SECTION 500 – CONCRETE PAVEMENT

SECTION 501 – QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, PORTLAND CEMENT CONCRETE PAVEMENT, PCCP

501.01 Description

This work shall consist of QC/QA portland cement concrete pavement, PCCP, placed on a prepared subgrade or subbase in accordance with 105.03.

501.02 Quality Control

The mixture for PCCP shall be produced by an approved plant in accordance with ITM 405, transported, and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803, for PCCP. The QCP shall be submitted to the Engineer at least 15 days prior to commencing PCCP paving operations.

An American Concrete Institute certified concrete field testing technician, grade 1, shall be on site to direct all sampling and testing.

A common testing facility shall be provided for both production control and acceptance testing.

MATERIALS

501.03 Materials

Materials shall be in accordance with the following:

Admixtures	912.03
Coarse Aggregate, Class AP, Size No. 8	904
Fine Aggregate, Size No. 23*	904
Fly Ash	901.02
Ground Granulated Blast Furnace Slag	901.03
Portland Cement	901.01(b)
Rapid Set Patching Materials	901.07
Water	913.01

*Or gradation as identified in the QCP

501.04 Concrete Mix Design

A concrete mix design submittal, CMDS, shall be in accordance with 501.05. The CMDS shall be submitted to and approved by the DMTE. The CMDS shall be submitted a minimum of seven calendar days prior to the trial batch utilizing the Department provided spreadsheet and shall include the following:

(a) a list of all ingredients
(b) the source of all materials
(c) the fine to total aggregate ratio
(d) the gradation of the aggregates
(e) the absorption of the aggregates
(f) the SSD bulk specific gravity of the aggregates

(g) the specific gravity of pozzolan
(h) the batch weights (mass)
(i) the names of all admixtures
(j) the admixture dosage rates and the manufacturer's recommended range

The CMDS is used to conduct a trial batch in accordance with 501.06. Upon completion of the trial batch, the Contractor shall document the adjustments to the CMDS and submit the concrete mix design trial, CMDT, to the DMTE for approval. The CMDT shall be submitted a minimum of three work days prior to production to the DMTE utilizing the Department furnished spreadsheet. Production shall not commence without an approved CMDT. Both the Contractor's and the Engineer's tests will be included in the CMDT submittal.

The CMDT is used to start production. The CMDT can be adjusted in accordance with 501.17 and will be documented as a concrete mix design for production, CMDP. The CMDP shall be submitted by the end of the second lot to the DMTE utilizing the Department's spreadsheet. Production shall stop upon the end of the first sublot of the third lot if the CMDP is not received by the DMTE.

(a) Change in Materials

A change in a CMDP to any of the following requires a new CMDS.

1. cement source, except for type I
2. cement types for IA, IIIA, ISA, IP-A, IS, II, III, IP, ISM
3. admixture type
4. pozzolan source or type
5. aggregate material

(b) Change in Source

A change in a CMDP to any of the following requires a new CMDT.

1. cement source, type I
2. admixture source utilizing the same type
3. aggregate source

When changes in the CMDP are in accordance with 501.04(b), the new CMDT shall be verified on the first sublot of production in accordance with 501.06, except the DMTE will use the acceptance test results for verification. The CMDT will be documented as a CMDP after verification. Production may continue until flexural strength tests are completed as long as all other properties are in accordance with 501.05. If the flexural strength is not in accordance with 501.05, production shall stop. All PCCP constructed with the new CMDT will be adjudicated as a failed material in accordance with normal Department practice in accordance with 105.03. No CMDT adjustments in accordance with 501.17 will be allowed. The CMDP shall be submitted to the DMTE utilizing the Department furnished spreadsheet by the end of the second lot. Production shall stop upon the end of the first sublot of the third lot if the CMDP is not received by the DMTE.

A CMDP from a previous contract may be submitted for use on additional contracts.

501.05 Concrete Mix Criteria

The CMD shall produce workable concrete mixtures having the following properties:

Minimum portland cement content ..... 440 lbs/yd^3 (260 kg/m^3)
Maximum water/cementitious ratio 0.450
Minimum portland cement/fly ash ratio..... 3.2 by weight (mass)
Minimum portland cement/GGBFS ratio..... 2.3 by weight (mass)
Target air content 6.5%
Minimum flexural strength, third
point loading ..... 570 psi (4000 kPa) at 7 days

The Contractor may elect to use fine and coarse aggregates in accordance with 904, or may propose the use of alternate gradations. If alternate gradations are proposed, the QCP shall specify the tolerances of material passing each sieve. In either case, 100% of the coarse aggregate shall pass the 1 in. (25 mm) sieve. The combined amount of fine and coarse aggregates passing the No. 200 (75 µm) sieve shall be from 0% to 2.0% for fine aggregate and gravel, and from 0% to 2.5% for fine aggregate and crushed stone or crushed slag.

The fine aggregate shall be at least 35% but not more than 50% of the total weight (mass) of the aggregate in each cubic yard (cubic meter). Proportions will be based upon saturated surface dry aggregates.

Absorption tests shall be performed on the fine aggregate in accordance with AASHTO T 84 and on the coarse aggregate in accordance with AASHTO T 85. Absorption test results for a particular size of aggregate that differ by more than 1.0 percentage point from the Department's source value shall be investigated. The Contractor shall report any differences that exceed 1.0% to the Department. The Contractor's results shall be used when calculating the water/cementitious ratio.

Fly ash or GGBFS used as an additive, or blended portland cements may only be incorporated in the concrete mix between April 1 and October 15 of the same calendar year. 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 500 lbs/yd^3 (300 kg/m^3). The use of fly ash or GGBFS as an additive will not be permitted when blended portland cements are used.

Water reducing admixture type A, or water reducing and retarding admixture type D, may be used in PCCP. However, admixture type A shall not be used in conjunction with admixture type D.

501.06 Trial Batch

A trial batch shall be produced and tested by the Contractor's certified technician to verify that the CMDS or CMDT meets the concrete mix criteria. The concrete shall be batched within the proportioning tolerances of 508.02(b). The Engineer will test the trial batch and provide the Contractor with the results. The trial batch shall be of sufficient

quantity to allow the Contractor and the Engineer to perform all required tests from the same batch. Trial batch concrete shall not be used for more than one test, except the concrete used for the unit weight (mass) may be used to conduct the air content test.

The target unit weight (mass) and water/cementitious ratio of the plastic concrete shall be determined by the trial batch. The flexural strength shall be determined by averaging a minimum of two beam breaks.

Test results shall be added to the CMDS or CMDT and submitted to the DMTE in accordance with 501.04.

501.07 Lots and Sublots

Lots will be defined as 7,200 syd (6000 m^2) of PCCP. Lots will be further subdivided into sublots of 2,400 syd (2000 m^2) of PCCP within a lot. Partial sublots of 480 syd (400 m^2) or less will be added to the previous sublot. Partial sublots greater than 480 syd (400 m^2) constitute a full sublot. Partial lots of one or two sublots constitute a full lot.

Lots and sublots will be tested on the CMD's for a given pay item. Lots and sublots will be closed out at the end of the paving season.

501.08 Acceptance

Acceptance of PCCP for flexural strength, air content, unit weight (mass), water/cementitious ratio, and thickness will be determined on the basis of tests performed by the Engineer in accordance with 505. The Engineer will randomly select the location within each sublot for sampling in accordance with ITM 802.

The random sample(s) per sublot shall be of sufficient quantity to perform all required tests and obtained in accordance with AASHTO T 141. Concrete and necessary labor for sampling shall be furnished as required by the Engineer. The test results of the sublots for each lot will be averaged and shall be in accordance with 501.05 and 501.06, except the lot average for thickness shall be in accordance with 501.26. Test results are to be shared in a timely manner.

Test or Determination	Frequency	Test Method	Precision
7-Day Flexural Strength	Two beams per sublot	AASHTO T 97	1 psi (10 kPa)
Air Content	One per sublot	AASHTO T 152 or ASTM C 173	0.1
Unit Weight	One per sublot	AASHTO T 121	1
Water/Cementitious Ratio	Once per week	ITM 403	0.001
Thickness	Two per sublot	ITM 404	0.1

Rounding will be in accordance with 109.01(a).

In the event that an acceptance sample is not available to represent a sublot(s), all test results of the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.

CONSTRUCTION REQUIREMENTS

501.09 General

Equipment for PCCP shall be in accordance with 508.

501.10 Preparation of Grade

The subgrade shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207.

501.11 Preparation of Subbase

Subbase, if required, shall be placed and shaped to the required grade and section in accordance with 302. Construction traffic shall not be allowed on the aggregate drainage layer of the subbase, except where PCCP placement is restricted. Exceptions shall be submitted for approval.

501.12 Placement

Placement of PCCP shall be by the slipformed or formed methods with equipment specified in 508.04. The subgrade or subbase shall be uniformly moist at the time of PCCP placement. Excessively dry subgrade or subbase shall be sprinkled with water. Dowel bars shall be coated with a bond breaking material and the coating shall be evident at the time of placement.

501.13 Process Control

The Engineer and Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

501.14 Concrete Mixing and Transportation

Concrete shall be mixed and delivered by one of the following:

(a) Central mixed concrete shall be completely mixed in a stationary mixer and transported in a truck agitator, truck mixer at agitating speed, or non-agitating equipment.

(b) Shrink mixed concrete shall be partially mixed in a stationary mixer and the mixing completed during transportation in a truck mixer.

(c) Transit mixed concrete shall be completely mixed in a truck mixer.

The batch ticket for contract dedicated plants and delivery tickets for ready mix plants shall include the approved CMDT or CMDP number. The tickets shall be delivered to the Engineer.

Discharge from non-agitating equipment shall be completed within 30 min of mixing the water, cement, and aggregates. Discharge from a truck agitator or a truck mixer shall be completed within 90 min of mixing the water, cement, and aggregates.

Concrete shall be uniformly mixed when delivered to the job site. The Engineer may conduct additional testing to verify uniformity of the mixture. Additional testing will consist of slump tests taken in accordance with AASHTO T 119 at approximately the 1/4 and 3/4 points of a load. If the slumps differ by more than 1 in. (25 mm) when the average slump is 3 in. (75 mm) or less, or by more than 2 in. (50 mm) when the average slump is greater than 3 in. (75 mm), paving operations may be suspended while the mixing process is jointly reviewed and problems resolved by the Engineer and the Contractor.

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 min of initial mixing per the QCP. Any addition of water shall be noted on the batch ticket and shall not occur as a continuing operation.

501.15 Weather Limitations

PCCP shall not be placed on frozen subgrade or subbase. PCCP shall be placed when the ambient temperature is 35°F (2°C) and above, unless procedures outlined in the QCP for lower temperatures are followed. Prior to attaining opening to traffic strengths in accordance with 501.23, sufficient means shall be taken to prevent the PCCP from freezing.

501.16 Placing Concrete

The batches shall be deposited so as to have a uniform mix and require as little rehandling as possible. The plastic concrete shall not be segregated during placement. Dowel bars and assemblies shall not be displaced during placement of concrete.

Concrete shall be thoroughly consolidated against the faces of all forms or adjacent concrete surfaces. Hand placed concrete shall be thoroughly consolidated with the use of a vibrator. Vibrators shall not operate in any one location so as to bring excessive mortar to the surface, and shall not come in contract with a dowel bar assembly, subgrade, subbase, or forms.

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

The Contractor shall be responsible for the protection of the existing joints from the intrusion of fresh concrete mortar, and for any damage to existing pavement caused by the operation of mechanical equipment. Concrete materials that fall on or are worked into the joints or surface tines of an existing slab, shall be removed immediately.

Concrete shall not be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated in accordance with the QCP.

The Contractor shall have available at all times sufficient materials for the protection of unhardened PCCP from the effects of rain. Covering material such as burlap

or polyethylene sheeting shall be provided. When rain appears imminent, paving operations shall stop. All available personnel shall be used to cover the PCCP.

501.17 CMDT Adjustments

The target water/cementitious ratio and target unit weight may be adjusted during the first lot of each year's production or as a result of fluctuations in fine or coarse aggregate specific gravities.

Adjustments to the dosage amount of admixtures will be permitted; however, a new CMDS will be required for the addition or deletion of an admixture.

The fine aggregate to total aggregate ratio may be adjusted by ±3% within the limits of 501.05.

501.18 Joints

Joints shall be in accordance with 503.

501.19 Finishing

PCCP shall be finished in accordance with 504.

501.20 Curing

PCCP shall be cured with an approved white pigmented liquid membrane forming compound. Alternative methods of curing may be approved by the Engineer. Curing shall be in accordance with 504. For formed PCCP, immediately after the forms are removed, the sides of the PCCP shall be cured.

