

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.

10 **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.

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MATERIALS

501.03 Materials. Materials shall be in accordance with the following:

	Admixtures	912.03
	Coarse Aggregate, Class AP, Size No. 8*	904.02
	Fine Aggregate, Size No. 23*	904.01
	Fly Ash.....	901.02
	Ground Granulated Blast Furnace Slag.....	901.03
	Portland Cement.....	901.01(b)
30	Water	913.01

* Or gradation as identified in the QCP

501.04 Concrete Mix Design. A concrete mix design, CMD, shall be in accordance with 501.05 and shall be verified by a trial batch in accordance with 501.06. The CMD shall be submitted in a format acceptable to the Engineer and include the following:

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- (a) a list of all ingredients
 - (b) the source of all materials
 - (c) the gradation of the aggregates
 - (d) the absorption of the aggregates
 - (e) the SSD bulk specific gravity of the aggregates

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

A change to any source of material requires a new CMD.

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A CMD in accordance with 502.03 may be used at gaps for public road approaches, driveways, or other permitted breaks. Concrete from commercial plants shall be produced in accordance with 502.05.

501.05 Concrete Mix Criteria. The CMD shall produce workable concrete mixtures having the following properties:

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

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The Contractor may elect to use fine and coarse aggregates in accordance with 904.01(g) and 904.02(e), 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 25 mm (1 in.) sieve. The combined amount of fine and coarse aggregates passing the 75 µm (No. 200) sieve shall be from 0% to 2.0% for sand and gravel, and from 0% to 2.5% for sand and crushed stone or crushed slag.

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

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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 and 904.03(f). 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 cements type IP, type IS, type IP-A, and type IS-A, 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 300 kg/m³ (500 lbs/yd³) and the use of fly ash or GGBFS as an additive will not be permitted.

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 CMD meets the concrete mix criteria. 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 mass (weight) may be used to conduct the air content test.

The target unit mass (weight) 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 CMD and submitted to the Engineer.

501.07 Lots and Sublots. Lots will be defined as 6000 m² (7,200 sq yd) of PCCP. Lots will be further subdivided into sublots of 2000 m² (2,400 sq yd) of PCCP within a lot. Partial sublots of 400 m² (480 sq yd) or less will be added to the previous subplot. Partial sublots greater than 400 m² (480 sq yd) constitute a full subplot. Partial lots of one or two sublots constitute a full lot.

501.08 Acceptance. Acceptance of PCCP for flexural strength, air content, unit mass (weight), 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 subplot for sampling in accordance with ITM 802.

The random sample(s) per subplot 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 subplot	AASHTO T 97	10 kPa (1 psi)
Air Content	One per subplot	AASHTO T 152 or ASTM C 173	0.1
Unit Weight	One per subplot	AASHTO T 121	1
Water/Cementitious Ratio	Once per week	ITM 403	0.001
Thickness	Two per subplot	ITM 404	0.1

130 Rounding will be in accordance with ASTM E 29 using the rounding method.

CONSTRUCTION REQUIREMENTS

501.09 General. Equipment for PCCP shall be in accordance with 507.

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.

140 **501.11 Preparation of Subbase.** Subbase, if required, shall be placed and shaped to the required grade and section in accordance with 304.

501.12 Placement. Placement of PCCP shall be by the slipformed or formed methods with equipment specified in 507.04. 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.

150 **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.

160 (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.

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.

170 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 25 mm (1 in.) when the average slump is 75 mm (3 in.) or less, or by more than 50 mm (2 in.) when the average slump is greater than 75 mm (3 in.), 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.

180 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 2EC (35EF) 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.

190 **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.

200 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 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.

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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.

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501.17 CMD Adjustments. The target water/cementitious ratio and target unit weight may be adjusted during the first lot of each year's production.

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

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

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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.

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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.

250 **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 3800 kPa (550 psi) 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.

260 **(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 3800 kPa (550 psi) 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.

270 **501.24 Shoulder Corrugations.** PCCP shoulders shall have formed or milled corrugations, if shown on the plans.

(a) Formed Corrugations. Formed corrugations consist of formed depressions in newly constructed PCCP shoulders. The corrugations shall be formed by means of a corrugated float.

