

506-R-716 PCCP PATCHING

(Adopted 02-20-20)

The Standard Specifications are revised as follows:

SECTION 506, BEGIN LINE 3, DELETE AND INSERT AS FOLLOWS:

506.01 Description

This work shall consist of the removal and replacement of *jointed plain PCCP or jointed reinforced PCCP* in accordance with 105.03.

MATERIALS

506.02 Materials

Materials shall be in accordance with the following:

Admixtures.....	912.03
Calcium Chloride, Type L.....	913.02
Chemical Anchor System.....	901.05
Coarse Aggregate, Class A or Higher, Size No. 11	904
Coarse Aggregate, Class AP, Size No. 8	904
Dowel Bars.....	910.01(b)10
<i>Dowel Bar Assemblies</i>	503.04
Fine Aggregate, Size No. 23	904
<i>Fly Ash</i>	901.02
<i>Joint Fillers</i>	906.01 ^A
<i>Joint Sealing Materials</i>	906.02(a)2
Portland Cement.....	901.01(b)
<i>Rapid Hardening Hydraulic Cement</i>	901.01(d)
<i>Slag Cement</i>	901.03
Water	913.01

^A *A flexible foam expansion joint material meeting the requirements of ASTM D 5249, type 2 may also be used for the retrofit pressure relief joint. If the flexible foam expansion joint is used, the basis for use will be a type C certification in accordance with 916.*

Coarse aggregate for partial depth patching shall be size No. 11. Coarse aggregate for full depth patching shall be size No. 8. Coarse aggregate for patchings shall be *dolomite, limestone, or gravel.*

Retrofitted tie bars shall be No. 5 or No. 6 epoxy coated reinforcing bars in accordance with 910.01(b)9.

The rapid hardening hydraulic cement or calciumsulfoaluminate, CSA, cement type selected shall be a type shown in ASTM C 1600 that will enable opening to traffic in accordance with the contract requirements. Food grade citric acid may be used as an organic retarding admixture in concrete utilizing CSA cement. The use and strength of food grade citric acid, or any other admixture, shall be approved in writing by the manufacturer of the CSA cement. The basis for use for the food grade citric acid will be visual inspection.

A bonding agent shall be selected from the Department's list of approved Non-Vapor Barrier Type Bonding Agents.

~~Dowel bars and dowel bar assemblies shall be in accordance with 503.04.~~

506.03 Concrete Mix Design

A concrete mix design submittal, CMDS, shall be in accordance with 506.04. The CMDS shall be submitted to ~~and approved by the DTE~~. The CMDS shall be submitted a minimum of seven calendar days prior to the trial batch. ~~utilizing~~*The CMDS shall use the Department provided spreadsheet and shall include the following:*

- (a) a list of all ingredients, *including the type of CSA cement, if applicable*
- (b) the source of all materials
- (c) the fine to total aggregate ratio
- (d) the absorption of the aggregates
- (e) the SSD bulk specific gravity of the aggregates
- (f) *the specific gravity of pozzolan*
- ~~(g)~~(g) the batch weights
- ~~(h)~~(h) the names of all admixtures
- ~~(i)~~(i) the admixture dosage rates and the manufacturer's recommended range.

The absolute volume of the mix design shall be 27.0 cu ft at the design air content of 6.5%.

The CMDS ~~is~~*shall be used to conduct a trial batch in accordance with 506.05. Upon completion of the trail batch, the Contractor shall submit the concrete mix design for production, CMDP CMDS and the Contractor's and the Engineer's trial batch results for the CMDS to the DTE. The CMDP results shall be submitted to the DTE utilizing the Department furnished spreadsheet a minimum of three work days prior to production. Production shall not commence without an approved until the DTE has assigned a mix number to the CMDS. The concrete mix design will henceforth be identified as a concrete mix design for production, CMDP. Both the Contractor's and Engineer's test results from the trial batch will be included in the CMDP submittal.*

A CMDP from another contract in the current or previous calendar year may be submitted for review for use on the current contract to the DTE. The DTE will notify the Contractor when the review is complete and whether or not the previously used CMDP can be used on the current contract.

A CMDP may be changed or adjusted in accordance with the following:

(a) Change in Materials

A change in a previously approved CMDP, for a given contract, to any of the following shall be submitted to the DTE as a CMDS, referencing the original CMDP.

1. cement source or type
2. pozzolan source or type
3. coarse aggregate source or type
4. admixture type.

