

509-R-722 PCCP JOINT REPAIR

(Adopted 12-17-20)

The Standard Specifications are revised as follows:

SECTION 509, BEGIN LINE 1, INSERT AS FOLLOWS:

SECTION 509 - PORTLAND CEMENT CONCRETE PAVEMENT, PCCP, JOINT REPAIR

509.01 Description

This work shall consist of partial depth repairs and bottom-half of slab repairs at PCCP joints in accordance with 105.03.

MATERIALS

509.02 Materials

Materials shall be in accordance with the following:

| | |
|---|-------------------|
| <i>Admixtures for Use in Concrete.....</i> | <i>912.03</i> |
| <i>Chemical Anchor System.....</i> | <i>901.05</i> |
| <i>Coarse Aggregate, Class A, Size No. 12*.....</i> | <i>904</i> |
| <i>Curing Materials.....</i> | <i>912.01(e)2</i> |
| <i>Epoxy Coated Reinforcing Bars.....</i> | <i>910.01(b)9</i> |
| <i>Fine Aggregate, Size No. 23.....</i> | <i>904</i> |
| <i>Joint Filler.....</i> | <i>906.01</i> |
| <i>Joint Sealant, Hot Poured.....</i> | <i>906.02(a)2</i> |
| <i>Latex Modifiers.....</i> | <i>912.04</i> |
| <i>Portland Cement.....</i> | <i>901.01(b)</i> |
| <i>Rapid Hardening Hydraulic Cement.....</i> | <i>901.01(d)</i> |
| <i>Rapid Setting Patch Materials**.....</i> | <i>901.07</i> |
| <i>Water.....</i> | <i>913.01</i> |

** Crushed stone only*

*** The material may be extended with a coarse aggregate that is approved by the manufacturer and the Engineer.*

Organic retarders, including food grade citric acid, may be used in concrete containing rapid hardening hydraulic cement.

Prepackaged concrete patching material shall be identified as grade 3U18 or 3U58 and selected from the Department's list of Concrete for PCCP Joint Repair.

509.03 Concrete Mix Design

A concrete mix design, CMD, for the partial depth joint repair and bottom-half joint repair shall be identified as being one of the following types and shall be in accordance with 509.04.

- (a) Prepackaged concrete patching material, CPM*
- (b) Ordinary portland cement-based concrete, OPCC*
- (c) Rapid hardening cement-based concrete, RHCC*

- (d) *Latex modified concrete, LMC*
- (e) *Latex modified concrete, very early strength, LMC-VE*
- (f) *Rapid setting patch materials, RSP.*

A concrete mix design submittal, CMDS, for OPCC, RHCC, LMC, and LMC-VE shall be submitted in accordance with 506.03, except that the trial batch shall be in accordance with 509.05. Prepackaged concrete patching materials, CPM and RSP, are not required to follow the submittal format of a CMDS, however, the Department shall be notified of their intended use. The CMDS, or notification of using CPM or RSP, shall be submitted a minimum of seven calendar days prior to the trial batch.

509.04 Concrete Mix Criteria

The fine aggregate for OPCC, RHCC, LMC, or LMC-VE shall be at least 48% but not more than 52% of the total volume of the aggregate in each unit volume of concrete. Proportions shall be based on aggregates in the bulk SSD condition.

The blend of coarse and fine aggregates for OPCC, RHCC, LMC, or LMC-VE shall meet the requirements stated in the table below. Aggregate volumes within the repair concrete will be determined based on the bulk SSD properties for each aggregate:

| <i>Combined Gradation of Coarse and Fine Aggregates</i> | |
|---|------------------------|
| <i>Sieve Size</i> | <i>Percent Passing</i> |
| <i>3/8 in. (9.5 mm)</i> | <i>98 - 100</i> |
| <i>No. 4 (4.75 mm)</i> | <i>77 - 93</i> |
| <i>No. 8 (2.36 mm)</i> | <i>40 - 80</i> |
| <i>No. 16 (1.18 mm)</i> | <i>25 - 50</i> |
| <i>No. 30 (600 μm)</i> | <i>15 - 35</i> |
| <i>No. 50 (300 μm)</i> | <i>0 - 18</i> |
| <i>No. 100 (150 μm)</i> | <i>0 - 8</i> |
| <i>No. 200 (75 μm)</i> | <i>0 - 2.3</i> |