(b) Milled Corrugations. Milled corrugations consist of cutting smooth strips in existing or newly constructed shoulders. The smooth strips shall be made by a cutting machine that provides a series of cuts without tearing or snagging. The equipment shall include guides to maintain uniformity and consistency in the alignment of the strips.

280 The operation shall be coordinated such that milled materials do not encroach on pavement lanes carrying traffic and all milled materials are disposed of in accordance with 104.07.

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

290 The profilograph shall be used on all full-width pavement lanes of 75 m (250 ft) or longer and having a design speed greater than 70 km/h (45 mph), unless otherwise specified.

If a pay item, profilograph, PCCP, is included in the contract, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 901. The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor. When a profilograph is not included as a pay item, the Department will furnish, calibrate, and operate the profilograph.

300 The 4.9 m (16 ft) long straightedge shall be used on all full-width pavement lanes shorter than 75 m (250 ft), tapers, within 15 m (50 ft) of bridge ends, within 15 m (50 ft) of an existing pavement which is being joined, ramps, or having a design speed of 70 km/h (45 mph) or less, unless otherwise specified.

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

310 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 tested 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.

320 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 until the test indicates a modulus of rupture of 3800 kPa (550 psi) 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 1.5 mm (1/16 in.) and the longitudinal length of the removal area exceeds 4.5 m (15 ft), or two or more areas are within 9.0 m (30 ft) of each other, the PCCP shall be retextured in accordance with 504.03.

Pavement smoothness variations shall be corrected to be in accordance with the smoothness requirements in the following table.

PAVEMENT SURFACE TOLERANCES	
Testing Method	Specified Tolerance
Profilograph	
Design speeds greater than 70 km/h (45 mph)	25 mm/0.16 km (1.0 in./0.1 mi) profile index or less
Design speeds 70 km/h (45 mph) or less	40 mm/0.16 km (1.6 in./0.1 mi) profile index or less
4.9 m (16 ft) Straightedge	
All pavements	6 mm (1/4 in.) or less
3 m (10 ft) Straightedge	3 mm (1/8 in.) or less

When the profilograph is being used, in addition to the requirements for the profile index, all areas having a high point deviation in excess of 8 mm (0.3 in.) shall be corrected. Verifying profilograph measurements will be taken only in the 0.16 km (0.1 mi) 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, 100 mm (4 in.) 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 0.6 m (2 ft) of the edge of pavement, over dowels, or within 1.5 m (5 ft) of a transverse construction joint. Cores shall be taken and measured in accordance with ITM 404. Core holes shall be filled in accordance with 506.

If a core measurement reveals that the pavement is more than 13 mm (0.5 in.) deficient in thickness, additional cores shall be drilled at 6.0 m (20 ft) 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 6.0 m (20 ft) intervals until two successive cores indicate a thickness deficiency of 13 mm (0.5 in.) or less, or where cores can no longer be drilled in the new PCCP.

If a core indicates a thickness deficiency of more than 25 mm (1.0 in.) and two cores drilled adjacent at 6.0 m (20 ft) intervals indicate a thickness deficiency of not more than 25 mm (1.0 in.), additional cores shall be drilled at 1.5 m (5 ft) intervals on each side of the initial core. The drilling shall continue in both directions at 6.0 m (20 ft) intervals until two successive cores indicate a thickness deficiency of 13 mm (0.5 in.) or less, or where cores can no longer be drilled in the new PCCP.

360 When a single core indicates a thickness deficiency of more than 25 mm (1.0 in.), or if two or more adjacent cores indicate a thickness deficiency of more than 13 mm (0.5 in.), 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 at 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.

370 **(a) PCCP Removal.** Where two adjacent cores indicate a thickness deficiency of more than 25 mm (1.0 in.) the PCCP shall be removed and replaced. Non-adjacent cores indicating a thickness deficiency of more than 25 mm (1.0 in.) 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 13 mm (0.5 in.).

380 **(b) PCCP Non-Payment.** Where two adjacent cores indicate a thickness deficiency of more than 13 mm (0.5 in.) 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 13 mm (0.5 in.) will be in accordance with 501.26(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 13 mm (0.5 in.).