~~A trial batch shall be conducted in accordance with 506.05, or verification of the new CMDS may be made during the first day of production by tests conducted by the Contractor and the Engineer. Production may continue until flexural strength tests are completed, provided all other properties are in accordance with 506.04. The test results shall be submitted to the DTE utilizing the Department spreadsheet no later than one day after the flexural strength test results are complete. If the flexural strength is not in accordance with 506.04, production shall stop and all PCCP patching constructed with the new CMDS will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.~~

(b) Adjustments to Materials

An adjustment in a previously approved CMDP, for a given contract, to any of the following shall be submitted to the DTE as a CMDS, referencing the original CMDP.

1. admixture source
2. admixture product of same type and from same source designated in the original CMDP
3. fine aggregate source
4. fine to total aggregate ratio in excess of $\pm 3\%$ from the value designated by the original CMDP
5. Increase in cement content from amount designated in the original CMDP.

The new CMDS shall be submitted to the DTE utilizing the Department spreadsheet a minimum of one work day prior to production. A trial batch or verification testing is not required for approval. Production shall not commence without an approved CMDP.

(c) Other Adjustments

~~Other adjustments in previously approved CMDP, for a given contract, to any of the following~~ *the admixture dosage rate* will be allowed and DTE notification and ~~approval~~ *review* prior to use is not required.

- ~~1. admixture dosage rate~~
- ~~2. fine aggregate to total aggregate ratio within $\pm 3\%$ of the value designated by the original CMDP.~~

~~An approved CMDP, from another contract in the current or previous calendar year may be used on additional contracts. The CMDP shall be submitted to the DTE for review and approval prior to use.~~

506.04 Concrete Mix Criteria

The design flexural strength of each CMDP shall be set such that the minimum opening to traffic strength is achieved at an age consistent with the work schedule, including any lane closure restrictions.

The fine aggregate shall be at least ~~35~~40% but not more than 45% of the total weight of the aggregate in each cubic yard. Proportions ~~will~~shall be based upon SSD aggregates.

Chemical admixtures type A, type B, type C, type D, type E, and type F may be allowed if shown on the CMDP. The supplied concrete mix shall include one of the following water reducing admixtures: type A, type D, type E, type F, or type G.

Type C admixtures or calcium chloride, type L, shall not be used in conjunction with type III portland cement. Calcium chloride, type L, may only be used in mixes for non-reinforced PCCP and for mixes in accordance with 506.04(a).

Blended portland pozzolan cements, fly ash, or slag cement may only be incorporated in the concrete mix when the ambient temperature is above 50°F during the entire placement period. If type IP, type IP-A, type IS or type IS-A cements are to be used, the minimum portland cement content shall be increased to 598 lbs/cu yd. The use of fly ash or slag cement will not be allowed when blended cement types IP, IP-A, IS, or IS-A are used.

The Contractor may use either portland cement or CSA cement in the concrete. Fly ash or slag cement may also be used.

If concrete has a permeability of 900 coulombs or less at 56 days, the acceptable range of air content will be 0 - 6.0%. Verification of this property for a mix design will be determined by testing specimens cast at the trial batch. Testing will be done per AASHTO T 23 Section 10.1 Standard Cure conditions.

The CMD shall produce workable concrete mixtures, ~~with the minimum amount of water,~~ having the following targets and field acceptance properties:

(a) Patches Less than or Equal to 15 ft in Length

The Contractor shall use either concrete as described below or concrete in accordance with 506.04(b). If concrete in accordance with 506.04(b) is used, 506.11(b) shall be used for the minimum open to traffic strength.

Targets for the CMD:

Minimum portland cement content	658/564 lbs/cu yd ^A
Maximum portland cement content.....	752 lbs/cu yd ^A
Minimum CSA cement content.....	564 lbs/cu yd ^{A, B}
Maximum CSA cement content	658 lbs/cu yd ^{A, B}
Minimum water/cementitious ratio (types I or IL).....	0.340 ^C
Maximum water/cementitious ratio (types I or IL).....	0.400 ^C
Minimum water/cementitious ratio (type III or CSA).....	0.340 ^C
Maximum water/cementitious ratio (type III or CSA)	0.435 ^C
Maximum fly ash or slag cement addition	30% of the cement content ^B

Maximum silica fume addition.....	7% of the cementitious content
Air Content.....	6.5%
Minimum modulus of rupture.....	400 psi at 24 h
Minimum modulus of rupture.....	550 psi at 3 days ^D
Relative Yield.....	1.00

Field Acceptance Properties:

Minimum water/cementitious ratio (types I or IL).....	0.320 ^C
Maximum water/cementitious ratio (types I or IL).....	0.420 ^C
Minimum water/cementitious ratio (type III or CSA).....	0.340 ^C
Maximum water/cementitious ratio (type III or CSA).....	0.450 ^C
Maximum water/cement ratio.....	0.45
Minimum Slump.....	2 to 6 in.
Air Content.....	6.5% ± 1.5% to 8.0%
Minimum Flexural strength, third point loading.....	300 psi at 24 h
Minimum flexural strength, third point loading modulus of rupture.....	500 psi at 3 days ^D
Relative yield.....	0.98 to 1.02

^A The cement content shall not be adjusted from the target stated on the CMDP during production.