(a) CPM or OPCC

CPM or OPCC shall produce workable mixtures, with the minimum amount of water, having the following properties:

| | |
|---|--|
| <i>Portland cement content.....</i> | <i>846 lb/cu yd</i> |
| <i>Maximum slump for OPCC and CPM 3U18.....</i> | <i>1.5 in.^A</i> |
| <i>Maximum slump for CPM 3U58.....</i> | <i>6 in.^A</i> |
| <i>Maximum water/cementitious ratio.....</i> | <i>0.400^B</i> |
| <i>Air content</i> | <i>7.0% ±1.5%</i> |
| <i>Minimum modulus of rupture</i> | <i>500 psi at 7 days^C</i> |
| <i>Minimum compressive strength</i> | <i>3,200 psi at 7 days^D</i> |
| <i>Maximum shrinkage in air.....</i> | <i>0.060% at 28 days^D</i> |
| <i>Relative yield for OPCC.....</i> | <i>1.00 ±0.02</i> |

^A *Measured five minutes after discharge from the mixer.*

^B *The target water cement ratio shall be established at the time of the trial batch and shall be based on the slump requirement.*

- ^C Concrete beams and cylinders cast for the purpose of evaluating the mix criteria shall be cured in accordance with AASHTO T 23 Section 10.1, Standard Cure conditions.
- ^D The maximum allowable shrinkage will only apply if the Contractor requests to omit tooling as part of re-establishing the longitudinal joint prior to sawing. Testing shall be in accordance with ASTM C157 and conducted on specimens cast using the same materials stated in the CMDS. Approval will be based on a Type A certification in accordance with 916 which shall be submitted to the Department’s Concrete Engineer.

Air entraining admixtures may be used. No other chemical admixtures shall be used.

(b) RHCC, LMC, or LMC-VE

RHCC, LMC, or LMC-VE shall be proportioned to meet the following requirements and properties:

| | |
|--|--------------------------------|
| Portland cement content for LMC | 658 lb/cu yd, minimum |
| Rapid hardening cement content | |
| for RHCC or LMC-VE..... | 658 lb/cu yd, minimum |
| Maximum allowable water/cementitious ratio | |
| for LMC | 0.400 ^A |
| Maximum allowable water/cementitious ratio | |
| for LMC-VE | 0.440 ^A |
| Maximum allowable water/cementitious ratio | |
| for RHCC..... | 0.450 ^B |
| Slump..... | 3 to 7 in. ^C |
| Air content for RHCC..... | 6.5% ±1.5% ^D |
| Air content for LMC and LMC-VE..... | 0.0% - 6.0% |
| Minimum modulus of rupture | 500 psi ^E |
| Minimum compressive strength | 3,200 psi ^E |
| Maximum shrinkage in air..... | 0.060% at 28 days ^F |

- ^A Including the water in the latex.
- ^B During production of RHCC, the water cement ratio shall be maintained within ±0.020 of the target stated on the CMDP, not to exceed 0.450.
- ^C Measured four to five minutes after discharge from the mixer.
- ^D If the RHCC has a permeability of 900 coulombs or less at 56 days, the acceptable range of air content is allowed to be the same as LMC and LMC-VE. Verification of this property will be determined from testing of specimens cast at the trial batch. Testing will be done per AASHTO T277, with the value determined by averaging the result of two specimens.
- ^E Concrete beams and cylinders cast for the purpose of evaluating the mix criteria shall be cured in accordance with AASHTO T23 Section 10.1, Standard Cure conditions. RHCC and LMC-VE shall achieve the minimum modulus of rupture in 12 hours or less. LMC shall achieve the minimum modulus of rupture in 24 hours or less. RHCC, LMC and LMC-VE shall provide opening to traffic within the requirements for maintenance of traffic and lane closure restrictions.

^F *The maximum allowable shrinkage will only apply if the Contractor requests to omit tooling the longitudinal joint prior to sawing. Testing shall be in accordance with ASTM C157 and conducted on specimens cast from concrete at the trial batch. Approval will be based on a Type A certification in accordance with 916, which shall be submitted to the Department's Concrete Engineer.*

(c) RSP

Prepackaged RSP material may be extended with a coarse aggregate as recommended by the manufacturer. Water shall be added in an amount not to exceed the amount recommended by the manufacturer. The material shall meet the same requirements for slump, compressive strength, and shrinkage as stated in 509.04(b).