501.21 Form Removal

Forms may be removed as soon as the PCCP has hardened sufficiently to prevent edge spalling or other damage. Form pullers shall not be supported on the PCCP during form removal operations.

501.22 Pavement Inspection

The Contractor and Engineer will conduct an inspection of the new PCCP for any damage, including freezing or random cracks. The inspection and all necessary repairs shall be completed prior to opening the pavement to non-construction traffic. All random, full-depth cracks in the PCCP shall be corrected in accordance with 503.06. All other damages shall be repaired by approved methods.

501.23 Opening to Traffic

The Contractor shall be responsible for controlling the opening of the PCCP to construction and non-construction traffic and include the procedures in the QCP. Pavement inspection will be completed in accordance with 501.22.

(a) Construction

Construction vehicles or equipment will be allowed on the PCCP after 10 days or when flexural tests indicate a modulus of rupture of 550 psi (3800 kPa) or greater. ITM 402 may be used as an alternate method to determine the flexural strength. All construction vehicles or equipment that may damage the PCCP shall not be used on the

PCCP unless adequate protection is provided. Approved joint cutting saws may be operated on the PCCP.

(b) Non-Construction

PCCP may be opened to traffic after 14 days. The PCCP may be opened earlier if test beams or ITM 402 indicate a modulus of rupture of 550 psi (3800 kPa) or greater. If adequate strengths are not met within 14 days, an investigation by the Engineer and Contractor will be conducted to determine if the PCCP is deficient. Resolutions for all deficiencies will be developed at the completion of the investigation. Cracks and joints shall be sealed in accordance with 503.05 and the PCCP cleaned prior to opening to traffic.

501.24 Shoulder Corrugations

Shoulder corrugations shall be in accordance with 606.

501.25 Pavement Smoothness

The pavement smoothness will be accepted by means of a profilograph, a 16 ft (4.9 m) long straightedge, or a 10 ft (3 m) long straightedge.

The profilograph shall be used where all of the following conditions are met:

(a) the design speed is greater than 45 mph (70 km/h), and

(b) the pavement lanes excluding shoulders are full width and 0.1 mi (0.16 km) or longer

If a pay item, profilograph, PCCP, is included in the contract, and the above conditions are met, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 912. The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor. When a profilograph, PCCP is not included as a pay item, and the above conditions are met, the Department will furnish, calibrate, and operate the profilograph or the Department will develop a change order in accordance with 109.05 to include profilograph, PCCP as a pay item.

The 16 ft (4.9 m) long straightedge shall be used on all full-width pavement lanes shorter that 0.1 mi (0.16 km), on tapers, within 50 ft (15 m) of a reinforced concrete bridge approach, and within 50 ft (15 m) of an existing pavement which is being joined, and shoulders greater than 10 ft (3 m) wide.

The 10 ft (3 m) long straightedge shall be used for transverse slopes, approaches, and crossovers.

As soon as the PCCP has cured sufficiently, the smoothness may be checked. Profile testing shall be completed prior to opening the pavement to traffic. The Department may direct that the pavement profile be evaluated within 24 h following placement. When profile testing is consistently outside pavement surface tolerances the paving operation shall be discontinued until an amended QCP is submitted. An initial profile index will be determined from the profilogram of this profile. The initial profile

index for areas requiring replacement will be adjusted to include the results of a profilogram of all replaced areas.

Pavement smoothness variations outside specified tolerances shall be corrected by grinding with a groove type cutter or by replacement. Grinding will not be permitted until the PCCP is 10 days old or the flexural strength test is 550 psi (3800 kPa) or greater. The grinding of the pavement to correct the profile shall be accomplished in either the longitudinal or the transverse direction. The PCCP texture after grinding shall be uniform. If the grinding operation reduces the tining grooves to a depth of less than 1/16 in. (1.5 mm) and the longitudinal length of the removal area exceeds 15 ft (4.5 m), or two or more areas are within 30 ft (9.0 m) of each other, the PCCP shall be re-textured in accordance with 504.03.

When the 16 ft (4.9 m) straightedge is used, the pavement variations shall be corrected to 1/4 in. (6 mm) or less. When the 10 ft (3 m) straightedge is used, the pavement variations shall be corrected to 1/8 in. (3 mm) or less.

When the profilograph is being used, the pavement variations shall be corrected to a profile index of 12.0 in./0.1 mi (30 mm/0.16 km) or less. In addition to the requirements for the profile index, all areas having a high or low points deviation in excess of 0.3 in. (8 mm) shall be corrected. Verifying profilograph measurements will be taken only in the 0.1 mi (0.16 km) length where corrections have been performed.

501.26 Pavement Thickness

PCCP thickness shall be determined after all corrective grinding. The Contractor shall obtain cores at the locations determined by the Engineer in accordance with ITM 802. Cores, 4 in. (100 mm) in diameter, shall be taken in the presence of the Engineer for the full depth of the PCCP. The Engineer will take immediate possession of the cores. Cores shall not be taken within 6 in. (150 mm) of the edge of pavement, within 3 in. (75 mm) of longitudinal joints, within 2 ft (0.6 m) of D-1 contraction joints, or within 5 ft (1.5 m) of a transverse construction joint. Cores shall be taken and measured in accordance with ITM 404. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

The width of adjudicated PCCP shall be the width of pavement lane in which the deficiency occurs. Pavement that has been replaced shall be investigated for thickness.

The thickness of the PCCP for each sublot shall be the average lengths of both cores from the sublot. Calculations shall be to the nearest 0.1 in. (2.5 mm).

501.27 Tolerance

Plastic unit weight, water/cementitious ratio, flexural beam, and air content tests will be performed during PCCP operations.

(a) Plastic Unit Weight

Sublots shall not vary by more than ±3.0% from the target unit weight. A stop paving order will be issued if the plastic unit weight exceeds ±3.0% from the target plastic unit weight (mass). Paving operations shall not resume until satisfactory changes are made or an alternate CMDT or CMDP is used.

Calculations for the plastic unit in lbs/yd^3 will be made and reported to the nearest figure in the tenth (calculations in kg/m^3 will be made and reported to the nearest whole unit).

(b) Water to Cementitious Ratio

The weekly water to total cementitious materials ratio shall not vary more than ±0.030 of the target value or exceed 0.450. A stop paving order will be issued if the test results exceed these values. Paving operations shall not resume until satisfactory changes are made or an alternate CMDT or CMDP is used.

Calculations for water to cementitious ratio will be made and reported to the nearest figure in the third decimal place.

(c) Flexural Strength

Average lot values of 570 psi (4000 kPa) and above shall be achieved. Price adjustments for values outside the tolerance limits will be in accordance with 501.28.

Calculations for flexural strength in psi will be made and reported to the nearest whole unit (kPa to the nearest 10 kPa).

(d) Air Content

The average lot air content values shall not vary more than -0.8% to +2.4% from the 6.5% target air content. The range of sublot air content values shall not exceed 2.5%. Price adjustments for values outside the tolerance limits or range will be in accordance with 501.28.

Calculations for air content percentage will be made and reported to the nearest figure in the first decimal place.

501.28 Pay Factors

When the PCCP test results for flexural strength, air content, air content range, smoothness, and thickness exceed the allowable tolerances, pay factors will be determined. The pay factors will be used to calculate a quality assurance adjustment quantity for the lot.

The adjustment for flexural strength, air content, air content range, thickness, and smoothness will be calculated as follows:

$$q = L \times U \times (P - 1.00)$$

where:

q = quality assurance adjustment quantity
L = lot quantity
U = unit price for QC/QA-PCCP, \$/yd^2 (\$/m^2)
P = pay factor

For sublot thickness determination:

$$q_T = l_T \times U \times (P - 1.00)$$

where:

q_T = quality assurance adjustment quantity
l_T = sublot quantity for thickness
U = unit price for QC/QA-PCCP, \$/yd^2 (\$/m^2)
P = pay factor

The quality assurance adjustment points for smoothness, Qs, will be calculated in accordance with 501.28(d).

The total quality assurance adjustments will be calculated as follows:

$$Q_T = \Sigma\ (q_{T1} + q_{T2} + q_{T3}), \text{ and}$$

$$Q = \Sigma\ (q_F + q_A + q_R + Q_T) + Q_S$$

where:

Q = total quality assurance adjustment quantity
Q_S = quality assurance adjustment for smoothness
q_F = lot quality assurance adjustments for flexural strength
Q_T = lot quality assurance adjustments for thickness
q_A = lot quality assurance adjustments for air content
q_R = lot quality assurance adjustments for range

If the Contractor is not required to remove the pavement or take other corrective actions, quality assurance adjustments of the lot will be assessed as determined by the Materials and Tests Division.

(a) Flexural Strength

When test results for flexural strength exceed the allowable tolerance, a pay factor will be assessed as follows:

1. Lots

Lot Average Flexural Strength	
Psi (kPa)	Pay Factors
570 (3927) and Above	1.00
565 – 569 (3893 – 3926)	0.98
560 – 564 (3858 – 3892)	0.96
555 – 559 (3824 – 3857)	0.94
550 – 554 (3789 – 3823)	0.92
545 – 549 (3755 – 3788)	0.89
540 – 544 (3720 – 3754)	0.86
535 – 539 (3686 – 3719)	0.83
525 – 534 (3617 – 3685)	0.78
515 – 524 (3548 – 3616)	0.72
514 (3547) or less	*

* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

2. Sublots

If a sublot value is less than 500 psi (3500 kPa), the PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. For a sublot completely removed, the sublot test value from the replacement sublot will replace the original test value.

(b) Air Content

When test results for air content exceed the allowable tolerance or range, a pay factor will be assessed as follows:

1. Lots

Lot Average Air Content	
Percent	Pay Factors
> 10.0	*
10.0	0.80
9.7 – 9.9	0.85
9.5 – 9.6	0.91
9.3 – 9.4	0.96
9.0 – 9.2	0.98
5.7 – 8.9	1.00
5.0 – 5.6	0.99
4.7 – 4.9	0.98
4.6	0.88
4.5	0.80
< 4.5	*

* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

Lot Range for Air Content	
Percent	Pay Factors
0.0 – 2.5	1.00
2.6 – 3.0	0.99
3.1 – 3.5	0.97
> 3.5	*

* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

2. Sublots

If a sublot value is less than 4.0% or greater than 10.0%, the PCCP will be adjudicated as a failed material in accordance with normal Department practice in accordance with 105.03. For a sublot completely removed, the sublot test value from the replacement sublot will replace the original test value.

(c) Thickness

When test results for pavement thickness do not meet the specified thickness, a pay factor will be assessed as follows:

Sublot Pay Factors For Thickness	
Average Core depth (ACD) Design Depth (DD)	
ACD Minus DD	Pay Factor
> + 0.5 in. (> + 13 mm)	1.05
+ 0.3 in. to 0.5 in. (+ 7 mm to + 13 mm)	1.02
± 0.2 in. (6 mm)	1.00
- 0.3 in. to - 0.5 in. (- 6 mm to - 13 mm)	0.96
- 0.6 in. to - 0.7 in. (- 14 mm to - 19 mm)	0.90
- 0.8 in. to - 1.0 in. - 20 mm to - 25 mm)	0.80
< - 1.00 in. (< - 25 mm)	*

* The PCCP will be adjudicated as a failed material in accordance with normal Department practice as listed in 105.03. The PCCP may be subject to removal and replacement or left in place with reduced or no payment.

(d) Smoothness

When the pavement smoothness is tested with a profilograph, pavement will be based on a zero blanking band on the final profile index after corrective action. A Quality Assurance Pay Factor (PFs) for smoothness will apply to the planned thickness of the PCCP. The quality assurance adjustment for each section will include the total area of each pavement lane excluding shoulders for 0.1 mi (0.16 km) long section represented by the profile index calculated by the following formula:

$$q_s = (PF_s - 1.00) \times A \times U$$

where:

q_s = quality assurance adjustment for smoothness for one section
PF_s = pay factor for smoothness
A = area of the section, SYS (m^2)
U = unit price for the material \$/SYS (\$/m^2)

The quality assurance adjustment for smoothness, Qs, for the contract will be the total of the quality assurance adjustments for smoothness, qs, on each section by the following formula:

$$Q_s = \Sigma\, q_s$$

SECTION PAY FACTORS FOR SMOOTHNESS ($PI_{0.0}$) ZERO BLANKING BANK	
Design Speed Greater Than 45 mph (70 km/hr)	
Profile Index in./0.1 mi. (mm/0.16 km)	Pay Factor
Over 0.00 to 1.00 in. (Over 0 to 25 mm)	1.06
Over 1.00 to 1.20 in. (Over 25 to 30 mm)	1.05
Over 1.20 to 1.40 in. (Over 30 to 35 mm)	1.04
Over 1.40 to 1.60 in. (Over 35 to 40 mm)	1.03
Over 1.60 to 1.80 in. (Over 40 to 45 mm)	1.02
Over 1.80 to 2.20 in. (Over 45 to 55 mm)	1.01
Over 2.20 to 2.60 in. (Over 55 to 65 mm)	1.00
Over 2.60 to 2.80 in. (Over 65 to 70 mm)	0.96
Over 2.80 to 3.00 in. (Over 70 to 75 mm)	0.92
All pavementS with a Profile Index ($PI_{0.0}$) greater than 3.00 in. (75 mm) shall be corrected.	