^B Fly ash or slag cement shall not be used in combination with CSA cement unless approved in writing by the manufacturer of the CSA cement.

^C The water/cementitious ratio shall not deviate more than 0.020 from the target stated in the CMDP and shall not fall outside the limits shown.

^D Beams shall be standard cured in a water tank in accordance with AASHTO T 23 and 505.01(a). The water does not need to be saturated with calcium hydroxide.

When a calcium chloride solution is added, ~~a maximum of the maximum amount of solid calcium chloride contained in solution shall not exceed 2%, by of the total batch weight of cement, shall be used. The percentage shall be reduced to 1 if the ambient temperature is above 80°F. If the mixture is used in an 805 application, calcium chloride shall not be used. If the ambient temperature is above 80°F, the maximum amount of solid calcium chloride contained in solution shall not exceed 1% of the total batch weight of cement.~~

(b) Patches Greater than 15 ft in Length

The Contractor shall use either concrete as described below, or portland cement concrete in accordance with 502.04(a). If concrete in accordance with 502.04(a) is used, a trial batch will not be required.

Targets for the CMD:

Minimum portland cement content (types I, IL or III).....	564 lbs/cu yd ^A
Maximum portland cement content (types I, IL, or III).....	752 lbs/cu yd ^A
Minimum CSA cement content.....	564 lbs/cu yd ^{A, B}
Maximum CSA cement content.....	658 lbs/cu yd ^{A, B}
Minimum water/cementitious ratio (types I or IL).....	0.340 ^C
Maximum water/cementitious ratio (types I or IL).....	0.400 ^C
Minimum water/cementitious ratio (type III or CSA).....	0.340 ^C
Maximum water/cementitious ratio (type III or CSA).....	0.435 ^C

<i>Maximum fly ash or slag cement addition</i>	<i>30% of the cement content^B</i>
<i>Maximum silica fume addition</i>	<i>7% of the cementitious content</i>
<i>Air Content</i>	<i>6.5%</i>
<i>Minimum modulus of rupture</i>	<i>425 psi at 24 h</i>
<i>Minimum modulus of rupture</i>	<i>550 psi at 3 days^D</i>
<i>Relative Yield</i>	<i>1.00</i>

Field Acceptance Properties:

<i>Minimum water/cementitious ratio (types I or II)</i>	<i>0.320^C</i>
<i>Maximum water/cementitious ratio (types I or II)</i>	<i>0.420^C</i>
<i>Minimum water/cementitious ratio (type III or CSA)</i>	<i>0.340^C</i>
<i>Maximum water/cementitious ratio (type III or CSA)</i>	<i>0.450^C</i>
<i>Slump</i>	<i>2 to 6 in.</i>
<i>Air content</i>	<i>5.0% to 8.0%</i>
<i>Minimum modulus of rupture</i>	<i>550 psi at 3 days^D</i>
<i>Relative yield</i>	<i>0.98 to 1.02</i>

^A *The target cement content during production shall not be adjusted from the value stated on the CMDP.*

^B *Fly ash or slag cement shall not be used in combination with CSA cement unless approved in writing by the manufacturer of the CSA cement.*

^C *The water cementitious ratio during production shall not deviate more than 0.020 from the target stated in the CMDP and shall not fall outside the limits above.*

^D *Beams shall be standard cured in a water tank in accordance with AASHTO T 23 and 505.01(a). The water does not need to be saturated with calcium hydroxide.*