509.05 Quality Control Plan

A quality control plan, QCP, shall be in accordance with sections 1.1 through 4.7 of ITM 803, except that the Quality Control Technician shall be an ACI Certified Technician, Level I or higher. As a minimum, the QCP shall contain the following information concerning aspects of producing, placing, finishing, and curing the joint repair concrete for joint restoration:

- (a) Copies of all applicable AASHTO, ASTM, and ITM standards relevant to work being performed.*
- (b) Testing facility, if applicable, and a list of testing equipment meeting the requirements of Section 6.3.1 of ITM 803.*
- (c) Materials shall be identified as to their source, transportation, handling, and storage.*
- (d) Process control of aggregate when bulk aggregate is used. To include, but not limited to:

 - 1. Gradation testing for each aggregate and calculation of blended gradation for control within allowable tolerance.*
 - 2. Absorption values for each aggregate, how they were determined, and subsequently checked.*
 - 3. Daily measurement and control of moisture content of each aggregate used in the concrete.**
- (e) Trial batch demonstration shall be described as to procedures, location, mixing equipment, batching sequence, accuracy, and verification. The identification and intended use of each concrete mix.*
- (f) Batching of concrete during repair operations shall be described to include weighing on scales, intended size of the batch, batching method, sequence, and mixing time. The*

methods to monitor materials used and the record of each batch shall also be included.

- (g) *Process control of concrete to address sampling and testing for slump, relative yield, air content, water cementitious ratio, and temperature. The frequency of tests shall be the first batch of the day and not less than three times per day including the first. If volumetric batching of concrete is utilized, the yield will be checked as described in 722.05(a) at the beginning of the day and not less than two times per day including the first load from each mobile mixer. The QCP shall include details as to actions in response to test results.*
- (h) *Joint repair operations shall be described, to include the materials and equipment used for re-establishing longitudinal and transverse joints, delivery, placement, consolidation, finishing, smoothness, texturing, curing of concrete, and procedures for monitoring each operation.*
- (i) *Process control for weather restrictions shall be addressed, including what materials will be on-hand to protect the edges and surface of the repair area, and what corrective actions are proposed in case the joint repair concrete is damaged by rain.*
- (j) *Documentation and submittals.*

509.06 Trial Batch

A trial batch shall be produced and tested to verify that the repair concrete is in accordance with the appropriate concrete mix criteria for CPM, OPCC, RHCC, LMC, LMC-VE, or RSP material. The trial batch shall be conducted prior to production. The equipment used for mixing concrete at the trial batch shall be the same as what is identified in the QCP for use during field production. The modulus of rupture from flexural strength testing and compressive strength will be determined by averaging a minimum of two tested specimens for each age. The beams and cylinders shall be cured in accordance with AASHTO T 23 Section 10.1, Standard Cure conditions. Only the specimen types intended for job control in accordance with 509.14 and determining opening to traffic strength in accordance with 509.17 are required to be included in the trial batch. The Engineer will test the concrete for the plastic and hardened concrete properties as follows using the property values listed in 509.04.

| | <i>CPM</i> | <i>OPCC</i> | <i>LMC</i> | <i>RHCC, LMC-VE</i> | <i>RSP</i> |
|-----------------------------|---------------------|---------------------|---------------------|-------------------------|-------------------|
| <i>Compressive strength</i> | <i>12, 36, 72 h</i> | <i>12, 36, 72 h</i> | <i>12, 24, 48 h</i> | <i>3, 6, 12, 24 h</i> | <i>3, 6, 12 h</i> |
| <i>Modulus of rupture</i> | <i>12, 36, 72 h</i> | <i>12, 36, 72 h</i> | <i>12, 24, 48 h</i> | <i>3, 6, 12, 24 h</i> | <i>3, 6, 12 h</i> |

| | | | | | |
|--|-----------------------------------|---|---|---------------------------------------|--------------|
| <i>Plastic testing</i> | <i>air, slump, W/C ratio*</i> | <i>relative yield, air, slump, W/C ratio*</i> | <i>relative yield, air, slump</i> | <i>relative yield, air, slump</i> | <i>slump</i> |
| <i>*The W/C ratio will be calculated after mix has been tested for slump</i> | | | | | |

The Engineer will provide the Contractor the results of the tests. Relative yield will be measured in accordance with 722.05(a) for repair concrete produced in a volumetric mixer. Mobile mixers will be calibrated in accordance with 722.13.

The trial batch shall be of a sufficient quantity to allow the Engineer to perform all required tests from the same batch. Trial batch concrete shall not be used for more than one test.

