: 14'-0" SEGMENT = 161'-0" RADIUS, 16'-0" SEGMENT = 184'-0" RADIUS, 18'-0" SEGMENT = 207'-0" RADIUS, AND 20'-0" SEGMENT = 230'-0" RADIUS.
6. WHERE TEMPORARY CONCRETE BARRIERS ARE PLACED ON A RADIUS, THE RESULTING GAPS BETWEEN THE BOX BEAM AND CONCRETE BARRIER SHALL BE SHIMMED.
7. THE SHIMMING SHALL CONSIST OF 8" X 8" X 1/4" SQUARE PLATE, AND FENDER WASHERS AS NEEDED TO SHIM THE BOX BEAM STIFFENER TO THE TCB.
8. FENDER WASHERS SHALL BE 3" NOMINAL O.D.
9. HARDWARE OTHER THAN THE BOX BEAM NEED NOT BE GALVANIZED.
10. THE PRESENCE OF NOMINAL HOLES DRILLED PER THIS SHEET WILL NOT AFFECT THE REUSABILITY OF THE CONCRETE SEGMENTS.

STATE OF NEW YORK DEPARTMENT OF TRANSPORTATION	
U.S. CUSTOMARY STANDARD SHEET	
TEMPORARY CONCRETE BARRIER (SHEET 3 OF 3)	
APPROVED SEPTEMBER 1, 2010 /S/ J.F. LYNCH, P.E. DEPUTY CHIEF ENGINEER CONSTRUCTION	ISSUED UNDER EB 10-034 619-01

EFFECTIVE DATE: 01/06/11

RFP

CONSTRUCTION DETAILS

SURFACE PREPARATION FOR CONCRETE REPAIRS

1. EXTENT, LOCATION, AND REPAIR TYPE OF ALL CONCRETE REPAIRS TO BE FIELD VERIFIED AND APPROVED BY THE ENGINEER AFTER CONTRACTOR HAS SOUNDED AND MARKED OUT ALL REPAIR AREAS. REPAIR CONFIGURATIONS SHOULD BE KEPT AS SIMPLE AS POSSIBLE, PREFERABLY WITH SQUARE CORNERS.

2. SAW CUT ALONG NEAT LINES AROUND REPAIR AREA PRIOR TO CONCRETE EXCAVATION. USE SAW CUT DEPTH OF ½" OR LESS AS REQUIRED TO AVOID CUTTING REINFORCING STEEL (REFER TO SPECIAL PROVISIONS)

3. REMOVE DETERIORATED AND DELAMINATED CONCRETE, UNDERCUT EXPOSED REINFORCING STEEL TO PROVIDE MINIMUM CLEARANCE AROUND BARS, REMOVE ADDITIONAL CONCRETE AS REQUIRED TO PROVIDE MINIMUM REQUIRED THICKNESS OF REPAIR MATERIAL.

4. IF REINFORCING STEEL IS EXPOSED THEN CLEAN BY MECHANICAL CLEANING AND THEN HIGH PRESSURE WASHING WITH WATER THAT CONTAINS NO DETERGENTS OR BOND INHIBITING CHEMICALS. WHERE ACTIVE CORROSION HAS OCCURED THAT WOULD INHIBIT BONDING, SANDBLAST STEEL TO WHITE METAL FINISH.

5. AFTER REMOVALS AND EDGE PREPARATIONS ARE COMPLETE, REMOVE BOND INHIBITING MATERIALS (DIRT, GREASE, LOOSELY BONDED AGGREGATE) BY ABRASION BLASTING OR HIGH PRESSURE WATER BLASTING WITH WATER THAT CONTAINS NO DETERGENTS OR BOND INHIBITING CHEMICALS. CHECK THE CONCRETE SURFACES AFTER CLEANING TO INSURE THAT SURFACE IS FREE FROM ADDITIONAL LOOSE AGGREGATE OR THAT ADDITIONAL DELAMINATIONS ARE NOT PRESENT.

6. WET CONCRETE REPAIR AREA SO THAT SUBSTRATE IS SATURATED SURFACE DRY WITH NO STANDING WATER.

7. APPLY BONDING COMPOUND TO EXISTING CONCRETE AND REINFORCING STEEL PRIOR TO PLACEMENT OF 4000 PSI, ⅜ IN., 660 CEMENT CONCRETE REPAIR MATERIAL.

8. PLACE APPROPRIATE REPAIR MATERIAL FOR SPECIFIC REPAIR TYPE. PLACEMENT AND SUBSEQUENT CURING SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND THE SPECIAL PROVISIONS.