506.05 Trial Batch

A trial batch shall be produced and tested by the Contractor's certified technician to verify that the CMDS is in accordance with the concrete mix criteria. Concrete produced at a plant shall be batched within the proportioning tolerances of 502.10. An American Concrete Institute certified concrete field testing technician, grade 1 shall be on site to direct all sampling and testing. The trial batch shall be produced at the plant prior to production. A sufficient number of flexural strength test beams shall be made and will be tested to demonstrate that opening to traffic strength is achieved at an age consistent with the proposed range of usage of the mixture. At a minimum, flexural strength gain will be determined at the target opening to traffic times and at the specified 24 h and 3 day targets as specified by the respective mix criteria. The Engineer will test the concrete's air content and determine the water/cementitious ratio, and prepare and test flexural beams. The flexural strength will be determined by averaging a minimum of two beam breaks. The Department will provide the apparatus to test the beams for flexural strength. Personnel shall be provided to assist the Department in casting, curing, and testing the beams. The Engineer will provide the Contractor the results of the tests. The Contractor shall submit, along with the CMDS, all supporting test results for approval to the DTE prior to placing concrete. The supporting test results shall be signed by the technician and include air content, slump, relative yield, water/cementitious ratio, and the flexural strengths at the targets listed in 506.04(a) or 506.04(b). Maturity in accordance with ITM 402 may be used as an alternate method to determine the flexural strength for opening to traffic.

A trial batch will not be required when the total quantity of ~~partial depth patching~~ or full depth patching will requires less than 10 cu yds of material per contract.

The trial batch shall be of 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, *except concrete used to measure relative yield may also be used to measure air content.*

506.06 Job Control

Control of PCCP for air content, *relative yield*, and flexural strength beams will be determined on the basis of tests performed by the Engineer in accordance with 505. Concrete and necessary labor for sampling shall be furnished as required by the Engineer. Testing for air content *and relative yield* will be on the first load of the day and once per every 50 cu yds.

(a) Beams for Validation of CMDP

~~Beams~~ *At least one set, consisting of three beams per set, will be made once per every 150 cu yds of concrete placed and tested for compliance with either the 3 day or 7 day flexural strength requirements in accordance with 506.04, for the purpose of CMDP validation. Air content and relative yield will be measured on each sample of concrete from which beams are made. Beams for validation shall be placed on the concrete pavement or shoulder adjacent to the patch and cured in a similar manner as the patch in accordance with 505.01(a) until patch area is open to traffic. At which point the beams shall be relocated off-site and standard cured in accordance with AASHTO T 23, Section 10.1.2 with the exception that the water does not need to be saturated with calcium hydroxide until the 3 or 7 day time period has elapsed. Failure of the validation beams to meet or exceed the 3 day or 7 day flexural strength requirements specified herein will result in the use of the CMDP being suspended until the Department concludes an investigation into why the failure occurred. If the CMDP is subsequently shown to be acceptable, another set of validation beams will be tested on the next use of the CMDP.*

(b) Beams for Opening to Traffic

Additional beams shall be cast for the purpose of opening to traffic for concrete meeting the requirements of 506.04(a) or 506.04(b). Such beams shall be cast from sampling the last load to finish the patching operations for the day's production for each of the concrete mixes used. Beams for opening to traffic shall be placed on top of a concrete patch that they represent and cured in a similar manner as the patch.

The Engineer will notify the Contractor when test results for air content, *relative yield*, or flexural strength are outside the requirements of 506.04. Rounding will be in accordance with 109.01(a).

CONSTRUCTION REQUIREMENTS

Patch areas shown on the plans or marked by the Engineer as greater than 15 ft in length may be subdivided. If a patch is subdivided, concrete mix in accordance with 506.04(b) shall be used in all portions of the patch and the requirements for opening to traffic will be in accordance with 506.11(b).

506.07 PCCP Removal

PCCP removal areas will be marked. *The Contractor may saw cut the patch areas prior to removing the patch. When the lane is subject to intermittent closures, the saw cutting shall occur no more than 24 h prior to removing the patch.* Vertical saw cuts around the perimeter of the removal areas shall be made in the PCCP and shall be full depth. Transverse cuts ~~shall be perpendicular to the centerline of the PCCP.~~ *that define the ends of the patch shall be straight and perpendicular to the centerline. In no case shall the transverse joint be over-cut into the adjacent pavement. Following the saw cutting, the concrete that remains in the corners of the patch area shall be removed by pneumatic hammers that do not damage the adjacent PCCP pavement or shoulders. Pneumatic hammers shall not exceed 45 lb.*

PCCP removal areas shall not remain open overnight. Shoulders or adjacent PCCP damaged during the removal shall be repaired as directed.