CONSTRUCTION REQUIREMENTS

509.07 Pre-Work Meeting Requirements

A pre-work meeting between the Engineer and the Contractor will be held on-site prior to beginning the work. The Contractor shall be prepared to discuss the following:

- (a) Work schedule*
- (b) Traffic control plan*
- (c) Equipment calibration and adjustments*
- (d) Inspection and evaluation of the condition and adequacy of equipment, including units for transport of materials*
- (e) CMDP*
- (f) The Contractor's daily rate of production per work crew*
- (g) QCP.*

509.08 PCCP Removal

PCCP removal areas for partial depth repairs will be determined by sounding and will be marked. The Contractor shall remove all concrete to the limits shown on the plans or as directed by the Engineer. A machine configured to safely and consistently mill the necessary profile as detailed on the plans shall be provided. The teeth on the milling head shall be spaced at either 1/2 in. or 5/8 in. The milling machine shall be subject to approval by the Engineer prior to the start of milling operations. Whenever possible, the rotating axis of the milling head shall operate perpendicular to the joint being repaired. Should PCCP removal be confined to one side of a joint, the milling machine shall be controlled so as to not cause damage to the adjacent pavement.

Unless otherwise approved by the Engineer, areas that are less than 1 sq ft shall be removed by saw cutting and chipping. The saw cutting shall be to a depth of 2 in. within the marked area. Overlapping saw cuts at the outer perimeter of the repair shall not extend more than 2 in. beyond the intersection. Removal of the concrete within the limits of the saw cuts shall be by hand chipping tools or handheld mechanically driven equipment. Mechanical hammers may be used to remove the concrete inside the area delineated by the saw cuts, but shall not be heavier than a nominal 35 lb. class. Mechanically driven tools shall be operated at a maximum angle of 45° from the PCCP surface. A jack hammer with

a wide chisel bit shall be used at a distance of 2 in. from the saw cut to remove the vertical edge and create a taper similar to the milling operations.

Removal areas within jointed reinforced concrete pavement, JRCP, are not required to utilize milling to initiate partial depth repairs. Saw cutting and hand chipping may be used as described above. Any wire mesh reinforcement exposed during the removal operations shall be removed.

PCCP removal areas shall not remain open overnight unless otherwise approved by the Engineer. Shoulders or adjacent PCCP damaged during the removal operations shall be repaired as directed.

Milling, or sawing and hand chipping, is allowed for transverse joint repairs that intersect a longitudinal joint that has already undergone partial depth joint repair. Removal areas along a longitudinal joint shall not disturb a transverse joint that has already undergone partial joint repair in accordance with this specification. Prior to any transverse joint repair that intersects a previous longitudinal repair, the existing partial depth repair along the longitudinal joint shall have achieved at least 12 h of curing, a passing soundness inspection, and adequate strength, as defined in 509.17. If there is no need for the transverse joint repair to completely cross the longitudinal joint, milling operations along the transverse joint shall stop short of the longitudinal joint so as not to cause damage beyond the longitudinal joint. Sawing and hand chipping shall be used to complete the removal process up to the longitudinal joint.

Longitudinal joint repairs shall be terminated 12 in. or more from a transverse joint.

The Engineer will check milled surfaces after PCCP removal to identify any unsound concrete that remains. Limits of the removal area will be identified by sounding with a rock hammer. Areas of unsound concrete will be marked and shall be removed with a chipping hammer. Removal of unsound concrete below the elevation of the tops of dowel bars or tie bars is not intended and unsound concrete shall remain in place in these areas. For transverse joints, any voids or significant surface irregularities resulting from the hand chipping operations that extend below the elevation of the top of the dowel bars shall be filled using hand placed clean sand to make a uniform, level, bedding material to support the joint filler. For longitudinal joints, void space below the elevation of the top of tie bars shall be filled with repair concrete.

Dowel bars shall not be damaged during the removal of unsound concrete. At locations where a transverse joint meets the edge of pavement, or where joints intersect, the Engineer will determine if the concrete is deteriorated for the entire depth, within the limits detailed on the plans for bottom-half joint repair. If either end of a dowel bar is exposed or misaligned in a bottom-half joint repair, the exposed portion shall be removed or cut flush with the concrete surface, as directed by the Engineer.

If the combination of removal for partial depth joint repair and bottom-half joint repair exposes more than two adjacent dowels at a contraction joint, the Engineer shall be notified to determine if full depth patching is to be conducted in accordance with 506.07(b).

If a snowplowable raised pavement marker is to be installed in an area of partial depth joint repair, the width of the removal area, in proximity to where the RPM is to be installed, may be increased in order to provide the necessary clearances as specified in 509.16.