MASS HIGHWAY	CONCRETE PIER & ABUTMENTS REPAIRS CONSTRUCTION NOTES	CPR-1

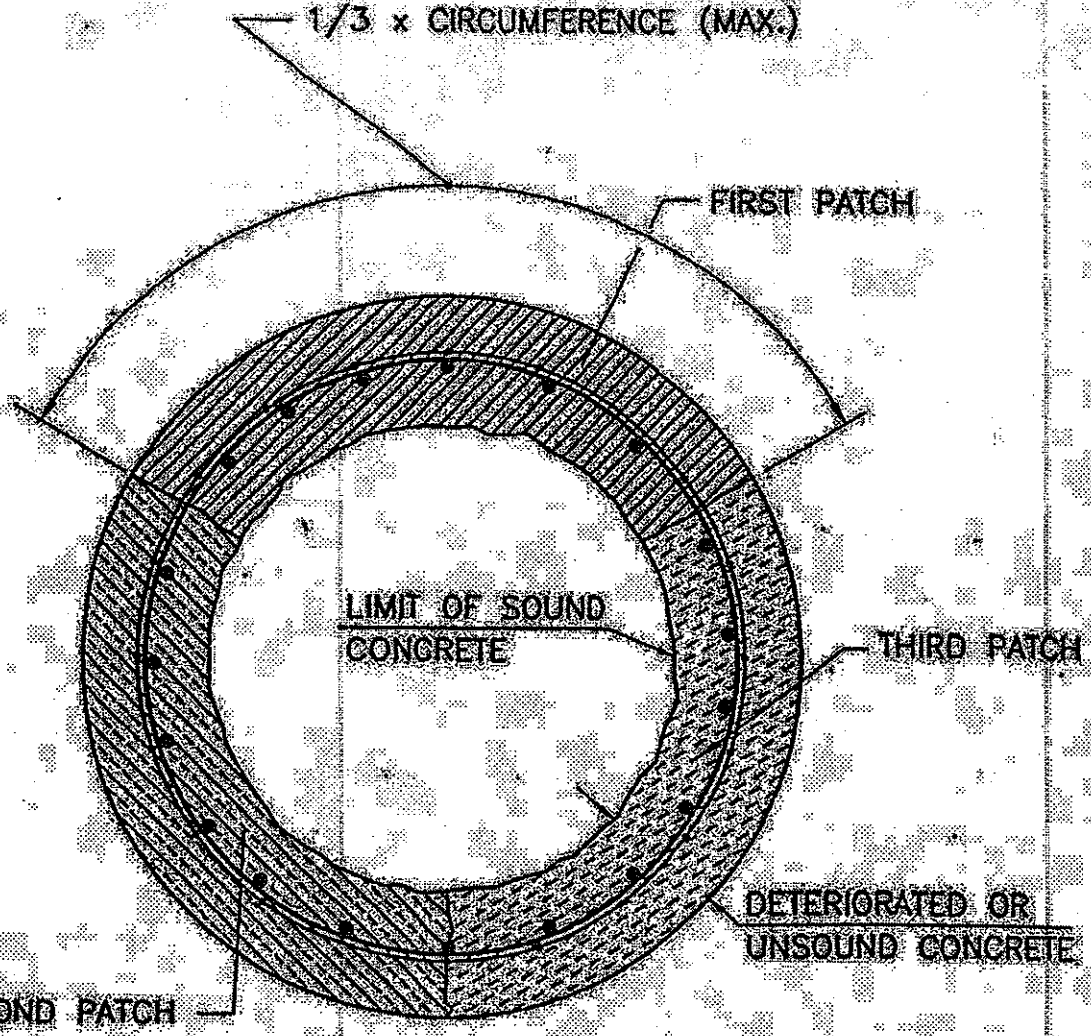
SEQUENCE OF CONSTRUCTION FOR COLUMN REPAIRS WITHOUT TEMPORARY PIER SUPPORTS

1. REMOVE CONCRETE FROM FIRST PATCH AREA TO BE PATCHED ONLY, SEE ROUND COLUMN SECTION DETAIL CPR-3.
2. CLEAN EXISTING REINFORCING STEEL AND CONCRETE (NEWLY EXPOSED). MISSING OR DETERIORATED REINFORCING STEEL SHALL BE REPLACED, AS DIRECTED BY THE ENGINEER (SEE CONCRETE REPAIR NOTES).
3. APPLY EPOXY BONDING COMPOUND TO ALL EXISTING REINFORCING STEEL AND CONCRETE (NEWLY EXPOSED) IMMEDIATELY PRIOR TO PLACING CONCRETE.
4. FORM AND PATCH SURFACE.
5. A MINIMUM OF 72 HOURS SHALL ELAPSE BETWEEN PLACING OF CONCRETE AND START OF NEXT PATCH.
6. REMOVE CONCRETE FROM SECOND PATCH AREA.
7. REPEAT STEPS 2 THRU 5.
8. REPAIR REMAINING SIDES IN A SIMILAR MANNER.
9. ALL WELDED WIRE FABRIC SHALL BE EPOXY COATED.
10. ALL CONCRETE SHALL BE 4000 PSI-$\frac{3}{8}$ IN.-660 CEMENT CONCRETE.
11. ALL SURFACES SHALL BE RUBBED TO PRODUCE A SMOOTH FINISH.
12. THE CONTRACTOR MAY SUBMIT AN ALTERNATE PIER COLUMN REPAIR PROCEDURE, SUBJECT TO APPROVAL BY THE ENGINEER, WHEN TEMPORARY PIER SUPPORTS ARE UTILIZED DURING REPAIRS.

PIER CAP REPAIR NOTES

1. THE CONTRACTOR SHALL PHASE PIER CAP REPAIRS SUCH THAT NO MORE THAN 50% OF ANY TWO FACES OF THE PIER CAP SHALL BE REPAIRED AT ANY ONE TIME. THE CONTRACTOR SHALL PROVIDE A SHORING SYSTEM TO SUPPORT THE CAP DEAD LOAD AND LIVE LOADS IF MORE THAN 50% OF ANY TWO FACES ARE TO BE REPAIRED AT ANY ONE TIME OR IF SO DIRECTED BY THE ENGINEER.

MASS HIGHWAY	CONCRETE PIER REPAIRS CONSTRUCTION NOTES	CPR-2



ROUND COLUMN SECTION

SEE "CONCRETE REPAIR NOTES" SHEET FOR
- SURFACE PREPARATION FOR CONCRETE REPAIRS : CPR-1
- SEQUENCE OF CONSTRUCTION FOR DEEP PATCH COLUMN REPAIRS : CPR-2