(a) Partial Depth Removal

The saw cut shall be a minimum of ± 2 in., to a maximum of ~~3 in~~ $1/3$ of the thickness of the existing pavement. Removal of all unsound concrete to a minimum depth of ± 2 in. shall be by hand chipping tools or handheld mechanically driven equipment. Mechanical hammers shall not be heavier than a nominal 45 lb class. Mechanically driven tools shall be operated at a maximum angle of 45° from the PCCP surface. If the saw cut face is damaged, a parallel saw cut 1 in. outside the initial saw cut shall be made and the concrete in this area shall be removed by hand chipping. *In lieu of using hand chipping tools or handheld mechanically driven equipment, a milling machine may be used. If a milling machine is used it shall be one that does not damage the adjacent pavement.*

~~If reinforcing bars are encountered during the removal operation shall be cause for~~ *for, the patch shall be changed to a full depth patch in accordance with 506.07(b). Wire mesh reinforcement exposed during the removal operations shall be removed.*

~~Exposure of unsound concrete below 3 in. shall be cause for~~ *If concrete is exposed below $1/3$ of the thickness of the existing pavement, the patch shall be changed to a full depth patch in accordance with 506.07(b).*

~~The p~~Partial depth cavities shall be thoroughly sandblasted and, just prior to placing new concrete, cleaned of all dust, chips, and water. The air lines for sandblasting and air cleaning shall be equipped with oil traps to prevent contamination of the surfaces.

(b) Full Depth Removal

~~The saw cut shall be full lane width and thickness of the PCCP.~~ After the full depth saw cut is completed, vehicle mounted removal equipment may be used to remove the concrete provided this equipment does not damage the adjacent sound concrete.

Removal areas in the same lane which are closer than 10 ft shall require the PCCP between these areas to be removed and replaced. If a transverse joint is located within the removal area, the limits of removal shall be ~~increased to a minimum of 1 ft beyond the joint~~ *as shown on the plans.*

Full depth *saw cutting and* removal shall be extended *at the direction of the Engineer* until sound PCCP is encountered to allow *the drilling and installation of dowel bars to be firmly anchored for load transfer, without inflicting further damage to the existing PCCP. Removal operations shall not damage the existing PCCP that is sound and is to remain in place.*

~~All subbase material disturbed during the removal operation shall be recompact~~
~~as directed. Existing subbase shall be completely removed. Before removing any type of asphalt treated, cement treated or concrete subbase, the Contractor shall saw cut the outline of the removal area using a power-driven saw with a diamond blade. The Contractor shall cut the asphalt treated subbase at least 2 in. deep on a neat line perpendicular to the subbase surface. The Contractor shall cut the cement treated subbase or concrete subbase full depth.~~

506.08 Concrete Mixing and Transportation

(a) For Patches Less than or Equal to 15 ft in Length

~~Concrete mixing and transportation shall be completed by central mixed, shrink mixed, or transit mixed methods. Concrete batching tolerances, mixing, and transportation shall be in accordance with 502.10 and the following.~~ Discharge from non-agitating equipment shall be completed within 30 minutes of mixing the water, cement, aggregates, and calcium chloride solution. Discharge from a truck agitator or a truck mixer shall be completed within 90 minutes of mixing the water, cement, and aggregates or within 30 minutes of the addition of calcium chloride solution. If the location of the plant is such that this time limit cannot be met, the calcium chloride solution shall be added to the concrete in a transit mixer at the site and the concrete shall then be mixed for an additional 40 revolutions prior to discharge.

~~Concrete shall be uniformly mixed when delivered to the job site. Tickets for each load of PCC shall indicate the weight of cement, and aggregates, volume of water, and the type and volume of admixtures. The weight of the cement shall be within 1% of the CMDP and the saturated surface dry weight of the aggregates shall be within 2% of the CMDP.~~

~~Wash water shall not be used as a portion of the mixing water.~~

~~When concrete is delivered in transit mixers, additional water to increase the workability of a load may be added within 45 minutes of initial mixing. Any addition of water shall be noted on the ticket and shall not occur as a continuing operation.~~

~~(a)~~1. Central Mixed Concrete

Central mixed concrete shall be in accordance with 502.10(a).

~~(b)~~2. Shrink Mixed Concrete

Shrink mixed concrete shall be in accordance with 502.10(b).

~~(c)~~3. Transit Mixed Concrete

Transit mixed concrete shall be in accordance with 502.10(c).

(b) For Patches Greater than 15 ft in Length

For patches containing portland cement, the mixing and transportation shall be in accordance with 502.10. If concrete containing CSA cement is used, it may be batched and mixed in a mobile volumetric mixer meeting the requirements of 722.09, regardless of the patch length. Calibration of the mobile mixer shall be in accordance with 722.13. Alternatively, a mixer from a CSA cement supplier may be used, contingent upon approval by the Engineer.

506.09 Weather Limitations

~~Placement of PCCP patches in continuous reinforced concrete pavement shall be after 1:00 p.m. when the next day's forecasted ambient temperature is 70°F or greater, unless otherwise directed.~~

PCCP patches shall not be placed on frozen subgrade, subbase, or PCCP.