509.09 Surface Preparation and Joint Filler Installation

The milled or hand chipped cavities shall be prepared to provide a clean, irregular surface for the development of a good bond between the joint repair concrete and the existing pavement. Broken concrete pieces shall be removed and the cavities shall be swept clean. The surface of the cavity shall be thoroughly sandblasted and cleaned with compressed air to remove all dust and chips. Cleaning with compressed air shall be performed as close to placing the concrete as possible, but not after installing any joint filler. If joint filler material has been installed, the surface may be cleaned again by using compressed air at low pressure so as to not damage the in-place filler or sand below the top of any exposed dowel bar just prior to placing the grout or concrete. The air lines for sandblasting and compressed air cleaning shall be equipped with oil traps to prevent contamination of the surfaces.

(a) Joint Filler - General Requirements

The installation of joint filler is required before concrete placement and shall be of a width that matches the existing transverse or longitudinal joint being repaired or a minimum width of 3/8 in, whichever is greater. The joint filler shall extend at least 3 in. beyond the length of the patch area. Joint filler shall be installed as one piece for the depth of the repair. Splicing long lengths of joint filler may be allowed. The method of splicing shall be subject to approval by the Engineer.

(b) Joint Filler at Transverse Joints and Bottom Half Repairs

Use of joint filler is required for establishing compression relief at all existing transverse D-1 contraction joints and along both the longitudinal and transverse joint sides of a bottom-half repair. The joint filler shall not only re-establish the joint within the repair but shall also prevent the infiltration of the concrete into and across the crack or joint. Prior to placement of the joint filler at a transverse contraction joint, the joint shall be tooled or widened sufficiently at the bottom of the repair to create a slot so that the joint filler can be inserted a minimum of 1/4 in. below the bottom of the repair concrete. The base of the slot shall not extend below the elevation of the top of any exposed dowel bar. Joint filler shall be cut or trimmed to match the irregularities of the concrete at the bottom of the slot. Duct tape shall be placed as a bond breaker on exposed dowel bars. Any void space that exists below the top of exposed dowels shall be filled with clean No. 23 natural sand that is sufficiently dry to flow into the gap.

(c) Longitudinal Joints

Joint repairs at longitudinal joints shall utilize either a joint filler to re-establish the joint or perform both of the following:

- 1. Tool the plastic repair concrete after placement to create a weak plane at the original joint location. The joint tooling equipment shall be identified in the QCP and approved by the Engineer*

prior to use. Tooling of the joint may be eliminated if the concrete used in the patch has been verified by the Engineer as meeting the shrinkage requirements stated in 509.04.

2. *Saw the joint after the repair concrete has adequately hardened. Sawing of the tooled joint shall be performed with a 1/4 in. blade. Sawing shall be done with care as soon as possible without causing excessive raveling of the repair material. The depth of the saw cut shall extend below the full depth of the repair by at least 1/4 in., but no closer than 1 in. above the tie bar. If it is determined that a crack forms at the bottom of the tooled joint before sawing can be performed without raveling, sawing to re-establish the joint shall not be performed.*

Areas designated by the Engineer as requiring bottom-half joint repair shall be prepared as shown on the plans. The reinforcing bars shall be installed in accordance with 503.03(g).

509.10 Concrete Mixing and Transportation

For onsite weighing and batching of OPCC or RHCC, the appropriate number of pre-packaged bags of cement, shall be at the mixing site to accommodate the day's production. The fine and coarse aggregate shall be pre-weighed to within 2% of their target for the batch size and placed in appropriate containers. Each aggregate component for a batch shall be identified as to material and weight, to facilitate accurate batching into the mixer in the proper sequence. Water, air entraining agent, and chemical admixtures, if appropriate, shall be at the mixing site. The water necessary to provide the required slump shall be measured by weight or volume and recorded for each batch. All components of cement, aggregates, water, air entraining agent, and any organic retarder shall be charged into a paddle type mixer according to the sequence defined in the QCP and mixed for a minimum of five minutes. The location of mixing shall be on the job site in close proximity to the joint repair operations.

Prepackaged concrete, CPM 3U18, and an air entraining admixture, may be used instead of batching individual components. Pre-packaged concrete, CPM 3U58, shall not be modified with admixtures.

A prepackaged RSP material containing coarse aggregate may be used. Addition of water and mixing shall be in accordance with the manufacturer's instructions.

Wash water shall not be used as a portion of the mixing water for any joint repair concrete.