501.29 Appeals

If the Contractor does not agree with the acceptance test results, a request may be made in writing for additional tests for a sublot(s) or lot. The basis of the appeal shall include applicable QC test results showing acceptable quality results and shall be submitted within five calendar days of receipt of the Department's written results for that lot. Upon review of the appeal, the Engineer may accept the PCCP in accordance with 105.03 or accept the appeal.

(a) Flexural Strength

Appeals will not be considered unless QC test results indicate greater than a 50 psi (350 kPa) difference between the Department's and the Contractor's tests. Upon approval for the additional testing, the Contractor shall obtain cores, as directed, in the presence of the Engineer.

The Engineer will determine the location of the cores within the appealed and adjacent sublots using the same CMD. The location of the cores will be at the center of a lane at the acceptance sample location. Cores shall not be taken over dowels or within 5 ft (1.5 m) of a header. Two cores shall be taken in each sublot for the full depth of pavement and shall be 4 in. (100 mm) in diameter. All core holes shall be filled with portland cement concrete within 24 h of drilling. If adjacent sublots were produced using different CMDs, the matter will be adjudicated as a failed material in accordance with normal Department practice.

Each core will be tested for split tensile strength in accordance with ASTM C 496. The cores will be submerged in lime saturated water prior to testing for a minimum of 40 h.

The average core split tensile strength will be determined for the appealed and adjacent sublots. Flexural strength will be calculated as follows:

$$F_D = S_D \text{ x } \left[\frac{F_{A1}}{2S_{A1}} + \frac{F_{A2}}{2S_{A2}} \right]$$

where:

F_D = flexural strength of the appealed sublot
F_{A1} = flexural strength of the previous adjacent sublot
F_{A2} = flexural strength of the subsequent adjacent sublot
S_D = split tensile strength of the appealed sublot
S_{A1} = split tensile strength of the previous adjacent sublot
S_{A2} = split tensile strength of the subsequent adjacent sublot

(b) Air Content

Appeals will not be considered unless QC test results indicate greater than a 0.5% difference between the Department's and the Contractor's tests. Upon approval for the additional testing, the Contractor shall obtain core(s) as directed in the presence of the Engineer.

The Engineer will determine the location of the core(s) within the appealed sublot(s). The location of the core will be at the center of a lane at the acceptance sample location. A core shall not be taken over dowels or within 5 ft (1.5 m) of a header. One 4 in. (100 mm) diameter full depth core shall be taken from the pavement for each sublot appealed. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

The air content for a sublot will be the hardened concrete air content determined from the core in accordance with ITM 401. When ACBF aggregates are used, the hardened concrete air content will be determined in accordance with ASTM C 457.

501.30 Method of Measurement

QC/QA-PCCP will be measured by the square yard (square meter) of the thickness specified. The area of QC/QA-PCCP will be the planned width of the pavement multiplied by the length of the pavement, or as directed in writing. The width of the pavement will be as shown on the typical cross section of the plans. The length of the pavement will be measured parallel to the surface of the pavement along the centerline of the roadway or ramp, excluding paving exceptions as shown on the plans.

Milled shoulder corrugations will be measured in accordance with 606.02.

501.31 Basis of Payment

The accepted quantities of QC/QA-PCCP will be paid for at the contract unit price per square yard (square meter) for the thickness specified, complete in place.

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made at the contract lump sum price for profilograph, PCCP.

Adjustments to the contract payment with respect to flexural strength, thickness, air content, range and smoothness will be included in a quality assurance adjustment pay item in accordance with 109.05.1.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment for pavement thickness determinations will be made at the contract lump sum price for coring, PCCP. A change order in accordance with 109.05 will be developed to adjust the cost of coring when the final QC/QA-PCCP quantity differs from the bid quantity by more than 2400 syd (2000 m^2). This adjustment covers the cost of cores for the adjusted quantity of QC/QA-PCCP. The adjustment, plus or minus, will be based on the difference in the number of sublots, rounded to the nearest full sublots, times $100.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Coring, PCCP	LS
Profilograph, PCCP	LS
QC/QA-PCCP, _____ in. (mm) thickness	SYS (m2)

The cost of trial batch demonstrations shall be included in the cost of PCCP.

The price of profilograph, PCCP will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

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

The cost of coring and refilling of the pavement holes for appeals shall be included in the cost of QC/QA-PCCP.

Traffic control for appeals shall be supplied with no additional payment.

Removal and replacement of QC/QA-PCCP damaged by freezing shall be with no additional payment.

SECTION 502 – PORTLAND CEMENT CONCRETE PAVEMENT, PCCP

502.01 Description

This work shall consist of portland cement concrete pavement, PCCP, placed on a prepared subgrade or subbase in accordance with 105.03.

MATERIALS

502.02 Materials

Materials shall be in accordance with the following:

Admixtures.....912.03
Coarse Aggregate, Class AP, Size No. 8 904
Fine Aggregate, Size No. 23 904
Fly Ash.....901.02
Ground Granulated Blast Furnace Slag.....901.03
Portland Cement.....901.01(b)
Rapid Set Patching Materials.....901.07
Water.....913.01

502.03 Concrete Mix Design

A concrete mix design submittal, CMDS, shall be in accordance with 502.04. The CMDS shall be submitted one week prior to production and approved by the DMTE. The CMDS shall be submitted utilizing the Department provided spreadsheet and shall include the following:

(a) a list of all ingredients
(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) the batch weights (mass)
(h) the names of all admixtures
(i) the admixture dosage rates and the manufacturer's recommended range

Production may commence once the DMTE approves the submission as a CMDP.

(a) Change in Materials

A change in a CMDP to any of the following requires a new CMDS.

1. cement type
2. admixture type
3. pozzolan type
4. aggregate material

(b) Change in Source

A change in a CMDP to any of the following requires a new CMDS.

1. cement source
2. admixture source
3. pozzolan source
4. aggregate source

(c) Change in Mixture

A change in a CMDP to any of the following requires a new CMDS.

1. proportions of aggregates by weight (mass) exceeding ± 2%
2. addition or deletion of an admixture

A CMDP in accordance with 501.05 may be used upon the approval of the DMTE. A CMDP in accordance with 502.04 from a previous contract may be submitted for use upon the approval of the DMTE.

502.04 Concrete Mix Criteria

The fine aggregate shall be at least 35% but not more than 45% of the total weight (mass) of the aggregate in each cubic yard (cubic meter). Proportions will be based upon saturated surface dry aggregates.

(a) Portland Cement Concrete

The CMD shall produce workable concrete mixtures, with the minimum amount of water, and having the following properties.

Portland cement content ..... 564 lbs/yd^3 (335 kg/m^3)
Maximum water/cementitious ratio 0.487
Maximum substitution of fly ash for portland cement 20%
Fly Ash/portland cement substitution ratio ..... 1.25 by weight (mass)
Maximum substitution of GGBFS for portland cement 30%
GGBFS/portland cement substitution ratio ..... 1.00 by weight (mass)
Slump, formed ..... 2 in. (50 mm) to 4 in. (100 mm)
Slump, slipformed ..... 1.25 in. (30 mm) to 3 in. (75 mm)
Air ..... 5.0% to 8.0%
Minimum flexural strength, third point loading,
with fly ash ..... 550 psi (3800 kPa) at 28 days
Relative yield ..... 0.98 to 1.02

Class C concrete in accordance with 702 using Class AP coarse aggregate may be substituted in PCCP.

Chemical admixtures type A, type B, type C, type D, and type E may be permitted with prior written approval.

Fly ash or GGBFS used as an additive, or blended portland cements may only be incorporated in the concrete mix between April 1 and October 15 of the same calendar year. If type IP, type IP-A, type IS or type IS-A cements are to be used, the portland cement content shall be increased to 598 lbs/yd^3 (355 kg/m^3). The use of fly ash or GGBFS as an additive will not be permitted when blended portland cements are used.

(b) High-Early Strength Concrete

The Contractor shall submit, along with the CMDS, all supporting test results for approval to the DMTE prior to placing concrete. Testing shall be conducted by an American Concrete Institute, ACI, certified concrete field testing technician, grade 1. The supporting test results shall be signed by the technician and include air content, slump, relative yield, water cement ratio, and the flexural strengths at one day, two days, and seven days.

The CMD shall produce workable concrete mixtures, with the minimum amount of water, and having the following properties.

Minimum portland cement content (type I or III)..... 564 lbs/yd^3 (335 kg/m^3)
Maximum fly ash addition .....10% of cement content
Maximum water/cementitious ratio (type I) 0.42
Maximum water/cementitious ratio (type III).....0.45
Maximum GGBFS addition .....15% of cement content
Slump, formed..... 2 in. (50 mm) to 4 in. (100 mm)
Slump, slipformed..... 1.25 in. (30 mm) to 3 in. (75 mm)
Air content.....5.0% to 8.0%
Minimum flexural strength, third point
loading.....550 psi (3800 kPa) at 2 days
Relative yield ..... 0.98 to 1.02

Fly ash or GGBFS used as an additive may only be incorporated in the concrete mix between April 1 and October 15 of the same calendar year.

Chemical admixtures type A, type B, type C, type D, and type E may be permitted with prior written approval.

502.05 Job Control

Control of PCCP for air content, slump, or relative yield 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 will be in accordance with the Frequency Manual.

The Engineer will notify the Contractor when test results for air content, slump, or relative yield are outside the requirements of 502.04. Rounding will be in accordance

with 109.01(a). The Contractor shall adjust the mixture such that it is in accordance with 502.04.

CONSTRUCTION REQUIREMENTS

502.06 General

Equipment for PCCP shall be in accordance with 508.

Aggregate stockpiles shall be located in well drained areas to prevent the soil from pumping into and contaminating the aggregate that is to be used in PCCP. Stockpiles shall be built in layers not to exceed 6 ft (2 m). Upper layers shall be prevented from spilling onto the lower layers.

Aggregate stockpiles shall be worked to minimize segregation and maintain uniform moisture content. Aggregates which have become contaminated shall not be used.

The water measuring device will be checked under actual working conditions or at any other time deemed necessary. All labor and equipment required for calibrating and checking shall be furnished.

The volume of the batched concrete shall not exceed the manufacturer's standard rating for the concrete mixer.

502.07 Preparation of Grade

The subgrade shall be shaped to the required grade and section, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

502.08 Preparation of Subbase

Subbase, if required, shall be placed and shaped to the required grade and section in accordance with 302. Construction traffic shall not be allowed on the aggregate drainage layer of the subbase, except where PCCP placement is restricted. Exceptions shall be submitted for approval.

502.09 Placement

Placement of PCCP shall be by the slipformed or formed methods with equipment specified in 508.04. The subgrade or subbase shall be uniformly moist at the time of PCCP placement. Excessively dry subgrade or subbase shall be sprinkled with water. Dowel bars shall be coated with a bond breaking material and the coating shall be evident at the time of placement.

If the slip-form method is used the subgrade or subbase shall firmly support the paving equipment to construct the specified alignment and grade. The slip-form paver shall be operated with as nearly a continuous forward movement as possible. If it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped. Edge slump of PCCP shall not exceed 1/4 in. (6 mm).

When the slip-form method is used, the Contractor shall have metal or wood forms available for protection of the PCCP edges should excessive edge slump occur.

If forms are used they shall be firmly supported by the subbase or subgrade for the entire length of the form at the specified alignment and grade. The alignment of the forms shall not deviate more than 1/4 in. (6 mm) in the horizontal direction from the planned PCCP width for tangent sections.

Forms shall be staked into place with a minimum of three pins for each 10 ft (3 m) section. A pin shall be placed at each side of every joint. Form sections shall be locked tightly and be free from play or movement in any direction. No excessive settlement or springing of forms under the finishing machine will be allowed. Forms shall be cleaned and oiled prior to the placing of concrete.

Forms shall be kept a minimum of 500 ft (150 m) ahead of concrete placement when distance permits. Any material displaced during form setting operations shall be thoroughly compacted. If material under the forms becomes unstable before concrete is placed, the forms shall be removed, the grade corrected, and the forms reset.