506.10 Placing Concrete

The concrete shall be placed level to the adjacent PCCP and consolidated by internal vibration. The concrete shall be hand finished in accordance with 504. Texturing and tining are not required if the PCCP is to be resurfaced with HMA or diamond ground in accordance with 507.06.

The PCCP patch shall be cured *with liquid membrane forming curing compound* in accordance with 504.04(a). *In addition to applying liquid membrane forming curing compound, if the ambient temperature is below 55°F at the time of placement, polyethylene film shall be placed over the patch and covered with a 4 in. layer of rigid or flexible insulation and firmly anchored. Otherwise, polyethylene film, insulation, or any other covering shall not be used.* Small dimension lumber weighted with sandbags may be used, but large objects such as rocks or concrete blocks shall not be used. *Covering with polyethylene film or any other covering does not replace the requirement to use liquid membrane forming curing compound.*

The PCCP patch shall be inspected in accordance with 502.17.

For patches which are not to be overlaid and have a length greater than 20 ft, pavement smoothness will be in accordance with 501.25 except profilograph requirements will not apply.

(a) Partial Depth

A non-vapor barrier type bonding agent shall be applied to the vertical and horizontal surfaces prior to placing concrete. Coated surfaces shall be protected from contaminants such as dust and dirt. Contaminated surfaces shall be recleaned and recoated. The bonding agent and concrete shall be placed in accordance with the bonding agent manufacturer's recommendations. The recommended time limits will be strictly enforced.

Existing joint openings within the patch shall be maintained for the full depth of the patch by preformed joint fillers or forms. After the patch has cured, these joints shall be sawed and sealed in accordance with 503.

(b) Full Depth

~~Patches shall be anchored with dowel bars to the adjacent PCCP as shown on the plans. Dowel bars shall be installed using a chemical anchoring system.~~

~~Patches constructed adjacent to transverse contraction joints or random cracks that are to remain in place shall be constructed with type D-1 contraction joints. The joint shall be made continuous across the width of the PCCP to match the existing joint or random crack. Patches greater than 18 ft shall have type D-1 contraction joints in accordance with 503. Subgrade treatment and subbase shall be constructed as shown on the plans.~~

Dowel bars shall be installed to provide load transfer from the adjoining PCCP to the patch. The diameter of the drilled holes shall be no more than 1/8 in. greater than the diameter of the dowel bar. Dowel bars shall be placed parallel to the pavement surface and to the longitudinal joint. Dowel alignment tolerances shall be as shown on the plans.

Dowel holes shall be drilled using hydraulic, electric, or pneumatic percussion drills without spalling or damaging the existing concrete. Drills shall be capable of independent adjustment of each drill shaft in the horizontal and vertical direction. The device used to drill dowel holes shall be slab-riding and be capable of drilling a minimum of three holes at a time. The drilled holes shall be free of dust, moisture, and grease prior to installation of the dowel bars. The chemical anchor system shall be injected to the back of the hole to eliminate air pockets prior to inserting the dowel bar. The quantity of material injected shall be sufficient to disperse the chemical anchor material along the entire length of the dowel bar and completely fill all voids around the bar. Application of the chemical anchor system by buttering it onto the dowel bar will not be allowed.

After the anchor system has been injected, the dowel bar shall be fully inserted in the hole using a back-and-forth twisting motion, leaving the proper length exposed. If it is necessary to use a hammer to seat the dowel bar, the exposed end shall be protected with a wood block.

A lightweight plastic, clear or semi-transparent grout retention ring shall be installed after each dowel bar is inserted into the hole. The grout retention ring shall be pushed flush to the vertically sawn concrete surface and shall be used to help retain the chemical anchor system in the dowel hole.

Retrofit tie bars shall be installed in accordance with 503 and as shown on the plans. The tolerance for horizontal and vertical translation shall be the same as for dowel bars.

Joint filler and grout retention rings shall be placed and installed at the pressure relief joint as shown on the plans. Oversized holes shall be drilled in the joint filler no more than 1/2 in. over the dowel bar diameter and at a spacing to match the installed dowel bars. The oversized holes are to allow a tolerance for ease of installation of the joint filler up against the sawed face without interference with the dowel bars. The joint filler shall be attached to the sawed face without wrinkles or buckling. Joint filler material with vertical slits or cuts will be rejected. Grout retention discs shall be installed to make the

annular space between the dowel and the oversized hole mortar tight. The joint material may be spliced along vertical joints that are joined and sealed with tape. The joint material shall not be spliced in the horizontal direction. An alternate method of installing a joint filler that has a mortar tight seal around the dowel bar may be allowed if approved by the Engineer.