LMC and LMC-VE shall be mixed in a mobile type volumetric mixer meeting the requirements of 722.09(a). The Engineer may also allow batching and mixing of OPCC or RHCC in a mobile-type volumetric mixer except the mixer shall carry sufficient quantities of unmixed ingredients to produce at least 2 cu yds and is not required to be self-propelled. Calibration of the mixer shall be in accordance with 722.13.

509.11 Weather Limitations

Joint repair concrete that has been placed shall be protected from rain. Materials described in the QCP for protection of the edges and surface of the repair area shall be readily available for use. Should any damage result, the Engineer will suspend operations until corrective action as described in the QCP is taken.

Joint repair concrete shall not be placed when either the ambient temperature or existing concrete pavement temperature is less than 50°F.

Temperature restrictions for chemical anchor systems used in anchoring deformed steel reinforcement for bottom half repairs shall be in accordance with the manufacturer's recommendations.

509.12 Placing and Finishing Concrete

CPM, OPCC, and RSP repair concrete shall be placed within 15 minutes of mixing. RHCC, LMC, and LMC-VE shall be placed within five minutes of mixing. All repair concrete shall be placed such that a cold joint does not occur within the limits of an individual, or intersecting, longitudinal or transverse joint repair. Placement may be isolated to one side of a joint if the joint face or joint filler is properly supported. Repair along a transverse joint that intersects a previously repaired longitudinal joint is allowed as described in 509.08.

For CPM and OPCC material, the cleaned surface shall be lightly sprayed with water to wet the surface without ponding and a bonding grout shall be applied to the prepared surface. The grout shall consist of two parts Type I or Type II portland cement and one part sand mixed with sufficient water to form a slurry that can be spread evenly onto the prepared concrete surface. The grout shall be mixed mechanically and applied by brushing or scrubbing, with a stiff bristle broom, onto the prepared and wetted concrete surface. The pot life of the grout shall not extend beyond 1 h. CPM or OPCC repair material shall be placed immediately after applying the bonding grout.

For RHCC, LMC, and LMC-VE, thoroughly soak the cleaned surface and maintain it in a wet condition for at least 2 h immediately prior to placing the repair concrete. Maintaining a wet surface shall be accomplished by covering the soaked surface with wet burlap. The burlap shall be re-wetted as necessary. A layer of white opaque polyethylene film, that is at least 4 mils thick, may be used to offset the need to rewet the burlap. Prior to placing the joint repair material, the burlap shall be removed. Any standing water in depressions, holes, or areas of concrete removal shall be blown out with compressed air or other type of blower sufficient for removal, or by the use of an approved vacuum system. The surface shall be damp at time of placing the repair concrete. Bonding grout shall not be used.

For RSP material, the cleaned surface shall be lightly sprayed with water to thoroughly wet the surface without ponding. RSP repair material shall be placed immediately after wetting the surface. Bonding grout shall not be used.

When using a bonding grout, if the material dries or whitens prior to placing the concrete joint repair material, the repair material shall not be placed. The dried grout shall be thoroughly removed by sandblasting and cleaning as specified in 509.09.

Concrete for partial depth joint repair shall be placed monolithically with concrete for bottom-half joint repair, using the same concrete mixture. Concrete shall be consolidated by internal vibration and struck off level to the adjacent PCCP. Joint filler shall remain straight for the length of the repair, within a tolerance of $\pm 1/4$ in. Concrete shall be hand finished and shall be controlled so that excess mortar and water is not worked into the surface. Final hand finishing shall have the trowels or floats work the surface from the joint toward the edge of the patch to avoid tearing the new concrete away from the existing pavement. Edging is required for fresh concrete adjacent to all joint filler or forms. Concrete repairs at transverse joints shall not protrude into an HMA shoulder by more than $3/8$ in. by forming or sawing the edges. The concrete surface of the partial depth joint repair shall be textured by brooming in the longitudinal direction of the repair. All repairs shall be broom textured regardless of subsequent surface treatments.

The final finished surface of the repair shall not vary more than $1/8$ in. from the existing pavement surface as measured with a straight edge over the joint. Partial depth patches that are not smooth shall be corrected by diamond grinding. Such grinding shall be completed after the concrete has gained sufficient strength for opening to traffic.

Immediately upon completion of finishing and texturing of the partial depth joint repair for all material types including CPM, OPCC, RHCC, LMC, LMC-VE, and RSP, grout shall be applied with a brush to the entire perimeter of the repair. Proportioning and mixing of the grout shall be the same as previously described in this section for bonding of CPM and OPCC material.