MASS HIGHWAY

CONCRETE PIER REPAIRS

SEQUENCE OF CONSTRUCTION

CPR-3

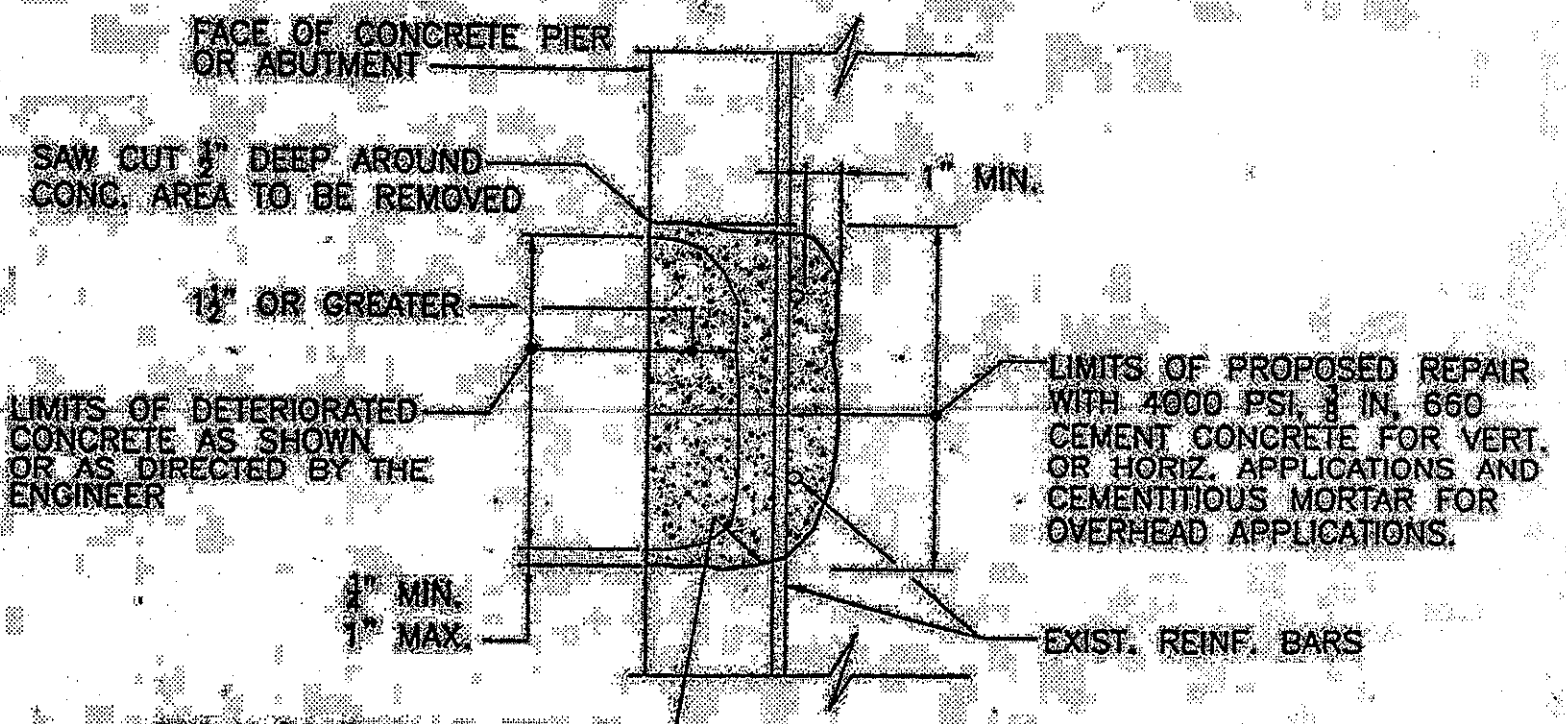
MASS HIGHWAY

CONCRETE PIER & ABUTMENT REPAIR DETAILS

PARTIAL DEPTH REPAIR

CPR-4

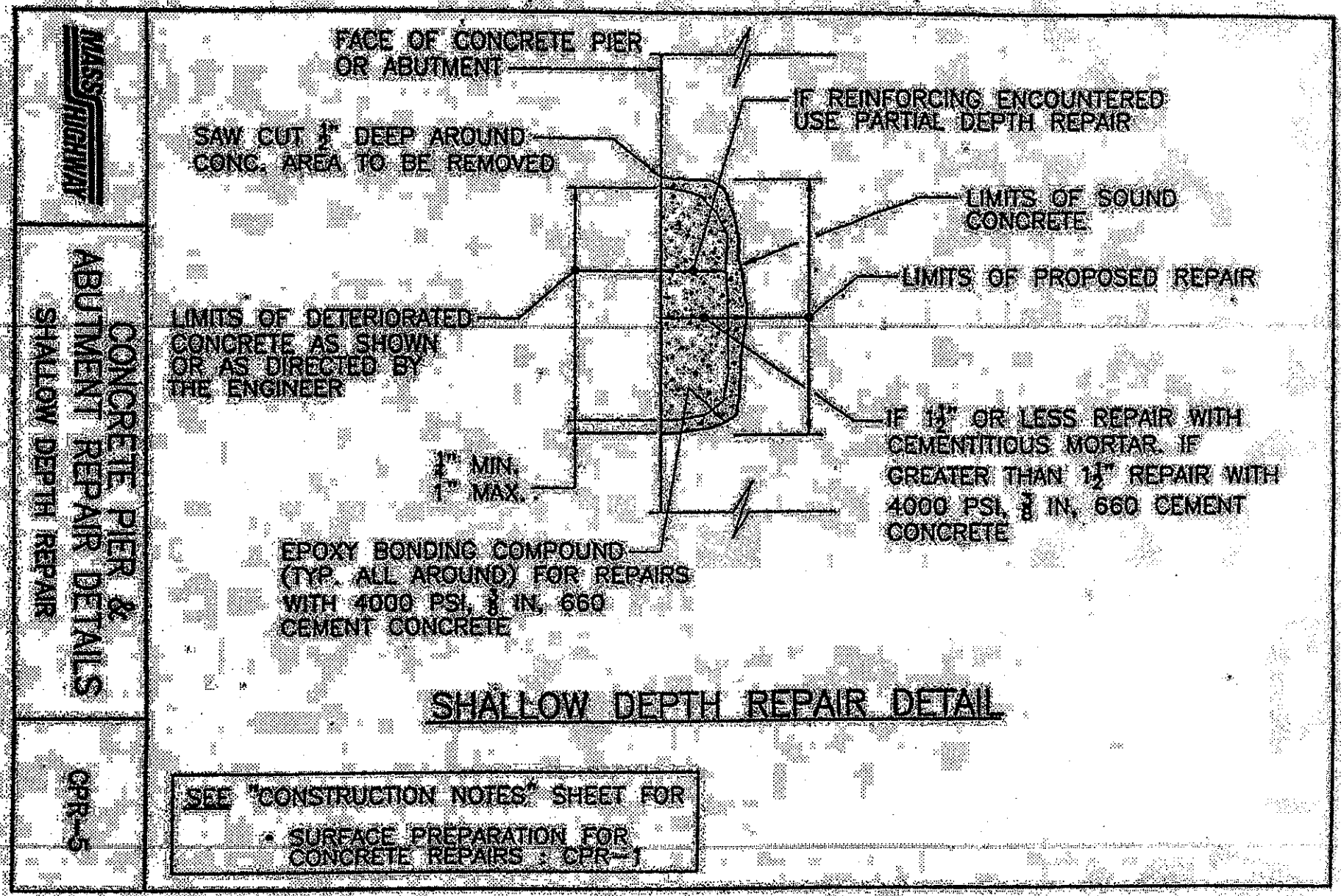
A00802 - 5

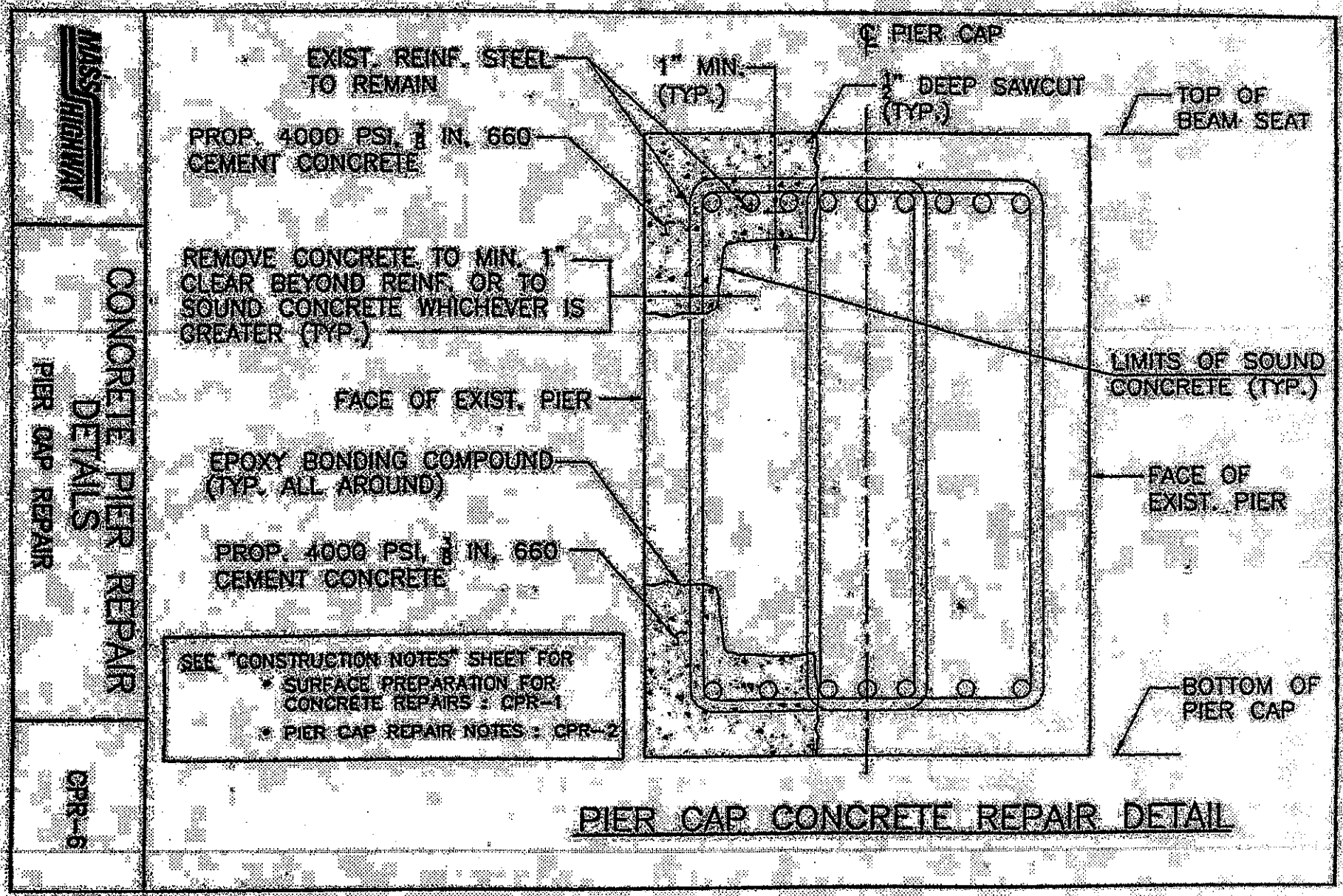


PARTIAL DEPTH REPAIRS

SEE "CONSTRUCTION NOTES" SHEET FOR