All patches greater than 15 ft shall be placed in accordance with 502.12 and shall have joints in accordance with 503. Dowel bars shall be installed within the boundaries of the patch at a spacing as shown on the plans or as approved by the Engineer.

Patches longer than 15 ft shall be finished in accordance with 504.

Patches longer than 15 ft, constructed with concrete containing portland cement, shall be cured in accordance with 504.04(a) unless ambient air and concrete temperatures warrant following the requirements in 506.10.

Patches constructed in accordance with 506.04(b) and containing CSA cement shall be water cured in accordance with 702.22(a)1 except that soaker hoses will not be required. Water curing shall be initiated after finishing and as soon as the concrete patch can support the wet covering. Water curing shall be maintained for a minimum of 1 1/2 h, and shall be removed no sooner than 1 h before the patch is opened to traffic.

Concrete shall be placed around manholes or similar structures in accordance with 720.

Sawing and sealing of transverse joints may be omitted when the existing PCCP is to be overlaid as part of the contract.

506.11 Opening to Traffic

For purposes of this section, traffic shall include construction vehicles, construction equipment, and all non-construction vehicles. Any construction vehicle or equipment that may damage the PCCP shall not be used on the PCCP unless adequate protection is provided. Joint cutting saws may be operated on the PCCP as determined by the Contractor.

(a) For Patches Less than or Equal to 15 ft in Length

A patch may be opened to traffic in accordance with the following when calcium chloride is used *in accordance with 506.04(a)*.

T	H	HT	T	H	HT
40 - 42°F	30	26	61 - 63°F	14	9
43 - 45°F	27	23	64 - 66°F	14	9
46 - 48°F	24	21	67 - 69°F	14	8
49 - 51°F	21	19	70 - 72°F	14	7
52 - 54°F	19	16	73 - 75°F	14	6
55 - 57°F	16	14	above 75°F	14	5
58 - 60°F	16	11			
T = Lowest ambient temperature during placement, or the temperature of concrete at time of delivery, whichever is lower H = Time in hours to open to traffic HT = Time in hours to open to traffic when the average daily traffic is less than 10,000					

PCCP patches with calcium chloride may be opened to traffic sooner than specified in the above table if test beams indicate a modulus of rupture of 300 psi or greater. ITM 402 may be used as an alternative method to determine the flexural strength.

When other admixtures or admixture systems are used, the PCCP patches may be opened to traffic when flexural strength tests indicate a modulus of rupture of 300 psi or greater. ITM 402 may be used as an alternate method to determine the flexural strength.

(b) For Patches Greater than 15 ft in Length

Traffic shall not be allowed on the PCCP until a modulus of rupture of 425 psi from flexural strength testing is achieved. The modulus of rupture will be determined by averaging two beams.

506.12 Method of Measurement

Partial depth patching and full depth patching will be measured by the square yard.

D-1 contraction joints and retrofitted tie bars used in PCCP patching will be measured in accordance with 503.07.

Subgrade treatment, when specified, will be measured in accordance with 207.05. New subbase will be measured in accordance with 302.08.

~~PCCP removal, subbase removal, and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, individual dowel bars, chemical anchor system, concrete, finishing, curing, and sawing and sealing of joints will not be measured for payment.~~

Retrofit pressure relief joints, retrofit contraction joints, non-vapor barrier bonding agent, anchored dowel bars installed at the beginning and end of the patch, individual dowel bars, joint fillers, joint materials, drilling holes for dowel bars, grout retention rings, and chemical anchor systems will not be measured for payment.

506.13 Basis of Payment

PCCP patching will be paid for at the contract unit price per square yard for the type of patching required.

D-1 contraction joints and retrofitted tie bars used in PCCP patching will be paid for in accordance with 503.08.

Subgrade treatment will be paid for in accordance with 207.06. New subbase will be paid for in accordance with 302.09.

Partial depth patches which have been directed to be full depth will be paid for at the contract unit price per square yard for PCCP patching, partial depth, plus 80% of the contract unit price per square yard for PCCP patching, full depth.

Payment will be made under:

Pay Item	Pay Unit Symbol
PCCP Patching, Full Depth.....	SYS
PCCP Patching, Partial Depth.....	SYS

~~The cost of PCCP removal, subbase removal, and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, individual dowel bars, chemical anchoring system, concrete, finishing, and curing, and sawing and sealing of joints shall be included in the cost of PCCP patching.~~

The cost of retrofit pressure relief joints, retrofit contraction joints, non-vapor barrier bonding agent, anchored dowel bars installed at the beginning and end of the patch, individual dowel bars, joint fillers, joint materials, drilling holes for dowel bars, grout retention rings, and chemical anchoring system shall be included in the cost of PCCP patching.