502.10 Concrete Mixing and Transportation

Concrete mixing and transportation shall be completed by central mixed, shrink mixed, or transit mixed methods. The minimum batch of concrete shall be 2 yd^3 (1.5 m^3). Discharge from non-agitating equipment shall be completed within 30 min of mixing the water, cement, and aggregates. Discharge from a truck agitator or a truck mixer shall be completed within 90 min of mixing the water, cement, and aggregates.

Concrete shall be uniformly mixed when delivered to the job site. Batch tickets for each load of PCC shall indicate the weight (mass) of cement, pozzolan, and aggregates, volume or weight (mass) of water, and the type and volume of admixtures. The weight (mass) of the cement shall be within 1% of the CMDP, the saturated surface dry weight (mass) of the aggregates shall be within 2% of the CMDP, and the volume or weight (mass) of water shall be within 1% of the required amount.

The Engineer may conduct additional testing to verify uniformity of the mixture. Additional testing will consist of slump tests taken in accordance with AASHTO T 119 at approximately the 1/4 and 3/4 points of a load. If the slumps differ by more than 1 in. (25 mm) when the average slump is 3 in. (75 mm) or less, or by more than 2 in. (50 mm) when the average slump is greater than 3 in. (75 mm), paving operations may be suspended while the mixing process is jointly reviewed and problems resolved by the Engineer and the Contractor.

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 min of initial mixing. Any addition of water shall be noted on the batch ticket and shall not occur as a continuing operation.

Stationary mixers shall be operated at the manufacturer's recommended drum speed. Batches shall not exceed the nominal capacity of the mixer. A maximum overload

of 10% may be permitted provided strength and consistency remain satisfactory and no spillage of concrete takes place.

(a) Central Mixed Concrete

Central mixed concrete shall be completely mixed in a stationary mixer and transported in a truck agitator, truck mixer at agitating speed, or non-agitating equipment.

Mixing for central mixed concrete shall be no less than 60 s per batch. The mixing time shall be measured from the time all cement and aggregates are in the drum. The batch shall be so discharged into the mixer that some of the water enters in advance of the cement and aggregates. All required water shall be in the drum by the end of the first quarter of the specified mixing time.

If a truck mixer or truck agitator is used for transportation, the concrete shall be agitated at the agitation speed designated by the manufacturer.

(b) Shrink Mixed Concrete

Shrink mixed concrete shall be partially mixed in a stationary mixer and the mixing completed at the plant in a truck mixer.

The time in a stationary mixer for shrink mixed concrete may be reduced to approximately 30 s. Mixing shall then be completed in a truck mixer at the plant by 50 to 100 revolutions of the drum at the mixing speed designated by the manufacturer. Agitation during transportation shall be at the agitation speed designated by the manufacturer.

(c) Transit Mixed Concrete

Transit mixed concrete shall be completely mixed and transported in a truck mixer.

Mixing for a truck mixer loaded to rated capacity shall be 70 to 100 revolutions of the drum at the mixing speed, but not less than the number of revolutions recommended by the manufacturer. Discharge shall be competed prior to 300 revolutions of the drum.

502.11 Weather Limitations

PCCP shall not be placed on a frozen subgrade or subbase. PCCP operations shall not begin until the ambient temperature is 35°F (2°C) and rising. PCCP operations shall be discontinued when the ambient temperature is descending and is 40°F (4°C) or below. PCCP operations may occur outside these temperatures when authorized in writing. Regardless of placement temperature, sufficient means shall be taken to prevent the PCCP from freezing prior to attaining opening to traffic strengths in accordance with 502.18. Any PCCP damaged by freezing shall be removed and replaced.

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and prevent the occurrence of overheated areas which might damage the materials. Unless authorized, the temperature of the mixed concrete shall not be less than 50°F (10°C) and not more than 80°F (27°C) at the time of placement.

When the water or the aggregates are heated, they shall be a minimum of 70°F (21°C) or a maximum of 150°F (66°C). When either aggregates or water are heated to above 100°F (38°C), they shall be combined in the mixer before the cement is added.

502.12 Placing Concrete

The batches shall be deposited so as to have a uniform mix and require as little rehandling as possible. The plastic concrete shall not be segregated during placement. Rakes shall not be used to handle plastic concrete. Dowel bars and assemblies shall not be displaced during placement of concrete. Plastic concrete shall not be contaminated with earth or other foreign matter.

Concrete shall be thoroughly consolidated against the faces of all forms or adjacent concrete surfaces. Hand placed concrete shall be thoroughly consolidated with the use of a vibrator. Vibrators shall not operate in any one location so as to bring excessive mortar to the surface, and shall not come in contact with a dowel bar assembly, subgrade, subbase, or forms.

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

The Contractor shall be responsible for the protection of the existing joints from the intrusion of fresh concrete mortar, and for all damage to existing pavement caused by the operation of mechanical equipment. Concrete materials that fall on or are worked into the joints or surface tines of an existing slab, shall be removed immediately.

Concrete shall not be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

The Contractor shall have available at all times sufficient materials for the protection of unhardened PCCP from the effects of rain. Covering material such as burlap or polyethylene sheeting shall be provided. When rain appears imminent, paving operations shall stop. All available personnel shall be used to cover the PCCP.

502.13 Joints

Joints shall be in accordance with 503.

502.14 Finishing

PCCP shall be finished in accordance with 504.

502.15 Curing

PCCP shall be cured with an approved white pigmented liquid membrane forming compound. Alternative methods of curing may be approved by the Engineer. Curing shall be in accordance with 504. For formed PCCP, immediately after the forms are removed, the sides of the PCCP shall be cured.

502.16 Form Removal

Forms may be removed as soon as the PCCP has hardened sufficiently to prevent edge spalling or other damage. Form pullers shall not be supported on the PCCP during form removal operations.

502.17 Pavement Inspection

The Contractor and Engineer will conduct an inspection of the new PCCP for any damage, including freezing or random cracks. The inspection and all necessary repairs shall be completed prior to opening the pavement to non-construction traffic. All random, full-depth cracks in the PCCP shall be corrected in accordance with 503.06. All other damages shall be repaired by approved methods.

502.18 Opening to Traffic

When fly ash, GGBFS, or cement type IP, type IS, type IP-A, or type IS-A is incorporated into the PCCP, traffic shall not be allowed on the PCCP until the test beams indicate a modulus of rupture of 550 psi (3800 kPa) or greater. Opening to traffic of PCCP not containing the above additives shall be based on the following.

(a) Construction

Construction vehicles or equipment may be allowed on the PCCP after 10 days or when the test beams indicate a modulus of rupture of 550 psi (3800 kPa) or greater. Any construction vehicle or equipment that may damage the PCCP shall not be used on the PCCP unless adequate protection is provided. Approved joint cutting saws may be operated on the PCCP as determined by the Contractor.

(b) Non-Construction

PCCP may be opened to traffic after 14 days or when test beams indicate a modulus of rupture of 550 psi (3800 kPa) or greater. Prior to opening to traffic, cracks and joints shall be sealed in accordance with 503.05 and the PCCP shall be cleaned.

502.19 Shoulder Corrugations

Shoulder corrugations shall be in accordance with 606.

502.20 Pavement Smoothness

Pavement smoothness will be in accordance with 501.25 except profilograph requirements will not apply.

502.21 Pavement Thickness

PCCP thickness shall be determined after all corrective grinding. The Contractor shall obtain cores at the locations determined by the Engineer in accordance with ITM 802. Cores, 4 in. (100 mm) in diameter, shall be taken in the presence of the Engineer for the full depth of the PCCP. The Engineer will take immediate possession of the cores. Cores shall not be taken within 2 ft (0.6 m) of the edge of PCCP, over dowels, or within 5 ft (1.5 m) of a transverse construction joint. Cores shall be taken and measured in accordance with ITM 404. All core holes shall be filled with PCC or rapid setting patch material within 24 h of drilling.

If a core measurement reveals that the pavement is more than 1/2 in. (13 mm) deficient in thickness, additional cores shall be drilled at 20 ft (6.0 m) intervals on each side of the original core. These additional cores shall be on a line which passes through the original core and parallel to the centerline of the pavement. The drilling shall continue in both directions at 20 ft (6.0 m) intervals until two successive cores indicate a thickness

deficiency of 1/2 in. (13 mm) or less, or where cores can no longer be drilled in the new PCCP.

If a core indicates a thickness deficiency of more than 1.0 in. (25 mm) and two cores drilled adjacent at 20 ft (6.0 m) intervals indicate a thickness deficiency of not more than 1.0 in. (25 mm), additional cores shall be drilled at 5 ft (1.5 m) intervals on each side of the initial core. The drilling shall continue in both directions at 20 ft (6.0 m) intervals until two successive cores indicate a thickness deficiency of 1/2 in. (13 mm) or less, or where cores can no longer be drilled in the new PCCP.

When a single core indicates a thickness deficiency of more than 1.0 in. (25 mm), or if two or more adjacent cores indicate a thickness deficiency of more than 1/2 in. (13 mm), the investigation will be expanded to include adjoining PCCP. The additional cores shall be taken from the adjoining traffic lanes or shoulders at the same station at which the first core or cores indicated the deficiency, whether the lane was paved a the same time or not.

The width of adjudicated PCCP shall be the width of pavement lane in which the deficiency occurs. Pavement that has been replaced shall be investigated for thickness.

(a) Sections

The quantity of PCCP for each pay item will be defined as a section. The section will be divided into subsections of 1200 syd (1000 m^2). Sections less than 1200 syd (1000 m^2) shall not be cored. A minimum of one core shall be drilled at a random location within each subsection. A section greater than or equal to 1200 syd (1000 m^2) shall have a minimum of four cores drilled. Partial subsections shall not be cored unless otherwise directed. Widening of 3 ft (1.0 m) or less shall not be cored unless otherwise directed. Formed drives shall not be cored unless otherwise directed. Verification of the required pavement depth on formed drives shall be checked in the presence of the Engineer prior to pouring, by making stringline measurements every 10 ft (3 m) across the width of the drive. Any location deficient in thickness by 1/4 in. (6 mm) or more shall be corrected prior to placing PCCP.

(b) Average PCCP Thickness

The thickness of the PCCP for each section shall be the average lengths of all cores from the section. However, no cores shall be included from areas for which no payment will be made. Where PCCP has been removed and replaced the initial core lengths will be discarded and the core lengths of the replaced PCCP will be substituted. Any core measurements exceeding the specified PCCP thickness by more than 0.5 in. (13 mm) will be recorded as the specified PCCP thickness plus 0.5 in. (13 mm). Calculations shall be to the nearest 0.1 in. (2.5 mm).

(c) PCCP Adjusted Payment

If the average PCCP thickness is equal to or greater than the specified thickness, no adjustments will be made. If an average PCCP thickness is less than the specified thickness by up to 0.5 in. (13 mm), payment for that section will be adjusted in accordance with the following.

$$Q_T = Q \times U \times (1 - M^2 / S^2)$$

where:

Q_T = Quality assurance assessment for thickness
Q = The placed quantity of the PCCP section
M = The average PCCP thickness of the section
S = The specified PCCP thickness of the section
U = Unit bid price

(d) PCCP Non-Payment

Where two adjacent cores indicate a thickness deficiency of more than 1/2 in. (13 mm), no payment will be made unless the PCCP is removed and replaced. Payment for PCCP with non-adjacent cores indicating a thickness deficiency of more than 1/2 in. (13 mm) will be in accordance with 502.21(c).

The limits of non-payment shall extend from deficient core to the transverse joint location nearest the first additional core indicating a thickness deficiency of less than 1/2 in. (13 mm).

(e) PCCP Removal

Where two adjacent cores indicate a thickness deficiency of more than 1.0 in. (25 mm) the PCCP shall be removed and replaced. Non-adjacent cores indicating a thickness deficiency of more than 1.0 in. (25 mm) do not require removal and replacement.

The limits of removal and replacement shall extend from the deficient core to the transverse joint location nearest the first additional core indicating a thickness deficiency of less than 1/2 in. (13 mm).

502.22 Method of Measurement

PCCP will be measured by the square yard (square meter) of the thickness specified. The area of PCCP will be the planned width of the pavement multiplied by the length of the pavement, or as directed in writing. The width of the pavement will be as shown on the typical cross section of the plans. The length of the pavement will be measured parallel to the surface of the pavement along the centerline of the roadway or ramp, excluding paving exceptions as shown on the plans.

Milled shoulder corrugations will be measured in accordance with 606.02.

502.23 Basis of Payment

The accepted quantities of PCCP will be paid for at the contract unit price per square yard (square meter) for the thickness specified, complete in place.