- SURFACE PREPARATION FOR CONCRETE REPAIRS : CPR-1


FACE OF CONCRETE PIER OR ABUTMENT
IF REINFORCING ENCOUNTERED USE PARTIAL DEPTH REPAIR
SAW CUT ½" DEEP AROUND CONC. AREA TO BE REMOVED
LIMITS OF SOUND CONCRETE
LIMITS OF PROPOSED REPAIR
LIMITS OF DETERIORATED CONCRETE AS SHOWN OR AS DIRECTED BY THE ENGINEER
IF 1½" OR LESS REPAIR WITH CEMENTITIOUS MORTAR. IF GREATER THAN 1½" REPAIR WITH 4000 PSI, ⅜ IN, 660 CEMENT CONCRETE
¼" MIN. 1" MAX.
EPOXY BONDING COMPOUND (TYP. ALL AROUND) FOR REPAIRS WITH 4000 PSI, ⅜ IN, 660 CEMENT CONCRETE
SHALLOW DEPTH REPAIR DETAIL
SEE "CONSTRUCTION NOTES" SHEET FOR
• SURFACE PREPARATION FOR CONCRETE REPAIRS : CPR-1
MASS HIGHWAY
CONCRETE PIER & ABUTMENT REPAIR DETAILS
SHALLOW DEPTH REPAIR
CPR-5
A00802-6