The cost of corrections for pavement smoothness and re-texturing shall be included in the cost of PCCP patching.

Repair or replacement of adjacent PCCP or shoulder damaged by the Contractor shall be made at no additional cost to the Department.

SECTION 901, AFTER LINE 157, INSERT AS FOLLOWS:

(d) Rapid Hardening Hydraulic Cement

Rapid hardening hydraulic or CSA cement shall be furnished from a manufacturer or manufacturer/distributor on the Department's list of Cement Sources. It shall be CSA cement or a blended CSA cement. A source may be added to the approved list by completing the requirements of ITM 806, Procedure U.

SECTION 901, BEGIN LINE 263, DELETE AND INSERT AS FOLLOWS:

~~901.03 Ground Granulated Blast Furnace Slag Cement Used As a Pozzolan~~

(a) General

~~Blast furnace~~ Slag cement shall consist of the non-metallic product, consisting

essentially of silicates and aluminosilicates of calcium and other bases, that is developed in a molten condition simultaneously with iron in a blast furnace. A glassy granular material is formed when molten blast furnace slag is rapidly chilled by immersion in water. This material is then ground to cement fineness, producing ~~ground granulated blast furnace~~ slag *cement*.

~~Ground granulated blast furnace~~ *Slag cement* will be accepted from one of the sources on the Department's list of approved ~~Fly Ash and Ground Granulated Blast Furnace Slag~~ *Pozzolan* Sources. ~~Ground granulated blast furnace~~ *Slag cement* from different sources or different grades of ~~ground granulated blast furnace~~ *slag cement* shall not be mixed or used alternately in the same construction unless approved in writing. ~~Ground granulated blast furnace~~ *Slag cement* will be subject to random assurance sampling and testing by the Department. Failure of these random samples to be in accordance with the specified requirements will be cause for suspension of ~~ground granulated blast furnace~~ *the slag cement* source approval.

(b) Acceptance Criteria

~~Ground granulated blast furnace~~ *Slag cement* will be accepted based on the manufacturer's or manufacturer/distributor's documented ability to consistently furnish these materials in accordance with the applicable ASTM and AASHTO requirements.

1. Requirements

~~The ground granulated blast furnace~~ *Slag cement* shall be in accordance with ASTM C 989 for grade 100 or 120.

For each 2,500 t produced, a complete ASTM C 989 analysis shall be performed on a sample composited randomly from the daily samples. The method of randomization shall be subject to approval by the Department.

2. Test and Calibration Procedure

The testing procedures followed shall be in accordance with ASTM C 989 or other methods approved in writing by the Department.

The minimum frequency for calibration of test equipment is:

- a. The No. 325 (45 μ m) sieve shall be calibrated every 100 determinations or every six months, whichever comes first.
- b. The analytical balances and scales shall be calibrated each year.
- c. The concrete compression machine shall be calibrated annually.
- d. The Blaine apparatus shall be calibrated annually.

- e. All instrumentation used for rapid chemical analysis shall be in accordance with the applicable requirements of ASTM C 114 using NIST reference materials.

3. Documentation

~~Ground granulated blast furnace~~ Slag *cement* suppliers requesting approval shall supply the following:

- a. For the initial approval, a current ~~Materials~~ Safety Data Sheet and a summary of results for all specified tests for six consecutive months shall be submitted. No test results shall be more than one year old at the time of request.
- b. To maintain approval, a summary of results for all specified tests shall be submitted monthly. The results of the daily tests shall be available by telephone during normal working hours.
- c. The ~~ground granulated blast furnace~~ slag *cement* suppliers shall furnish a QCP in accordance with the applicable requirements of ITM 806. The QCP shall ensure the Department of a continuous supply of ~~ground granulated blast furnace~~ slag *cement* which is in accordance with the requirements. This QCP will be reviewed to determine its adequacy.
- d. Certification:
 - (1) For source approval, the supplier shall furnish a certification indicating the grade of ~~ground granulated blast furnace~~ slag *cement*, the name, location, and type of manufacturing facility. It shall state that the ~~ground granulated blast furnace~~ slag *cement* shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. A sample certification form addressing all of the required information is included in ITM 804.
 - (2) For certification of test reports, the test results generated in accordance with 901.03(b) shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility, and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving ~~ground granulated blast furnace~~ slag *cement* represented by these results.