Milled shoulder corrugations will be paid for in accordance with 606.03.

Payment will be made for portland cement content of more than 564 lbs/yd^3 (335 kg/m^3) when ordered in writing. Additional payment for the quantity used will be at the net unit price of portland cement as shown by certified vouchers for the quantity used in accordance with 109.05.

The quality assurance adjustment quantity for thickness will be determined in accordance with 502.21(c).

An adjustment to the contract payment with respect to thickness will be made utilizing the quality assurance adjustment pay item. The unit price for this pay item will be one dollar ($1.00). The quantity is the total calculated in accordance with 502.21(c). A change order developed in accordance with 109.05 will be prepared to reflect contract adjustments.

Payment for pavement thickness determinations will be made at the contract lump sum price for coring, PCCP in accordance with 501.31. A change order in accordance with 109.05 will be developed to adjust the cost of PCCP when the final PCCP quantity differs from the bid quantity by more than 2400 syd (2000 m^2). This adjustment covers the cost of cores for the adjusted quantity of PCCP. The adjustment, plus or minus, will be based on the difference in the number of subsections, rounded to the nearest full subsection, times $100.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
PCCP, _____, in. (mm) thickness	SYS (m2)
Quality Assurance Adjustment	DOL

No additional payment will be made for PCCP which has an average thickness above that shown on the plans.

The cost of trial batch demonstrations shall be included in the cost of PCCP.

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

Removal and replacement of PCCP found to be deficient or damaged by freezing shall be completed with no additional payment.

The cost of coring and refilling of the pavement holes for appeals shall be included in the cost of PCCP.

SECTION 503 – PCCP JOINTS

503.01 Description

The construction of PCCP joints, dowel bar assemblies, and joint sealing operations shall be in accordance with the following.

MATERIALS

503.02 Materials

Materials shall be in accordance with the following:

Chemical Anchor 901.05
Dowel Bars.....910.01(b)10
Epoxy Coated Reinforcing Bars.....910.01(b)9
Joint Filler 906.01
Joint Materials.....906
PCC Sealer/Healer 901.06
Reinforcing Bars 910.01

Tie bars shall be epoxy coated reinforcing bars.

Bent tie bars shall be deformed billet steel in accordance with 910.01 and ASTM A 615 (A 615M), grade 40 (300).

CONSTRUCTION REQUIREMENTS

503.03 Joints

Joints shall be constructed in accordance with the type and dimensions and at the locations shown on the plans or as directed. All joints shall be perpendicular to the subgrade.

Longitudinal joints shall be parallel to the centerline. The longitudinal joint shall not deviate from the true line shown on the plans by more than 1/4 in. (6 mm). Transverse joints shall be at right angles to the centerline and be continuous for the full width of the pavement.

All joints shall be cut to the required dimensions and sealed. All sawed joints shall be made by sawing equipment in accordance with 508.07 and shall be in accordance with the following.

(a) Type D-1 Contraction Joint

Type D-1 contraction joints shall be created by sawing slots in the pavement unless alternative methods are approved. The sawed contraction joint spacing shall be as shown on the plans or as directed, but shall not exceed 18 ft (5.5 m).

Sawed contraction joints shall be cut in two operations. The initial saw cut shall commence as soon as the concrete has hardened sufficiently to permit sawing without raveling, usually 2 to 12 h after placement. All joints shall be saw cut through the edges of the pavement to the required depth before uncontrolled shrinkage cracking takes place. The sawing operations shall be carried on during day and night, regardless of weather conditions. The sawing of a joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued if a crack develops ahead of the saw. Formed contraction joints may be used where conditions make sawing impractical.

The second saw cut shall be made after the concrete has sufficiently cured, but before opening the pavement to non-construction traffic. Slurry or saw residue remaining in the slot shall be immediately flushed. Construction traffic shall not be allowed on the PCCP after the second saw cut until the joint is sealed.

The sawed slot shall be cleaned to remove all foreign matter from the entire depth of cut. Joint sealing shall be in accordance with 503.05.

(b) Longitudinal Joint

Longitudinal joints shall be created by sawing slots in the pavement unless alternative methods are approved. The longitudinal joint spacing shall be as shown on the plans or as directed, but shall not exceed 16 ft (5.0 m). Tie bars shall be placed by mechanical equipment in accordance with 508.04(a), or rigidly secured in place by chairs, or other approved methods.

Longitudinal joints shall be cut to the depth, width, and line shown on the plans. The longitudinal joint slots shall be sawed concurrently with the initial D-1 contraction joint slots. If random cracking occurs ahead of sawing, the sawing operations shall be discontinued in that area. A second saw cut shall be made when construction traffic uses the PCCP prior to sealing. Joint sealing shall be in accordance with 503.05.

Longitudinal joints may be replaced with longitudinal construction joints when approved by the Engineer.

(c) Transverse Construction Joints

Transverse construction joints shall be constructed when there is an interruption of more than 30 min in the PCCP placement operations. A transverse construction joint located at a D-1 contraction joint shall be in accordance with 503.03(a), except the initial saw cut shall be omitted. All other transverse construction joints shall be located at least 6 ft (2 m) from an adjacent D-1 contraction joint.

Tie bars for transverse construction joints may be placed in the plastic or hardened concrete. A header board with openings for tie bars shall be used when placing tie bars in plastic concrete. The header board shall be rigid and accurately set to grade. Tie bars placed in hardened concrete shall be retrofitted in accordance with 503.03(g).

(d) Longitudinal Construction Joint

The longitudinal construction joint spacing shall be as shown on the plans or as approved. Tie bars shall be placed by mechanical equipment in accordance with 508.04(a) or other approved methods. Longitudinal construction joint saw cuts may be made as soon as the PCCP has sufficiently hardened.

Longitudinal construction joints shall be cut to the depth, width, and line shown on the plans. Construction traffic shall not be allowed on the PCCP after the saw cuts are made until the joints are sealed. Joint sealing shall be in accordance with 503.05.

Bent tie bar spacing shall be adjusted to prevent interference with the D-1 contraction joints. Bent tie bars shall not be omitted. Bent tie bars shall be replaced with retrofitted tie bars when more than one tie bar breaks within 30 ft (10 m) during straightening.

The longitudinal construction joint for shoulder widths less than 6 ft (1.8 m) may be replaced by a longitudinal joint or be eliminated by extending the type D-1 contraction

joint through the shoulder. If either option is used, the mainline and shoulder shall be constructed at the same time.

(e) Terminal Joints

Terminal joints shall consist of a sleeper slab, polyethylene bond breaker, and HMA mixtures. The polyethylene bond breaker shall be an approved polyethylene sheeting having a thickness of 6 mils (150 µm) or greater. HMA mixtures shall consist of type B surface and intermediate mixtures in accordance with 402.04. A MAF in accordance with 402.05 will not apply. Aggregate requirements of 904.03(d) do not apply. The portion of the sleeper slab on which the polyethylene bond breaker is to be placed shall be finished to a smooth trowel finish.

(f) Expansion Joints

Expansion joints shall be constructed at the locations shown on the plans and shall consist of joint filler.

The joint filler shall be shaped to the subgrade, parallel to the surface, and be full width of the pavement. Damaged or repaired joint filler shall not be used.

The joint filler shall be held in a position which is normal to the surface. Finished joints shall deviate no more than 1/4 in. (6 mm) in the horizontal alignment from a straight line. There shall be no offsets between adjacent sections when the joint filler consists of more than one section. No plugs of concrete will be permitted within the expansion joint.

(g) Retrofitted Tie Bars

Retrofitted tie bars shall be secured at right angles to the pavement with a chemical anchoring system.

503.04 Dowel Bar Assemblies

The dowel bar assemblies shall be in accordance with the following.

(a) The dowel bars shall be supported by an approved welded wire assembly which shall hold the bars rigid during placement of the PCCP. The wire for the welded assembly shall be in accordance with ASTM A 82. The maximum angle of deviation shall not exceed 1 in 48 units during placement.

(b) The assembly shall have two continuous parallel spacer bars and two continuous parallel bearing members of size W 7.5 (7 mm) or greater. One spacer bar shall be located at or near each end of the dowel. Alternate ends of dowels shall be welded to a spacer bar so that the dowels remain parallel to each other and permit sliding movement in the joint. The free ends of each dowel shall be retained securely in place by means of wire loops.

(c) Suitable struts or ties shall be provided to hold the assembly in correct position during installation.

(d) The assembly shall have an upright support welded to the spacer bar and a continuous bearing member at the end of each dowel.

(e) If the upright support consists of a single vertical wire, the support shall be size W 7.5 (7 mm) or greater wire. Otherwise, the support shall be 1/4 in. (6 mm) or greater in diameter.

(f) The dowel bar assembly shall be held securely in place during placing, consolidating, and finishing the PCCP by means of metal pins. Pins used on granular subbase shall penetrate a minimum of 12 in. (300 mm) below the dowel bar assembly. Pins shall be size W 7.5 (7 mm) or greater wire and shall be provided with a hook or arm welded to the pin so that it shall secure the assembly in place. A minimum of 8 pins shall be used for each 10, 11, or 12 ft (3.0, 3.4, or 3.7 m) section of assembly. A minimum of 10 pins shall be used for assembly sections greater than 12 ft (3.6 m) and less than or equal to 16 ft (5.0 m).

(g) After the dowel bar assembly is securely in place, all tie wires which parallel the dowel bars, and are welded to the two continuous parallel spacer bars, shall be cut near the center of the tie.

(h) Dowel bars shall be placed 6 in. (150 mm) from the edges of the pavement and spaced at 1 ft (0.3 m) on center across the joint.

503.05 Sealing Cracks and Joints

Cracks and joints in the PCCP shall be cleaned and sealed in accordance with the sealant manufacturer's recommendations. Water blasting shall not be applied under pressure which may damage the concrete. All cracks and joints shall be sealed prior to discontinuing work for the winter.

When preformed elastomeric joint seals are used, the material shall be installed in one continuous piece by means of an approved machine. The seal shall not be stretched more than 5% while being placed and show no twisting, rollover, folding, cutting, or excess lubricant-adhesive on the top of the seal. Elastomeric joint seal may be installed in two separate pieces for phased construction with the splice point occurring at the highest point of the joint. The splicing method used shall be in accordance with the seal manufacturer's recommendations.

503.06 Random Crack Remediation

Random cracks shall be satisfactorily corrected.

(a) Transverse

Random cracks shall be corrected by PCCP replacement. The replacement shall be full lane width and a minimum of 6 ft (1.8 m) in length. Transverse PCCP removal limits shall be perpendicular to the centerline and shall include the entire random crack. Load transfer for the replacement PCCP shall be obtained by using dowel bars or epoxy coated tie bars. PCCP replacement areas shall have dowel bars which match contraction joints in any adjacent panels.

(b) Longitudinal

Random cracks within 18 in. (450 mm) of a longitudinal joint shall be routed and sealed. All longitudinal saw cuts in areas of random cracks shall be sealed with a sealer/healer or a bonding agent in accordance with ASTM C 881, grade 1.

Random cracks outside 18 in. (450 mm) of a longitudinal joint shall be satisfactorily corrected by routing and sealing or by PCCP replacement. PCCP with random cracks where differential movement has occurred shall be replaced in accordance with 503.06(a).

503.07 Method of Measurement

D-1 contraction joints and terminal joints will be measured by the linear foot (meter). The pay length for terminal joints will equal the width of the PCCP.

Retrofitted tie bars will be measured by the number of units installed.

503.08 Basis of Payment

D-1 contraction joints and terminal joints will be paid for at the contract unit price per linear foot (meter), complete in place.

Retrofitted tie bars will be paid for at the contract unit price per each, complete in place.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
D-1 Contraction Joint	LFT (m)
Retrofitted Tie Bars	EACH
Terminal Joint	LFT (m)

The cost of furnishing and placing all materials, not specified as a pay item, shall be included in the cost of PCCP.

The cost of dowels, dowel bar assemblies, backer rod, joint sealants and all necessary incidentals shall be included in the cost of D-1 contraction joints.

The cost of the sleeper slab, reinforcing steel, bond breaker, and HMA mixtures shall be included in the cost of the terminal joint.

The cost of retrofitted tie bars or PCCP replacement used to repair damaged PCCP due to fault or negligence, remediation of random cracking, or the replacement of broken deformed bars shall be included in the cost of the PCCP.

SECTION 504 – PCCP FINISHING AND CURING

504.01 Description

All PCCP surfaces shall be finished and cured in accordance with the following.