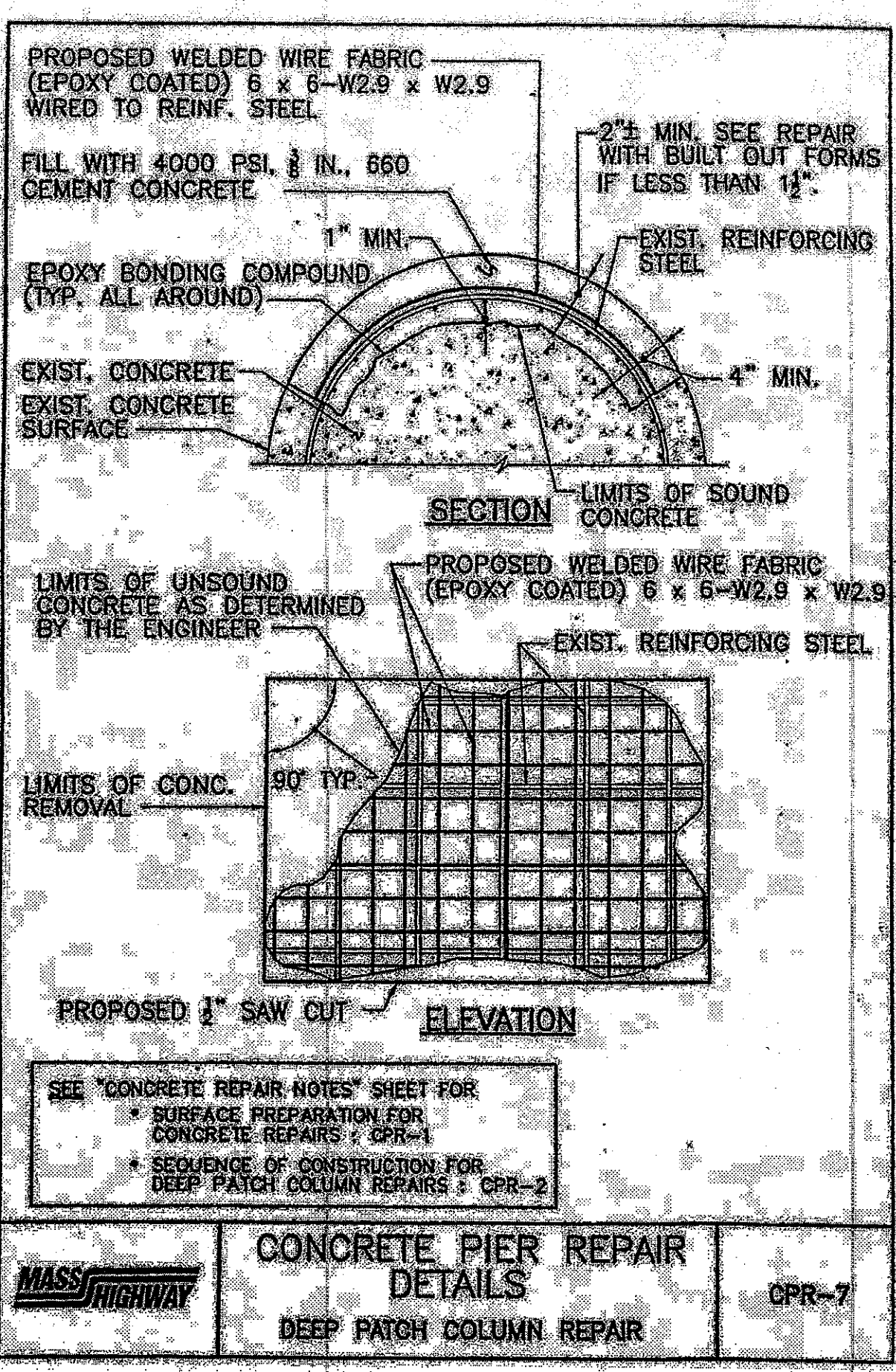


CONCRETE PIER REPAIR DETAILS

PIER CAP REPAIR

CPR-3

A00802 - 7


PROPOSED WELDED WIRE FABRIC (EPOXY COATED) 6 x 6-W2.9 x W2.9 WIRED TO REINF. STEEL
FILL WITH 4000 PSI, ⅜ IN., 660 CEMENT CONCRETE
2"± MIN. SEE REPAIR WITH BUILT OUT FORMS IF LESS THAN 1½".
1" MIN.
EXIST. REINFORCING STEEL
EPOXY BONDING COMPOUND (TYP. ALL AROUND)
EXIST. CONCRETE
EXIST. CONCRETE SURFACE
4" MIN.
LIMITS OF SOUND CONCRETE
SECTION
LIMITS OF UNSOUND CONCRETE AS DETERMINED BY THE ENGINEER
PROPOSED WELDED WIRE FABRIC (EPOXY COATED) 6 x 6-W2.9 x W2.9
EXIST. REINFORCING STEEL
LIMITS OF CONC. REMOVAL
90° TYP.
PROPOSED ½" SAW CUT
ELEVATION
SEE "CONCRETE REPAIR NOTES" SHEET FOR
• SURFACE PREPARATION FOR CONCRETE REPAIRS : CPR-1
• SEQUENCE OF CONSTRUCTION FOR DEEP PATCH COLUMN REPAIRS : CPR-2
MASS HIGHWAY
CONCRETE PIER REPAIR DETAILS
DEEP PATCH COLUMN REPAIR
CPR-7

SURFACE PREPARATION FOR CONCRETE REPAIRS

1. EXTENT, LOCATION, AND REPAIR TYPE OF ALL CONCRETE REPAIRS TO BE FIELD VERIFIED AND APPROVED BY THE ENGINEER AFTER CONTRACTOR HAS SOUNDED AND MARKED OUT ALL REPAIR AREAS. REPAIR CONFIGURATIONS SHOULD BE KEPT AS SIMPLE AS POSSIBLE, PREFERABLY WITH SQUARE CORNERS.