509.13 Curing

A resin-based liquid membrane forming compound in accordance with 912.01(e)2 shall be applied as soon as possible after the bleed water has dissipated. The compound shall be agitated in the shipping container to obtain a homogenous mixture for transfer to the job site application equipment. Application of curing compound shall be in accordance with the following:

- (a) Rate of application shall be at least one gallon per 200 sq ft of surface curing area.*
- (b) Curing compound shall be applied to provide a uniform, solid, white opaque coverage on all exposed concrete surfaces similar to a white sheet of paper.*
- (c) If the applied curing compound is damaged by rain or other means during the curing period, the damaged area shall be repaired as soon as possible by re-application at a rate equal to the original coat.*

- (d) *If the Engineer determines that the initial, or corrective re-application, results in unsatisfactory curing, the Engineer may prohibit the use of curing compound and instead require the use of wet double burlap or waterproof covers in accordance with 504.04.*

Whenever weather conditions exist that cause unusual or adverse placing and finishing conditions or equipment failures occur, the application of curing materials shall be expedited, or the mixing and placing operations shall be temporarily suspended as the conditions require.

When a deficiency is identified in the curing process, the joint repair shall be removed and replaced. If the repair is removed exposing an underlying bottom-half repair, the bottom-half repair shall also be removed and replaced.

509.14 Job Control

Control of concrete for slump, air content, or relative yield, as appropriate for the mix, and strength based on modulus of rupture obtained from flexural strength beams or compressive cylinders will be determined on the basis of tests performed by the Engineer in accordance with 505. The labor necessary for concrete sampling shall be furnished as required by the Engineer. Testing for slump, air content, and relative yield as appropriate for the mix, will be on the first batch of the day and a minimum of once per every 400 cu ft thereafter. Beams or cylinders will be made for evaluating the quality of the delivered mix at least once for every three days of production or whenever slump, relative yield, or air content are failing the upper limit. The beams or cylinders will be tested for compliance with strength requirements, at an age consistent with the mixtures intended use as defined in 509.04. Beams or cylinders for this purpose shall be cured in accordance with Section 10.1 of AASHTO T 23 and 505.01(a).

The Engineer will notify the Contractor when measurements for slump, unit weight, air content, or modulus of rupture are outside of the specified requirements. Rounding will be in accordance with 109.01(a).

509.15 Joint Sealing

Joint openings within a repair area shall be maintained for the full depth of the joint repair concrete as described in sections 509.09 and 509.12. Longitudinal and transverse joints shall be sawed to create a reservoir for the sealant, to be followed by cleaning and sealing. If the longitudinal joint was re-established by sawing in accordance with 509.09(c)2, additional sawing to create a reservoir for the sealant is not required. If the longitudinal joint was not sawed due to cracking in accordance with 509.09(c)2, the reservoir for the sealant shall be sawcut to a maximum depth of 7/8 in. The cleaning and sealing of the joint shall be in accordance with 507.04(a) and as follows. Transverse and longitudinal joints shall be sealed with hot pour joint sealant in accordance with the sealant manufacturer's recommendations. Joints shall be sealed with joint sealing materials within 1/4 in. below the surface and shall extend beyond the limits of the patch to any existing sealant that is to remain in place. A distributor in accordance with 409.03 shall be used with an indirect-heat, double boiler kettle and mechanical agitator. The hot poured joint sealant shall be placed utilizing a "V" shaped wand tip to allow the penetration of the material into the joints.

Any grinding to correct smoothness of partial depth patches shall be completed prior to joint sealing.

509.16 Snowplowable Raised Pavement Markers

Snowplowable raised pavement markers, RPM, shall be located and installed in accordance with 808.11, except that the marker shall be installed a minimum of 2 in. from the longitudinal joint. If the marker is installed within the limits of the partial depth patch, the slot shall be at least 2 in. from the edge of the repair. The repair material shall have attained a modulus of rupture of 500 psi or greater from flexural strength testing or 4,000 psi from compressive testing, prior to creating the slot for the adhesive and RPM. The slot may be created by grinding or by saw cutting and hand chipping. Each RPM installation will be inspected for proper installation. There shall be no visual cracks at the surface of the partial depth patch and the installation will be sounded to detect any loss of bond between the partial depth patch material and the substrate PCCP. Any such defect shall require repair of the partial depth patch and reinstallation of the RPM to the satisfaction of the Engineer, which may involve removal and replacement of the partial depth patch along the longitudinal joint between the limits of the transverse contraction joints. Any such repairs shall be made at no additional cost to the Department.