MATERIALS

504.02 Materials

The materials shall be in accordance with the following:

Curing Materials.....912.01

CONSTRUCTION REQUIREMENTS

504.03 Finishing

PCCP shall be finished with equipment in accordance with 508.04. The operations shall be controlled so that an excess of mortar and water is not worked to the top. Long handled floats may be used to smooth and fill in open textured areas in the PCCP.

Hand methods of finishing may be used when finishing equipment breaks down or in tight working areas where field conditions limit the use of mechanical devices. Hand placed concrete shall be further finished by means of a longitudinal float or an approved transverse smoothing float in accordance with 508.08(a).

The edges of formed PCCP adjacent to HMA or compacted aggregate shall be tooled. A continuous radius with a uniform smooth dense mortar finish shall be produced.

The PCCP surface shall be textured with a double thickness burlap drag or a minimum 4 ft (1.2 m) wide turf drag.

The textured surface of PCCP shall be tined, unless otherwise specified. Tining shall consist of transverse grooves that are between 3/16 and 1/8 in. (2.3 and 3.3 mm) in width, between 1/8 and 3/16 in. (3 and 4.8 mm) in depth, and be spaced as follows: 5/8 in., 1 in., 7/8 in., 5/8 in., 1 1/4 in., 3/4 in., 1 in., 1 in., 1 in., 1 in., 3/4 in., 7/8 in., 1 3/4 in., 7/8 in., 3/8 in., 1 in., 1 in., 1 1/4 in., 1 1/2 in., 7/8 in., 3/4 in., 7/8 in., 1 in., 7/8 in., 1 in. (16 mm, 25 mm, 22 mm, 16 mm, 31 mm, 19 mm, 25 mm, 25 mm,25 mm, 25 mm, 19 mm, 22 mm, 44 mm, 22 mm, 9 mm, 25 mm, 25 mm, 31 mm, 38 mm, 22 mm, 19 mm, 22 mm, 25 mm, 22 mm, 25 mm). The grooving pattern shall be repeated across the pavement. The grooves shall be formed in the plastic concrete without tearing the surface and without bringing pieces of the coarse aggregate to the top of the surface.

Texturing and curing operations may be performed by a single machine subject to satisfactory performance.

Areas of PCCP which are not finished in accordance with these requirements shall be corrected by retexturing.

Retexturing shall consist of cutting longitudinal or transverse grooves in the PCCP surface by means of saw blades or other approved devices. The grooves shall be spaced 3/4 in. (19 mm) center to center and be 1.8 in. (3.0 mm) in width and depth. Alternative patterns may be used, subject to approval. The PCCP surface, after cutting, shall not be polished.

504.04 Curing

Curing materials shall be applied to exposed surfaces and sides of newly placed PCCP within 30 min after the finishing operations have been completed, or as soon as marring of the concrete does not occur. Paving operations shall be immediately suspended if sufficient curing materials are not available on site.

When forms are used, the edges of the pavement shall be cured immediately upon removal of the forms. The edge shall be covered with curing materials equal to the material used on the surface or banked with soil 12 in. (300 mm) wide or greater.

When conditions arise which prevent immediate application of curing materials, the paving operation shall be suspended and the PCCP shall be kept wet with a fine spray of water. The fine spray of water shall continue until application of curing materials resumes.

Curing shall be continuous for 96 h unless a longer period is ordered and shall be in accordance with the following.

(a) Liquid Membrane Forming Compounds

Immediately after surface water has disappeared, a uniform coating of the liquid membrane forming curing compound shall be applied.

The compound shall be applied in a continuous uniform film at a rate not less than 1 gal./150 ft^2 (1 L/3.7 m^2). It shall be applied in two applications. The curing compound may be warmed in a water bath during cold weather at a temperature not exceeding 100°F (38°C). Thinning with solvents will not be permitted. Non-uniform film rates will result in the discontinuance of that application method.

A new coat of curing compound shall be applied to areas damaged by rain or other means during the curing period. The recoating shall be applied as soon as possible and at a rate equal to that specified for the original coat.

(b) Double Burlap

The PCCP shall be covered with wet burlap, laid directly on the surface, and kept wet with a fine spray of water. This initial burlap shall receive an additional covering of wet burlap no later than 9:00 A.M. the day following its placement. The two layers of burlap shall be kept wet for the required curing period.

(c) Waterproof Covers

The PCCP shall be kept wet with a fogged spray of water, or be covered with wet burlap laid directly on the surface and kept wet with a fine spray of water. The PCCP shall receive a cover no later than 9:00 A.M. the day following its placement. If white burlap polyethylene sheets are used, the burlap side shall be wet or the surface of the concrete thoroughly wetted just prior to the blanket being placed.

The covers shall be weighted down on each edge and shall be as wide as the full width of the pavement being cured. Adjoining covers shall overlap 12 in. (300 mm) or more and the laps held securely in place.

Covers may be reused provided they are airtight. All torn covers shall be repaired with patches. All units not in accordance with these requirements shall not be used.

The covers shall remain in place for the required curing period.

(d) Straw

The PCCP shall be covered with wet burlap, laid directly on the surface, that is kept wet with a fine spray of water. The burlap shall be removed by 9:00 A.M. the day following its placement and the surface immediately covered with straw no less than 3 in. (75 mm) deep. The straw shall be thoroughly saturated immediately after being placed, and kept wet for the required curing period. After the cure period, the straw shall be removed from the pavement and disposed of properly.

Straw curing shall not be used in cities or towns unless written permission is obtained.

504.05 Method of Measurement

Finishing and curing operations will not be measured for payment.

504.06 Basis of Payment

The cost of finishing and furnishing and placing curing materials shall be included in the cost of the PCCP.

SECTION 505 – TESTS AND PROCEDURES

505.01 Test Methods and Procedures

The following test methods and procedures shall be used with exceptions as listed below.

Air Test	AASHTO T 152* or ASTM C 173**
Flexural Strength	AASHTO T 97*
Making and Curing Specimens	AASHTO T 23*
Sampling Fresh Concrete	AASHTO T 141
Sieve Analysis of Aggregates	AASHTO T 27
Slump	AASHTO T 119
Specific Gravity and Absorption, Coarse Aggregate	AASHTO T 85
Specific Gravity and Absorption, Fine Aggregate	AASHTO T 84
Thickness of PCCP	ITM 404
Unit Weight and Relative Yield	AASHTO T 121*
Water-Cementitious Ratio	ITM 403

* The concrete shall be consolidated by the method of internal vibration in beam forms or in an aluminum measure or air meter bowl, as appropriate for the test.

** If slag aggregate is used, the method and procedure for the test shall be in accordance with ASTM C 173.

The chosen method of concrete consolidation shall be the same for all concrete test specimens.

(a) Exceptions to AASHTO T 23

The exceptions to AASHTO T 23 for making and curing specimens in the field shall be as follows.

1. Non-watertight beam forms (molds) will be permitted.

2. After 24 h the molded specimens are taken to the storage location and removed from the molds.

3. Field stored beams will not require 24 ± 4 h lime water soak prior to time of testing.

(b) Exceptions to AASHTO T 97

The exceptions to AASHTO T 97 for conducting a flexural test on concrete beams shall be as follows.

1. The beam size shall be measured to the nearest 1/16 in. (1.0 mm).

2. The test result shall be discarded when the break occurs outside the middle third of the beam.

(c) Exceptions to AASHTO T 121

The exceptions to AASHTO T 121 for determining the unit weight of concrete shall be as follows.

1. A strike-off bar in accordance with AASHTO T 152 may be used in lieu of a strike-off plate.

2. Weight (mass) shall be determined to the nearest 0.01 lb (0.005 kg).

(d) Exceptions to AASHTO T 141

The exceptions to AASHTO T 141 for sampling fresh concrete shall be as follows.

1. Where job conditions dictate, the entire sample may be obtained from one portion of the load.

(e) Exceptions to AASHTO T 152

The exceptions to AASHTO T 152 for determining the air content in portland cement concrete shall be as follows.

1. The sample for aggregate correction factor shall be prepared in accordance with 6.0. The aggregate correction factor shall be determined in accordance with 8.3 and read directly from the meter.

2. The aggregate correction factor test shall be re-run for confirmation if the test results for gravel is greater than 0.4% or if the test results for crushed stone is greater than 0.6%.

3. For aggregates indicating a high correction factor, the aggregate may be washed from the concrete sample and used to determine the correction factor.

SECTION 506 – PCCP PATCHING

506.01 Description

This work shall consist of the removal and replacement of 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
Fine Aggregate, Size No. 23 904
Portland Cement.....901.01(b)
Water.....913.01

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 patching shall be stone or gravel.

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

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 DMTE. The CMDS shall be submitted a minimum of seven calendar days prior to the trial batch utilizing the Department provided spreadsheet and shall include the following.

(a) a list of all ingredients
(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 batch weights (mass)
(g) the names of all admixtures

(h) the admixture dosage rates and the manufacturer's recommended range

The CMDS is used to conduct a trial batch in accordance with 506.05. Upon completion of the trial batch, the Contractor shall submit results of the concrete mix design trial to the DMTE for approval a minimum of three work days prior to production utilizing the Department provided spreadsheet. The DMTE will approve the submission as a CMDP, and production may commence. Both the Contractor's and the Engineer's tests will be included in the CMDS submittal.

(a) Change in Material

A change in a CMDP to any of the following requires a new CMDS.

1. cement type
2. admixture type
3. aggregate material

(b) Change in Source

A change in a CMDP to any of the following requires a new CMDS.

1. cement source
2. admixture source
3. aggregate source

Verification of the new CMDS will be conducted during production including sampling and testing within the first 10 cyd (8 m^3), for the following.

1. cement source, type I only
2. admixture source, air entraining admixtures only

A new CMDP will be issued upon approval of test verification by the DMTE.

(c) Change in Mixture

A change in a CMDP to any of the following requires a new CMDS.

1. proportions of aggregates by weight (mass) exceeding ± 2%
2. addition or deletion of an admixture

A CMDP in accordance with 506.04 in the current or previous calendar year may be substituted for use upon the approval of the DMTE.

506.04 Concrete Mix Criteria

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

The CMD shall produce workable concrete mixtures, with the minimum amount of water, having the following properties:

Minimum portland cement content ..... 658 lbs/cy^3 (390 kg/m^3)

Maximum water/cement ratio 0.45
Minimum slump .....2 in. (50 mm)
Air Content.....6.5% ± 1.5%
Minimum Flexural strength, third point
loading..... 300 psi (2100 kPa) at 24 h
Minimum flexural strength, third point
loading.....500 psi (3500 kPa) at 3 days

When calcium chloride solution is added, a maximum of 2%, by weight (mass) of cement, shall be used. The percentage shall be reduced to one if the ambient temperature is above 80°F (27°C). If the mixture is used in a 805 application, calcium chloride shall not be used.

506.05 Trial Batch

A trial batch shall be produced and tested to verify that the CMD is in accordance with the concrete mix criteria. 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. The Engineer will test the concrete's air content and determine the water/cement ratio, and prepare and test flexural beams. The flexural strength will be determined by averaging a minimum of two beam breaks. The Engineer will provide the Contractor the results of the tests.

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.

506.06 Job Control

Control of PCCP for air content 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 will be on the first load of the day and once per every 50 cyd (40 m^3). Beams will be made once per every 150 cyd (120 m^3) and tested for compliance with three day flexural strength requirements.

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

CONSTRUCTION REQUIREMENTS

506.07 PCCP Removal

PCCP removal areas will be marked. Vertical saw cuts around the perimeter of the removal areas shall be made in the PCCP. Transverse cuts shall be perpendicular to the centerline of the PCCP.

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 1 in. (25 mm), to a maximum of 3 in. (75 mm). Removal of all unsound concrete to a minimum depth of 1 in. (25 mm) shall be by hand chipping tools or hand held mechanically driven equipment. Mechanical hammers shall not be heavier than a nominal 45 lb (21 kg) class. Mechanically driven tools shall be operated at a maximum angle of 45 degrees from the PCCP surface. If the saw cut face is damaged, a parallel saw cut 1 in. (25 mm) outside the initial saw cut shall be made and the concrete in this area shall be removed by hand chipping.

Reinforcing steel encountered during the removal operation shall be cause for 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. (75 mm) shall be cause for a full depth patch in accordance with 506.07(b).

The 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 (3.0 m) 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 (0.3 m) beyond the joint.

Full depth removal shall be extended until sound PCCP is encountered to allow dowel bars to be firmly anchored.

All subbase material disturbed during the removal operation shall be recompacted as directed.