390 **(c) PCCP Thickness.** The thickness of the PCCP for each lot shall be the average lengths of all cores from the lot. 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 planned PCCP thickness by more than 13 mm (0.5 in.) will be recorded as the planned PCCP thickness plus 13 mm (0.5 in.). Calculations shall be to the nearest 2.5 mm (0.1 in.).

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

400 **(a) Plastic Unit Weight.** Sublots shall not vary by more than $\pm 3.0\%$ from the target unit weight. A stop paving order will be issued if the plastic unit weight exceeds $\pm 3.0\%$ from the target plastic unit mass (weight). Paving operations shall not resume until satisfactory changes are made or an alternate CMD is used.

Calculations for the plastic unit mass in kg/m³ will be made and reported to the nearest whole unit (calculations in lbs/yd³ will be made and reported to the nearest figure in the tenth).

410 **(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 CMD is used.

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

420 **(c) Flexural Strength.** Average lot values of 4000 kPa (570 psi) 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 kPa will be made and reported to the nearest 10 kPa (psi to the nearest whole unit).

(d) Air Content. The average lot air content values shall not vary more than $\pm 0.8\%$ from the 6.5% target air content. The range of subplot 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.

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

501.28 Adjustment Points. When the PCCP test results for flexural strength, air content, smoothness, and thickness exceed the allowable tolerances, adjustment points will be assessed. The adjustment points will be used to calculate a quality assurance adjustment quantity for the lot.

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

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$$q = L \times U \times \frac{P}{100}$$

where:

q = quality assurance adjustment quantity

L = lot quantity

U = unit price for QC/QA-PCCP, \$/m² (\$/yd²)

P = adjustment points

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

The total quality assurance adjustments will be calculated as follows:

$$Q = 3 (q_F + q_T + q_A + q_R) - Q_s$$

where:

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

470 If the total adjustment points for a lot are greater than 50, or the total adjustment points for flexural strength and air content is greater than 40, the PCCP will be evaluated by the Materials and Tests Division. 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, adjustment points will be assessed as follows:

1. Lots

	Average Lot Flexural Strength, kPa (psi)	Adjustment Points
480	4000 (570) and Above	0
	3950 (565) - 3999 (569)	2
	3900 (560) - 3949 (564)	4
	3850 (555) - 3899 (559)	6
	3800 (550) - 3849 (554)	8
	3750 (545) - 3799 (549)	11
	3700 (540) - 3749 (544)	14
	3650 (535) - 3699 (539)	17
	3600 (525) - 3649 (534)	22
	3550 (515) - 3599 (524)	28
490	3549 (514) or less	28 + *

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

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(b) Air Content. When test results for air content exceed the allowable tolerance or range, adjustment points will be assessed as follows:

1. Lots.

	Average Lot Air Content Net Percentage	Adjustment Points
	9.1 or greater	20 + *
510	8.9 - 9.0	20
	8.6 - 8.8	15
	8.3 - 8.5	9
	8.1 - 8.2	4
	7.6 - 8.0	2
	7.4 - 7.5	1
	5.7 - 7.3	0
	5.0 - 5.6	1
	4.7 - 4.9	2
	4.6	12
520	4.5	20
	4.4 or less	20 + *

* 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 Net Percentage	Adjustment Points
	3.6 or greater	6 + *
530	3.1 to 3.5	3
	2.6 to 3.0	1
	0.0 to 2.5	0

* 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 subplot 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 subplot completely removed, the subplot test value from the replacement subplot will replace the original test value.

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(c) Thickness. When test results for pavement thickness do not meet the specified thickness, adjustment points will be assessed as follows:

	Pavement Deficiency	Adjustment Points
550	0.0 mm to less than 3.0 mm (0.1 in.)	0
	3.0 mm (0.1 in.) to less than 13 mm (0.5 in.)	4
	13 mm (0.5 in.) to less than 25 mm (1.0 in.)	8

(d) Smoothness. When test results for smoothness exceed the minimum requirements, adjustments will be based on the initial profile index for each lane in accordance with the following:

	Initial Profile Index, mm/0.16 km (in./0.1 mile)	Adjustment Points
560	0.0 to less than 13 (0.5)	3
	13 (0.5) to less than 18 (0.7)	2
	18 (0.7) to less than 23 (0.9)	1
	23 (0.9) and above	0

A 0.16 km (0.1 mi) section will not be eligible for adjustments if that section or an adjacent 0.16 km (0.1 mi) section requires corrective action to meet smoothness requirements.