509.17 Opening to Traffic

Opening to traffic strength will be based on the modulus of rupture from one flexural strength test or the average of two cylinders. Cylinders will be either 6 in. by 12 in. or 4 in. by 8 in. Completed partial depth repairs and bottom-half repairs may be opened to traffic when flexural strength tests indicate a minimum modulus of rupture of 500 psi or when compressive strength tests indicate a minimum of 3,200 psi based on the average of the two individual cylinder breaks. Beams or cylinders for this purpose will be cast from repair concrete placed near the very end of each day's production for each different CMDP used and cured in accordance with Section 10.2 of AASHTO T 23 and 505.01(a).

Prior to opening to traffic, the Contractor and the Engineer will conduct an inspection of the partial depth patches to determine if there are any failures. Failures will include, but are not limited to, debonding of the repair concrete or random surface cracks. Repair of the failed partial depth joint repair or bottom-half joint repair shall be completed by an approved method prior to opening the pavement to non-construction traffic.

509.18 Method of Measurement

Partial depth joint repair will be measured at the surface, by the square foot, using linear dimensions measured to the nearest 0.1 ft.

Bottom-half joint repair will be measured by the square foot using linear dimensions measured to the nearest 0.1 ft at the mid-depth of the pavement, when the following conditions are met:

- (a) The PCCP is removed full depth to visibly expose the subbase below.*

(b) The minimum number of reinforcing bars are furnished and installed as shown on the plans.

If the above requirements for bottom-half repairs are not met, the Engineer will only take measurements for payment under partial depth joint repair regardless of depth of the repair.

Additional removal width to accommodate the Contractor's equipment will not be measured.

For repairs at intersecting joints, the same area of joint repair will not be measured twice.

Sawing and sealing of joints in areas of partial depth joint repair will not be measured.

509.19 Basis of Payment

Partial depth joint repair and bottom-half joint repair will be paid for at the contract unit price per square foot. Measured areas of partial depth joint repair that are not located at a joint or crack will be paid as partial depth joint repair.

Payment will be made under:

| Pay Item | Pay Unit Symbol |
|--|------------------------|
| <i>Joint Repair, Partial Depth</i> | <i>SFT</i> |
| <i>Joint Repair, Bottom-half</i> | <i>SFT</i> |

The cost of the trial batch for each concrete mixture, removing and disposing of the in-place concrete pavement as marked by the Engineer, tapering the edges of the repair back at 30 to 60 degrees, cleaning, sandblasting and air blasting, treatment of dowel bars, furnishing and installing bonding grout, furnishing and installing joint filler or tooling and sawing to re-establish the joint within or along the repair, furnishing and placing the concrete within the repair, vibrating, screeding, finishing, texturing, placing cement slurry around the edges, curing and protecting the concrete, sawing and sealing to re-establishing joints, cleanup, and any other materials, labor, equipment, or incidentals necessary to complete the work as specified shall be included in the cost of the joint repair, partial depth pay item.

The cost of removal and disposal of the in-place concrete pavement as determined by the Engineer, cleaning sandblasting and air blasting, treatment of dowel bars, furnishing and installing steel reinforcement, furnishing and installing bonding grout, furnishing and installing joint filler and sawing to re-establish the joint within or along the repair, furnishing, placing, and vibrating the concrete within the repair, sawing and sealing to re-establishing joints, cleanup, and any other materials, labor, equipment, or incidentals necessary to complete the work as specified shall be included in the cost of the joint repair, bottom-half pay item.

Areas of removal for PCCP Joint Repair, which after inspection by the Engineer, are determined to need PCCP Patching, Full Depth in accordance with 506.07(b), will be paid at 40% of the contract unit price per sq ft for the work represented for both Joint Repair, Partial Depth and Joint Repair, Bottom-half. PCCP Patching, Full Depth will be paid at 100% of the contract unit price.

During periods of overnight lane closure, if the Engineer inspects an area of joint repair and determines that PCCP Patching, Full Depth in accordance with 506.07(b) is necessary, the joint repair may be completed if needed to meet the opening to traffic requirement. If completed in order to meet the opening to traffic requirement, the joint repair will be paid at 100% of the contract unit price.

Joint repair areas that do not meet the curing requirements of 509.13 shall be removed and replaced at no additional cost to the Department.

Additional removal width to accommodate the Contractor's equipment shall be at no additional cost to the Department.

Removal and replacement of partial depth patches and snowplowable raised pavement markers as described in 509.16 for debonding and other defects shall be at no additional cost to the Department.