506.08 Concrete Mixing and Transportation

Concrete mixing and transportation shall be completed by central mixed, shrink mixed, or transit mixed methods. Discharge from non-agitating equipment shall be completed within 30 min of mixing the water, cement, aggregates, and calcium chloride solution. Discharge from a truck agitator or a truck mixer shall be completed within 90 min of mixing the water, cement, and aggregates or within 30 min 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 (mass) of cement, and aggregates, volume of water,

and the type and volume of admixtures. The weight (mass) of the cement shall be within 1% of the CMDP and the saturated surface dry weight (mass) 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 min of initial mixing. Any addition of water shall be noted on the ticket and shall not occur as a continuing operation.

(a) Central Mixed Concrete

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

(b) Shrink Mixed Concrete

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

(c) Transit Mixed Concrete

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

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 forcasted ambient temperature is 70°F (21°C) 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 in accordance with 504.04(a). In addition, polyethylene film shall be placed over the patch and covered with a 4 in. (100 mm) layer of rigid or flexible insulation and firmly anchored. Small dimension lumber weighted with sandbags may be used, but large objects such as rocks or concrete blocks will not be permitted.

The PCCP patch shall be inspected in accordance with 502.17.

(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 (5.5 m) shall have type D-1 contraction joints in accordance with 503.03(a).

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

A patch may be opened to traffic in accordance with the following when calcium chloride is used.

T	H	HT	T	H	HT
40-42°F (4-5°C)	30	26	61-63°F (16-17°C)	14	9
43-45°F (6-7°C)	27	23	64-66°F (18-19°C)	14	9
46-48°F (8-9°C)	24	21	67-69°F (20-21°C)	14	8
49-51°F (10-11°C)	21	19	70-72°F (22°C)	14	7
52-54°F (12°C)	19	16	73-75°F (23-24°C)	14	6
55-57°F (13-14°C)	16	14	Above 75°F (Above 24°C)	14	5
58-60°F (15°C)	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 permitted by the above table if test beams indicate a modulus of rupture of 300 psi (2100 kPa) 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 (2100 kPa) or greater. ITM 402 may be used as an alternate method to determine the flexural strength.

506.12 Method of Measurement

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

PCCP removal, subbase and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, dowel bars, reinforcing bars, chemical anchor system, concrete, finishing, and curing, and sawing and sealing of joints 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 (square meter) for the type of patching required.

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

Payment will be made under:

Pay Item	**Pay Unit Symbol**
PCCP Patching, Full Depth	SYS (m2)
PCCP Patching, Partial Depth	SYS (m2)

The cost of PCCP removal, subbase, and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, dowel bars, reinforcing 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 to repair or replace adjacent PCCP or shoulder damaged by the Contractor shall be included in the cost of PCCP patching.

SECTION 507 – PCCP RESTORATION

507.01 Description

This work shall consist of cleaning and sealing of joints and cracks, patching, profiling, underseal, and retrofit load transfer in accordance with 105.03.

MATERIALS

507.02 Materials

Materials shall be in accordance with the following:

Asphalt Emulsion AE-90, AE-90S, AE-150.....902.01(b)
Dowel Bars.....910.01(b)10
Fine Aggregates, Size No. 23 or 24 904
Joint Sealing Materials.....906.02
Rapid Set Patching Materials.....901.07

CONSTRUCTION

507.03 Cracks

Sealing and filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F (4°C), or when other unsuitable conditions exist, unless approved by the Engineer.

(a) Routing, Cleaning and Sealing

Cracks in PCCP shall be routed and cleaned when specified. Cracks shall be routed with a vertical-spindle router with carbide-tipped or diamond router bits to form a reservoir not exceeding 0.5 in. (13 mm) wide with a minimum depth of 0.75 in. (19 mm). The operation shall be coordinated such that routed materials do not encroach on pavement lanes carrying traffic and all routed materials are disposed of in accordance with 104.07. The cracks shall be cleaned with compressed air or by other suitable means. Air compressors shall be capable of producing a minimum air pressure of 100 psi (690 kPa). Water blasting shall not be utilized.

Cracks shall be sealed with asphalt rubber in accordance with the manufacturer recommendations within 0.25 in. (7 mm) of the surface. A distributor in accordance with 409.03 shall be used with an indirect-heat double boiler kettle and mechanical agitator. The asphalt rubber shall be placed utilizing a “V” shaped wand tip, to allow the penetration of the materials into the cracks.

Application of asphalt rubber shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt rubber has set.

(b) Cleaning and Filling

The cracks shall be cleaned by blowing with compressed air or by other suitable means when specified. Air compressors shall be capable of producing a minimum air pressure of 100 psi (690 kPa). Water blasting shall not be utilized.

Cracks shall be filled with asphalt emulsion. The cracks shall be completely filled or overbanded not to exceed 5 in. (125 mm), or as required. Asphalt emulsion shall be placed utilizing a “V” shaped wand tip, to allow the penetration of the materials into the cracks. The filled cracks shall be covered with sufficient fine aggregate to prevent tracking of the asphalt emulsion. All excess cover material shall be removed from the pavement.

Application of asphalt emulsion shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section,

temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt emulsion has set.

507.04 Joints

Sealing and filling operations shall not be conducted on a wet surface, when the ambient temperature is below 40°F (4°C), or when other unsuitable conditions exist, unless approved by the Engineer.

(a) Sawing, Cleaning and Sealing

Joints in PCCP shall be sawed, cleaned and sealed when specified. Air compressors shall be capable of producing a minimum air pressure of 100 psi (690 kPa). Water blasting shall not be utilized. The existing joints shall be sawed to the width and depth as shown on the plans. Slurry or saw residue remaining in the slot shall be immediately flushed. Traffic may be allowed on the PCCP for up to 7 calendar days after the saw cutting prior to sealing.

Joints shall be sealed with joint sealing materials in accordance with the sealant manufacturer's recommendations. Transverse joints shall be sealed with silicone sealant or preformed electrometric joint sealant. Longitudinal joints shall be sealed with an asphalt rubber or silicone sealants.

Application of asphalt materials shall be completed without covering existing pavement markings. When traffic is to be maintained within the limits of the section, temporary traffic control measures in accordance with 801 shall be used. Treated areas shall not be opened to traffic until the asphalt material has set.

(b) Cleaning and Filling

Joints in PCCP shall be cleaned by blowing with compressed air or by other suitable means when specified. Air compressors shall be capable of producing a minimum air pressure of 100 psi (690 kPa). Water blasting shall not be utilized.

Joints shall be filled with asphalt rubber in accordance with the manufacturer's recommendations within 0.25 in. (7 mm) of the surface. A distributor in accordance with 409.03 shall be used with an indirect-heat double boiler kettle and mechanical agitator. The asphalt rubber shall be placed utilizing a "V" shaped wand tip, to allow the penetration of the materials into the joints.

507.05 PCCP Patching

(a) Full Depth Patching

PCCP patching shall be in accordance with 506.

(b) Partial Depth Patching

Partial depth patching shall be constructed at locations shown on the plans. Existing joints directed to be patched partial depth, shall be milled to a depth of 3 in. (75 mm) the full width of the lane. The minimum length of milling is 6 in. (150 mm) beyond the map-cracked area. The milled area shall be cleaned of all loose material prior to patching. Cleaning shall be by blowing the milled areas with compressed air at a minimum pressure of 100 psi (690 kPa). When the milled areas are satisfactorily cleaned,

the milled areas shall be tacked with AE-T in accordance with 406 and patched with HMA.

The milled areas shall be filled with HMA partial depth patching. Partial depth patches shall consist of HMA Surface, type A in accordance with 402.04. MAF in accordance with 402.05 will not apply. The mixture shall be compacted by a vibratory roller in accordance with 409.03(d). A minimum of four passes of the rollers shall be completed. Partial depth patches shall be completed during work hours and opened to traffic at the close of the workday. Mixtures will be accepted in accordance with 402.09.

507.06 Profiling

Profiling consists of the diamond grinding of the pavement. The grinding shall be completed by mechanical grinding equipment in accordance with 508.08(c). Grinding shall be completed in a longitudinal direction and shall begin and end at lines normal to the pavement centerline in any ground section. The operation shall be coordinated such that the slurry or residue materials are continuously removed from the pavement. The slurry shall not encroach into adjacent pavement lanes carrying traffic, or flow into gutters or other drainage facilities and shall be immediately and directly deposited into a tanker truck and removed from the jobsite. Final disposal of the material shall be in an approved manner and in accordance with 104.07. Pavement smoothness will be measured and adjusted in accordance with 501.25 and 502.28(d) after the cracks are routed, cleaned, and sealed in accordance with 507.03 and joints are sawed, cleaned, and resealed in accordance with 507.04.

507.07 Undersealing

Undersealing shall be in accordance with 612.

507.08 Retrofit Load Transfer for PCCP

Retrofit load transfer consists of diamond saw slot cutting and placing dowel bar assemblies in the PCCP, parallel to the centerline of the roadway without damaging adjacent PCCP. The diamond-sawed slot shall be cut using two diamond saw blades per slot to cut the edges of the slot. The PCC within the slot and the burrs and bumps remaining in the base of the slots after cutting shall be removed with hand or mechanical chipping hammers which shall not exceed a nominal 15 lb (7 kg) in weight (mass) and shall be operated at a maximum angle of 45 degrees from the pavement surface.

All surfaces of the slots shall be thoroughly cleaned by sand blasting and all cracks in the slots shall be sealed with a silicone sealer. The slots shall be cleaned and blown dry with compressed air.

Dowel bar assemblies shall be as shown on the plans. Prior to placement, the assemblies shall be coated with a bond breaking material and placed on non-metallic supports in the slots. Dowel bars shall be parallel to the pavement surface.

Rapid setting patch material shall be mixed and cured in accordance with the manufacturer's recommendations. The material shall be placed in the slots and troweled to match existing adjoining PCCP. Excess material removed during placing and troweling shall not be reused.

Transverse contraction joints with retrofitted load transfers shall be sawed for the full lane width and sealed in accordance with 503.03(a) except the joint shall be cut in one operation. Transverse random cracks with retrofitted load transfer slots shall be routed and sealed for the full lane width in accordance with 503.05.

PCCP damaged outside the area of the slots due to Contractor's operations shall be repaired in an acceptable manner or replaced.

507.09 Method of Measurement

Routing and sealing of cracks, filling of cracks, sawing and sealing of joints, and filling of joints will be measured by the linear foot (meter), complete in place. Retrofit load transfer will be measured by each dowel bar assembly installed, complete in place. PCCP patching will be measured in accordance with 506.12. Profiling, regardless of depth, will be measured by the square yard (square meter). Asphalt material and drilled holes for undersealing will be measured in accordance with 612.06.

HMA partial depth patching will be measured by the ton (megagram), in accordance with 109.01(b).

Construction activities for the cutting, cleaning of the PCCP, dowel bars, dowel bar supports, dowel bar end caps, foam core board, patching material and all other incidentals will not be measured.

Routing of cracks or sawing of joints will not be measured. Routing and sealing of transverse random cracks at retrofitted load transfer assemblies will not be measured.

Temporary traffic control measures for routing, sealing or filling of cracks or sawing, sealing, or filling of joints, and profiling will be measured in accordance with 801.17.

507.10 Basis of Payment

Routing and sealing of cracks, filling of cracks, sawing and sealing of joints and filling of joints will be paid for by the linear foot (meter), complete in place. The accepted quantities of retrofit load transfer will be paid for at the contract unit price per each assembly installed, compete in place. PCCP patching will be paid for in accordance with 506.13. Profiling will be paid for by the square yard (square meter). Undersealing and drilled holes will be paid for in accordance with 612.07. The accepted quantities for HMA partial depth patching will be paid for at the contract unit price per ton (megagram), complete in place.

The cost of temporary traffic control measures for routing, sealing or filling of cracks or joints, and profiling will be paid for in accordance with 801.18.

Payment will be made under:

Pay Item	**Pay Unit Symbol**
Cracks in PCCP, Rout and Seal	LFT (m)
Cracks in PCCP, Filled	LFT (m)

HMA Partial Depth Patch ..... TON (Mg)
Joints in PCCP, Saw and Seal .....LFT (m)
Joints in PCCP, Filled .....LFT (m)
Profiling PCCP.....SYD (m2)
Retrofit Load Transfer.....EACH

The cost of milling, cleaning, tacking, and all incidentals shall be included in the cost of the pay item, partial depth patching.

The cost of cutting of slots, cleaning, dowel bars, dowel bar supports, dowel bar end caps, foam board, mortar, and curing materials shall be included in the cost of the pay item retrofit transfer.

The cost of cleaning, sealing materials, and all incidentals shall be included in the cost of the pay item cracks in PCCP, filled or joints in PCCP, filled.

The cost of routing, cleaning, sealant materials, and all incidentals shall be included in the cost of the pay item cracks in PCCP, rout and seal. The cost of sawing, cleaning, sealant materials, and all incidentals shall be included in the cost of the pay item joints in PCCP, saw and seal.