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 subplot(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 350 kPa (50 psi) 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 1.5 m (5 ft) of a header. Two cores shall be taken in each subplot for the full depth of pavement and shall be 100 mm (4 in.) 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.

$$F_D = S_D \times \frac{[F_{A1} + F_{A2}]}{[2S_{A1} + 2S_{A2}]}$$

where:

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

(b) Air Content. Appeals will not be considered unless QC test results indicate greater than a 0.5 percent 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 subplot(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 1.5 m (5 ft) of a header. One 100 mm (4 in.) diameter full depth core shall be taken from the pavement for each subplot appealed. All core holes shall be filled with PCC within 24 h of drilling.

The air content for a subplot will be the hardened concrete air content determined from the core in accordance with ITM 401.

501.30 Method of Measurement. PCCP will be measured by the square meter (square yard) 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 PCCP shoulder corrugations will be measured by the meter (linear foot) of shoulder milled, measured parallel to the center line of the roadway. Formed shoulder corrugations will not be measured.

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

Removal and replacement of PCCP damaged by freezing shall be completed 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.....	904.02
Fine Aggregate, Size No. 23.....	904.01
Fly Ash.....	901.02
Ground Granulated Blast Furnace Slag.....	901.03
Portland Cement.....	901.01(b)
Water	913.01

502.03 Concrete Mix Design. The concrete mix design, CMD, shall be in accordance with 502.04. The CMD shall be submitted, prior to placement of the mixture, in a format acceptable to the Engineer 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 mass (weights)
- (h) the names of all admixtures
- (i) the admixture dosage rates and the manufacturer's recommended range

A change to any source of material or proportions of aggregate will require a new CMD. A change to the dosage amount of an admixture will be permitted; however, a new CMD will be required for the addition or deletion of an admixture.

502.04 Concrete Mix Criteria. The fine aggregate shall be at least 35% but not more than 45% of the total mass (weight) of the aggregate in each cubic meter (cubic yard). 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	335 kg/m ³ (564 lbs/yd 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 mass (weight)
50	Maximum substitution of GGBFS for portland cement.....	30%
	GGBFS/portland cement substitution ratio	1.00 by mass (weight)
	Slump, formed.....	50 mm (2 in.) to 100 mm (4 in.)
	Slump, slipformed	30 mm (1.25 in.) to 75 mm (3 in.)
	Air	5.0% to 8.0%
	Minimum flexural strength, third point loading, with fly ash	3800 kPa (550 psi) at 28 days
	Relative yield	0.98 to 1.02

60 Class C concrete in accordance with 702 may be substituted for PCC.

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 cements type IP, type IS, type IP-A, and type IS-A, 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 355 kg/m³ (598 lbs/yd³) and the use of fly ash or GGBFS as an additive will not be permitted.

70 When fly ash or GGBFS is used, the Contractor shall submit a CMD and all supporting test results for approval to the Engineer at least 15 days prior to placing concrete. The supporting test results from a trial batch shall include flexural strength data obtained at an age consistent with the contract work schedule.

80 **(b) High-Early Strength Concrete.** The Contractor shall submit, along with the CMD, all supporting test results for approval to the Engineer 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).....	335 kg/m ³ (564 lbs/yd 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
90	Slump, formed.....	50 mm (2 in.) to 100 mm (4 in.)
	Slump, slipformed	30 mm (1.25 in.) to 75 mm (3 in.)
	Air content.....	5.0% to 8.0%
	Minimum flexural strength, third point loading.....	3800 kPa (550 psi) 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.

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

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 except that the minimum frequency will be one test for each 800 m² (950 sq yd).

- 110 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 ASTM E 29 using the rounding method. 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 507.

- 120 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 2 m (6 ft). 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.

- 130 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.

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502.08 Preparation of Subbase. Subbase, if required, shall be placed and shaped to the required grade and section in accordance with 304.

502.09 Placement. Placement of PCCP shall be by the slipformed or formed methods with equipment specified in 507.04. 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.