2. SAW CUT ALONG NEAT LINES AROUND REPAIR AREA PRIOR TO CONCRETE EXCAVATION. USE SAW CUT DEPTH OF $\frac{1}{2}$" OR LESS AS REQUIRED TO AVOID CUTTING REINFORCING STEEL (REFER TO SPECIAL PROVISIONS)

3. REMOVE DETERIORATED AND DELAMINATED CONCRETE, UNDERCUT EXPOSED REINFORCING STEEL TO PROVIDE MINIMUM CLEARANCE AROUND BARS. REMOVE ADDITIONAL CONCRETE AS REQUIRED TO PROVIDE MINIMUM REQUIRED THICKNESS OF REPAIR MATERIAL.

4. IF REINFORCING STEEL IS EXPOSED THEN CLEAN BY MECHANICAL CLEANING AND THEN HIGH PRESSURE WASHING WITH WATER THAT CONTAINS NO DETERGENTS OR BOND INHIBITING CHEMICALS. WHERE ACTIVE CORROSION HAS OCCURED THAT WOULD INHIBIT BONDING, SANDBLAST STEEL TO WHITE METAL FINISH.

5. AFTER REMOVALS AND EDGE PREPARATIONS ARE COMPLETE, REMOVE BOND INHIBITING MATERIALS (DIRT, GREASE, LOOSELY BONDED AGGREGATE) BY ABRASION BLASTING OR HIGH PRESSURE WATER BLASTING WITH WATER THAT CONTAINS NO DETERGENTS OR BOND INHIBITING CHEMICALS. CHECK THE CONCRETE SURFACES AFTER CLEANING TO INSURE THAT SURFACE IS FREE FROM ADDITIONAL LOOSE AGGREGATE OR THAT ADDITIONAL DELAMINATIONS ARE NOT PRESENT.

6. WET CONCRETE REPAIR AREA SO THAT SUBSTRATE IS SATURATED SURFACE DRY WITH NO STANDING WATER.

7. APPLY BONDING COMPOUND TO EXISTING CONCRETE AND REINFORCING STEEL PRIOR TO PLACEMENT OF 4000 PSI, $\frac{3}{8}$ IN., 660 CEMENT CONCRETE REPAIR MATERIAL.