The cost of all grinding, diamond cutting heads, and cleaning of the pavement, shall be included in the cost of the pay item for profiling.

SECTION 508 – EQUIPMENT

508.01 Production, Transportation, and Placement of PCC Mixtures

The Contractor shall provide and calibrate all equipment necessary for the mixing, transportation, and placement operations for PCCP.

508.02 Mixing Plant

(a) Plant Inspection

The concrete production equipment shall be capable of producing a uniform mixture. A plant inspection in accordance with 106.03 will be made by the Engineer annually, after a plant is moved, or as deemed necessary.

(b) Proportioning System

Batching plants shall be equipped to proportion aggregates and bulk cement by weight (mass) by means of automatic and interlocked proportioning devices. PCCP produced in accordance with 500 shall document each ingredient in each batch.

All scales and other measuring devices shall be accurate to within ± 0.5% throughout their range unless otherwise approved. For applied loads less than 1,000 lb (450 kg) on the cement scale and 4,000 lb (1800 kg) on the aggregate scale, the scales shall be accurate to 2.0% or one gradation.

Means of control shall be provided so that as the quantity desired in the weighing hopper is approached, the materials may be added at a slower rate and shut off with precision. The accuracy of the proportioning system shall be as follows.

admixtures ..... ± 3%
aggregates ..... ± 2%
cementitious materials ..... ± 1%
water, volume or weight (mass) ..... ± 1%

The plant shall be equipped with a recording device capable of producing a ticket to permanently record the batch number, time of day, weight (mass) of all materials in the mix, volume or weight (mass) of mixing water added, and admixture quantities or equipped with a suitable non-resettable batch counter which will indicate correctly the number of batches produced. The CMD number shall be included on the ticket.

(c) Material Storage

The plant shall have separate storage bins or tanks for each material in the mixture. Each compartment shall discharge efficiently and freely into the weighing hopper or feed through a meter.

1. Aggregates

The aggregate storage area shall be well drained. All stockpiles shall be sufficiently separated and identified by signs or other approved methods.

2. Cementitious Materials

The storage bins shall be sealed and vented to preclude dusting during operation and have a sampling port.

3. Admixtures

Separate tanks for each admixture shall be provided.

(d) Hoppers

Weighing hoppers shall be constructed to eliminate accumulation of materials and to discharge fully. The fine aggregate and coarse aggregate shall be weighed separately into a weigh hopper in the respective amounts defined in the CMD. Separate scales and hoppers shall be used for weighing the cement. Pozzolans may be weighed into the cement hopper in one cumulative operation provided that the portland cement is weighed in first.

(e) Mixing System

The concrete mixing system shall be either a central stationary mixer or a transit truck mixer. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete, the speed of rotation of the mixing drum or blades, and the manufacturer's name and address.

The mixer shall be capable of combining the ingredients of the concrete within the specified time into a thoroughly mixed and uniform mass.

1. Central or Stationary Mixers

Stationary mixers shall be equipped with a timing device which does not permit the batch to be discharged until the specified mixing time has elapsed.

2. Truck Mixers

Truck mixers shall be equipped with means by which the number of revolutions of the drum at mixing speed may be verified.

508.03 Transportation

(a) Truck Mixers and Truck Agitators

Truck mixers and agitators shall be capable of maintaining and discharging the concrete at a satisfactory rate and degree of uniformity. The haul units shall be examined daily for accumulations of hardened concrete or mortar and compared to the manufacturer's standard for wear of blades.

(b) Non-Agitator Trucks

Bodies of non-agitating hauling equipment shall be smooth, mortar tight, metal containers. They shall be capable of discharging the concrete at a controlled rate. The bodies shall be examined daily for accumulations of hardened concrete, mortar, or foreign matter.

508.04 Placement Equipment

(a) Slipform

The paver shall spread, consolidate, and shape the freshly placed concrete in one complete pass to provide a dense and homogeneous pavement. The paver shall be of sufficient weight (mass) and power to construct the specified PCCP, at an adequate variable forward speed, and without transverse, longitudinal, or vertical instability. The paver shall be equipped with an automated steering and elevation control system.

The paver shall consolidate by vibrating the concrete for the full width and depth of the PCCP. Vibration shall be accomplished by internal vibrators, which have a variable frequency range of 7,000 to 12,000 vibrations per min. The amplitude of vibration shall be between 0.025 in. (0.6 mm) and 0.06 in. (1.5 mm). The vibrators shall be spaced and operated to achieve acceptable consolidation. The paver shall include a hand held tachometer or other suitable device for measuring the frequency of the vibrators. The automated vibrator control shall be capable of stopping vibration when forward movement ceases.

Mechanical tie bar inserters shall be rigidly attached to the paver and may be operated manually or automatically controlled.

A mechanical belt placer, if used, shall have a re-combining deflector plate mounted on the end of the discharge belt.

(b) Form Riding Equipment

The finishing machine shall be supported by forms and be equipped with two or more oscillating type transverse screeds and a transverse smoothing float.

Forms for riding equipment shall be of sufficient thickness to maintain the true cross section and shall be furnished in sections no less than 10 ft (3 m) in length. Forms shall have a minimum depth equal to the prescribed edge thickness of the concrete pavement without a horizontal joint, and a minimum base width equal to the depth of the forms. Flexible or curved forms shall be of an acceptable design. Forms shall be provided with adequate devices for secure setting so that when in place they can withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base a minimum of 2/3 of the height of the form. The top face of the form shall not vary from a true plane by more than 1/8 in. in 10 ft (3.0 mm in 3 m) and the upstanding leg shall not vary by more than 1/4 in. (6 mm). The forms shall contain provisions for locking the ends of abutting form sections together tightly for secure setting.

The transverse screed and transverse smoothing float shall be suspended from and guided by a rigid frame. The frame shall have a maximum effective wheel base of 14 ft (4.2 m). The length of the float shall be approximately 2 in. (50 mm) less than the normal width of the pavement and have an adjustable crown section. The forward speed of the float shall be adjustable.

The vibration equipment shall consolidate the full width and depth of the strip of PCCP being placed. Vibrators may be either the surface pan type or the internal type with either immerse tube or multiple spuds. Vibrators may be attached to the spreader or the finishing machine or mounted on a separate carriage. The frequency of the surface pan type shall be 3500 impulses per min or greater. The frequency of the internal type shall have no less than 5000 impulses per min for tube vibrators and spud vibrators shall have a frequency of from 10,000 to 12,000 impulses per min in air. The paver shall include a device, such as a hand held tachometer for measuring the frequency of the vibrators. Vibrators shall have automatic controls, which stop vibration when forward motion ceases. The maximum spacing of spud vibrators shall be 2 ft (0.6 m). A warning device shall be connected to each vibrator circuit to indicate a failure of any individual vibrator and shall be visible from the ground.

(c) Hand Placement

1. Steel Forms

Steel forms shall be 10 ft (3 m) or greater in length. Forms shall be capable of being staked in three locations or more for each 10 ft (3 m) section and shall be equipped to interlock. Forms shall support finishing equipment without deflection in either the vertical or horizontal direction. The top face of the form shall not vary from a true plane by more than 1/8 in. in 10 ft (3.0 mm in 3 m).

2. Wood Forms

Wood forms shall support finish equipment without deflection in either vertical or horizontal direction.

3. Finishing Equipment

The finish device or machine shall be capable of producing a uniform surface free of voids and in accordance with the planned profiles and cross section.

A mechanical tube finisher shall consist of a single or multiple rotating strike-off/finish tubes setting approximately transverse to the longitudinal movement of the machine. The length of finish tubes shall be a minimum of 2 ft (0.6 m) longer than the planned PCCP width. The forward speed of the machine as well as the rate of the finish tube rotation shall be variable and it shall be reversible to allow for multiple finish passes.

A vibratory screed finisher shall consist of a truss frame with a minimum base width of 1 ft (0.3 m), which extends across the transverse width of the PCCP. The frame shall extend 2 ft (0.6 m) beyond the width of the PCCP and shall hold its shape when moved forward. The screed shall move forward with either hydraulic or manual wenches, which are capable of maintaining the screed at a right angle to the direction of travel. The screed shall be vibrated as it moves forward and the vibration shall stop when forward motion ceases. Vibration shall be accomplished with mechanical driven eccentric weights or with auxiliary driven pneumatic vibrators.

A mechanical bridge deck finishing machine shall consist of a single or multiple rotating cylinders setting approximately parallel to the longitudinal movement of the machine and operating transversely. The forward motion of the machine as well as the transverse movement of the finish cylinders shall be variable.

A hand operated strike off shall be rigid and shall hold its shape when moved forward with a combined longitudinal and transverse motion.

A mechanical belt placer, if used, shall have a re-combining deflector plate mounted on the end of the discharge belt.

4. Vibrators

Hand spud vibrators shall be capable of transmitting 7000 to 10,800 impulses per min in air. The diameter of the head shall be 1 1/4 to 2 1/2 in. (32 to 64 mm).

508.05 Curing

Mechanical equipment shall be self-supported and ride on wheels or tracks located outside the paving lane. The mechanical sprayer shall be capable of applying a continuous uniform film at a minimum rate of 1 gal./150 sq ft (1 L/3.7 m^2) and shall be of the fully atomizing type. The equipment shall provide adequate agitation of the compound during application.

Hand spraying equipment shall be of the fully atomizing type.

508.06 Texturing Equipment

Mechanical texturing equipment shall be capable of forming transverse grooves of uniform depth and alignment in the plastic PCCP, without tearing the surface. The texturing comb shall have steel tines spaced as specified.

Hand tools consisting of fluted floats, rakes with spring steel tines, or finned floats with a single row of fins shall produce grooves which conform to the same requirements as those specified for the grooves formed by the mechanical equipment.

508.07 Sawing Equipment

Sawing equipment shall be self-propelled single or gang-mounted units. The saw shall be capable of maintaining the specified alignment and depth of cut without damaging the PCCP.

508.08 Miscellaneous Equipment

(a) Hand Tools

Long handled floats used to smooth and fill in open texture areas in the pavement shall have blades no less than 5 ft (1.5 m) in length and 6 in. (150 mm) in width. Equipment made of or coated with aluminum or aluminum alloys shall not be used.

Straight edges shall be 10 ft (3 m) in length and mounted on a long handle. The handle shall be 3 ft (1 m) longer than one-half of the width of the pavement being placed.

(b) Joint Sealing

Joint sealant material shall be installed using manufacturer's recommended equipment.

Air compressors shall be capable of producing a minimum air pressure of 80 psi (550 kPa).

Water blasting equipment shall be capable of operating at 1500 psi (10 MPa) without damaging the PCCP.

(c) Grinding

Grinding shall be completed by mechanical grinding equipment using diamond tipped saw blades mounted on a power driven, self-propelled machine containing transverse and longitudinal grade controls. The cutting head shall be no less than 36 in. (900 mm) wide to produce a uniform texture per the full width of the cutting head shaft. The pavement surface after cutting shall have a uniform texture but shall not be smooth or polished. Tearing or dislodging of aggregates will not be permitted.

508.09 Testing Facility and Equipment

(a) Testing Facility

The test facility shall be capable of maintaining a controlled curing environment in accordance with AASHTO T 23 and contain sufficient storage tanks with curing solution to cure both production control and acceptance test beams. Water shall be conveniently available for cleaning testing equipment and for serving other tasks at the facility. Office space, having suitable heat and air conditioning, shall be provided to the Department within the testing facility. A telephone shall be provided in the testing facility. Floor space shall be provided for a Department furnished beam breaker.

A current set of AASHTO's Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II Tests, and ASTM C 173 shall be provided.

(b) Testing Equipment

Testing equipment shall be provided to perform production control testing and shall be maintained in suitable working order. The equipment shall be in accordance with AASHTO requirements where applicable. The Contractor shall provide a spud vibrator with power source in suitable working order.

(c) Profilograph

The profilograph shall be in accordance with ITM 912.

(d) Straightedge – 16 ft (4.9 m)

A 16 ft (4.9 m) straightedge shall be a rigid beam mounted on two solid wheels on axles 16 ft (4.875 m) apart. The straightedge has a mounted push bar to facilitate propelling the device along or across the pavement. Tolerance points are located at the 1/4, 1/2, and 3/4 points and may be composed of threaded bolts capable of being adjusted to the tolerance required.

(e) Straightedge – 10 ft (3 m)

A 10 ft (3 m) straightedge is the same as a 16 ft (4.9 m) straightedge except that the wheels are mounted 10 ft (3.048 m) apart. A hand held rigid beam may be substituted.