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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 6 mm (1/4 in.).

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.

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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 6 mm (1/4 in.) 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 3 m (10 ft) 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.

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Forms shall be kept a minimum of 150 m (500 ft) 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 1.5 m³ (2 yd³). 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 mass (weight) of cement, pozzolan, and aggregates, volume or mass (weight) of water, and the type and volume of admixtures. The mass (weight) of the cement shall be within 1% of the CMD, the saturated surface dry mass (weight) of the aggregates shall be within 2% of the CMD, and the volume or mass (weight) 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 25 mm (1 in.) when the average slump is 75 mm (3 in.) or less, or by more than 50 mm (2 in.) when the average slump is greater than 75 mm (3 in.), 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 charged 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.

230 **(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 completed prior to 300 revolutions of the drum.

240 **502.11 Weather Limitations.** PCCP shall not be placed on frozen subgrade or subbase. PCCP operations shall not begin until the ambient temperature is 2EC (35EF) and rising. PCCP operations shall be discontinued when the ambient temperature is descending and is 4EC (40EF) 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.

250 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 10EC (50EF) and not more than 27EC (80EF) at the time of placement.

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

260 **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.

270 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.

280 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.

290 **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.

300 **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 3800 kPa (550 psi) 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 3800 kPa (550 psi) 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 3800 kPa (550 psi) 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. PCCP shoulders shall have formed or milled corrugations, if shown on the plans.

(a) Formed Corrugations. Formed corrugations consist of formed depressions in newly constructed PCCP shoulders. The corrugations shall be formed by means of a corrugated float.

(b) Milled Corrugations. Milled corrugations consist of cutting smooth strips in existing or newly constructed shoulders. The smooth strips shall be made by a cutting machine that provides a series of cuts without tearing or snagging. The equipment shall include guides to maintain uniformity and consistency in the alignment of the strips.

The operation shall be coordinated such that milled materials do not encroach on pavement lanes carrying traffic and all milled materials are disposed of in accordance with 104.07.

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

The profilograph shall be used on all full-width pavement lanes of 75 m (250 ft) or longer and having a design speed greater than 70 km/h (45 mph), unless otherwise specified.

350 If a pay item, profilograph, is included in the contract, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 901. The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor. When a profilograph is not included as a pay item, the Department will furnish, calibrate, and operate the profilograph.

The 4.9 m (16 ft) long straightedge shall be used on all full-width pavement lanes shorter than 75 m (250 ft), tapers, within 15 m (50 ft) of bridge ends, within 15 m (50 ft) of an existing pavement which is being joined, ramps, or having a design speed of 70 km/h (45 mph) or less, unless otherwise specified.

360 The 3 m (10 ft) 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 tested within 24 h following placement. When profile testing is consistently outside pavement surface tolerances the paving operation shall be discontinued until other methods and equipment are approved.

370 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 until the test beams indicate a modulus of rupture of 3800 kPa (550 psi) 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 1.5 mm (1/16 in.) and the longitudinal length of the removal area exceeds 4.5 m (15 ft), or two or more areas are within 9.0 m (30 ft) of each other, the PCCP shall be retextured in accordance with 504.03.

380 Pavement smoothness variations shall be corrected to be in accordance with the smoothness requirements in the following table.

PAVEMENT SURFACE TOLERANCES	
Testing Method	Specified Tolerance
Profilograph	
Design speeds greater than 70 km/h (45 mph)	30 mm/0.16 km (1.2 in./0.1 mi) profile index or less
Design speeds 70 km/h (45 mph) or less	40 mm/0.16 km (1.6 in./0.1 mi) profile index or less
4.9 m (16 ft) Straightedge	
All pavements	6 mm (1/4 in.) or less
3 m (10 ft) Straightedge	3 mm (1/8 in.) or less

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

390 **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, 100 mm (4 in.) 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 0.6 m (2 ft) of the edge of pavement, over dowels, or within 1.5 m (5 ft) of a transverse construction joint. Cores shall be taken and measured in accordance with ITM 404. Core holes shall be filled in accordance with 506.