8. PLACE APPROPRIATE REPAIR MATERIAL FOR SPECIFIC REPAIR TYPE. PLACEMENT AND SUBSEQUENT CURING SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND THE SPECIAL PROVISIONS.

MASS HIGHWAY	DECK SLAB REPAIRS CONSTRUCTION NOTES	DSR-1

CONCRETE DECK REPAIR NOTES

1. SHALLOW DEPTH REPAIR SHALL BE USED IN AREAS IF SOUND CONCRETE IS REACHED LESS THAN 1½" IN DEPTH FROM THE TOP OF THE DECK SLAB AND/OR REINFORCING STEEL IS NOT ENCOUNTERED. REMOVE SOUND CONCRETE TO OBTAIN MINIMUM REPAIR DEPTH OF ¾" IN REPAIR AREA.

2. PARTIAL DEPTH REPAIR SHALL BE USED IN AREAS IF SOUND CONCRETE IS REACHED MORE THAN 1½" IN DEPTH FROM THE TOP OF THE DECK SLAB AND/OR REINFORCING STEEL IS ENCOUNTERED. DETERIORATED CONCRETE SHALL BE REMOVED TO A MINIMUM DEPTH OF 1" BELOW THE BOTTOM OF THE TOP LAYER OF EXISTING REINFORCING STEEL OR UP TO A MAXIMUM OF 50% OF THE THICKNESS OT THE CONCRETE DECK.

3. FULL DEPTH REPAIR SHALL BE USED IN AREAS IF SOUND CONCRETE IS NOT REACHED UNTIL A DEPTH EQUAL TO OR GREATER THAN ONE-HALF (½) THE THICKNESS OF THE DECK SLAB.

4. PARTIAL DEPTH OVERHEAD REPAIR - DETERIORATED CONCRETE SHALL BE REMOVED FROM THE UNDERSIDE OF DECK TO A MINIMUM DEPTH OF 1" ABOVE THE TOP OF THE BOTTOM LAYER OF EXISTING DECK REINFORCING STEEL. IF SOUND CONCRETE IS NOT REACHED UNTIL A DEPTH EQUAL TO 50% OF THE SLAB THICKNESS THEN THE CONTRACTOR SHALL REMOVE THE REMAINING DEPTH OF CONCRETE ABOVE AND REPAIR AS A FULL DEPTH REPAIR.

5. A NEW REINFORCEMENT BAR (EPOXY COATED) SHALL BE PLACED TO SUPPLEMENT AN EXISTING REINFORCEMENT BAR WHEN AN EXISTING BAR HAS A SECTION LOSS OF 25% OR MORE OF THE ORIGINAL CROSS SECTION, AS DETERMINED BY THE ENGINEER, OR THE EXISTING REINFORCEMENT IS BROKEN. A NEW REINFORCEMENT BAR (EPOXY COATED) SHALL EXTEND 32 BAR DIAMETERS PAST LOCATIONS WHERE THE EXISTING REINFORCEMENT BAR HAS A SECTION LOSS OF 25% OR MORE, OR THE EXISTING REINFORCEMENT BAR IS BROKEN. IN LIEU OF SUPPLEMENTING A BAR ADJACENT TO A DETERIORATED BAR, THE CONTRACTOR MAY CUT OUT THE DETERIORATED BAR AND MECHANICALLY SPLICE THE NEW BAR TO EXISTING REINFORCEMENT.

FOR CONTINUATION OF NOTES SEE DSR-3.

MASS HIGHWAY	DECK SLAB REPAIRS CONSTRUCTION NOTES	DSR-2

CONCRETE DECK REPAIR NOTES (CONTINUED)

6. THE TOP DECK SURFACE OF THE CONCRETE FOR ALL REPAIRS SHALL BE EVEN WITH THE ADJACENT EXISTING DECK SLAB AND SHALL MAINTAIN THE EXISTING GRADES AND CROSS SLOPES.

7. UPON APPROVAL OF THE ENGINEER, MODIFY THE LIMITS OF CONCRETE REMOVAL AS SHOWN IN THE LIMITS OF REPAIR AREA (PLAN VIEW) WHEN SUPPLEMENTARY REINFORCEMENT BARS ARE REQUIRED.

8. DECK REINFORCEMENT BAR DETAILS SHOWN ARE GENERAL. ACTUAL REINFORCEMENT BAR SPACINGS AND LOCATIONS WILL VARY FROM LOCATION TO LOCATION.

9. THE NEW REINFORCEMENT BAR SHALL BE PLACED AT THE SAME LEVEL ALONG THE EXISTING DETERIORATED OR BROKEN REINFORCEMENT BAR.