400 If a core measurement reveals that the pavement is more than 13 mm (0.5 in.) deficient in thickness, additional cores shall be drilled at 6.0 m (20 ft) 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 6.0 m (20 ft) intervals until two successive cores indicate a thickness deficiency of 13 mm (0.5 in.) or less, or where cores can no longer be drilled in the new PCCP.

410 If a core indicates a thickness deficiency of more than 25 mm (1.0 in.) and two cores drilled adjacent at 6.0 m (20 ft) intervals indicate a thickness deficiency of not more than 25 mm (1.0 in.), additional cores shall be drilled at 1.5 m (5 ft) intervals on each side of the initial core. The drilling shall continue in both directions at 6.0 m (20 ft) intervals until two successive cores indicate a thickness deficiency of 13 mm (0.5 in.) 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 25 mm (1.0 in.), or if two or more adjacent cores indicate a thickness deficiency of more than 13 mm (0.5 in.), 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 at the same time or not.

420 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 will be defined as a section. The section will be divided into subsections of 1000 m² (1200 sq yd). A minimum of one core shall be drilled at a random location within each subsection. Partial subsections shall not be cored unless otherwise directed. Widening of 1.0 m (3 ft) or less shall not be cored unless otherwise directed. A section greater than 1000 m² (1200 sq yd) shall have a minimum of four cores drilled.

430 **(b) PCCP Adjusted Payment.** If an average pavement thickness is less than the designated thickness by 13 mm (0.5 in.) or less, payment for that section will be adjusted in accordance with 502.23.

(c) PCCP Non-Payment. Where two adjacent cores indicate a thickness deficiency of more than 13 mm (0.5 in.), 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 13 mm (0.5 in.) will be in accordance with 502.21(e).

440 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 13 mm (0.5 in.).

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

450 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 13 mm (0.5 in.).

(e) 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 planned PCCP thickness by more than 13 mm (0.5 in.) will be recorded as the planned PCCP thickness plus 13 mm (0.5 in.). Calculations shall be to the nearest 2.5 mm (0.1 in.).

460 **502.22 Method of Measurement.** PCCP will be measured by the square meter (square yard) 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 501.30. Formed shoulder corrugations will not be measured.

470 **502.23 Basis of Payment.** The accepted quantities of PCCP will be paid for at the contract unit price per square meter (square yard) for the thickness specified, complete in place.

Milled corrugations will be paid for in accordance with 501.31.

Payment will be made for portland cement content of more than 335 kg/m³ (564 lbs/yd³) 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 adjusted pavement quantity for thickness will be determined by the following:

$$A_P = Q \times \frac{[M_T^2]}{[S_T^2]}$$

where:

A_P = Adjusted pavement quantity

Q = The placed quantity of the pavement section

M_T = The average thickness of the pavement section as determined from 502.22(f)

S_T = The specified thickness of the pavement section

Furnishing, calibrating, and operating the profilograph, and furnishing profile information will be paid for in accordance with 501.31. Payment for PCCP measured with a profilograph will be based on the final profile index. The payment will be adjusted based on the average final profile index for the total area of PCCP represented by the profile index in accordance with the following.

Design Speed Greater Than 70 km/h (45 mph)		Design Speed Less Than Or Equal To 70 km/h (45 mph)	
Final Profile Index Mm/0.16 km (in./0.1 mile)	% of Contract Unit Price	Final Profile Index mm/0.16 km (in./0.1 mile)	% of Contract Unit Price
0 to 30 (0 to 1.2)	100.0	0 to 41 (0.0 to 1.6)	100.0
over 30 to 33 (1.2 to 1.3)	98.0	over 41 to 46 (1.6 to 1.8)	98.0
over 33 to 36 (1.3 to 1.4)	96.0	over 46 to 51 (1.8 to 2.0)	96.0
over 36 to 38 (1.4 to 1.5)	92.0	over 51 to 56 (2.0 to 2.2)	92.0
All pavement with a profile index greater than 38 (1.5) shall be corrected		All pavement with a profile index greater than 56 (2.2) shall be corrected	

An extra work agreement 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 2000 m² (2400 sq yd). 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.

510 Payment will be made under:

Pay Item	Pay Unit
PCCP, _____ mm (in.)..... thickness	m2 (SYS)

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

520 No payment will be made for deficient PCCP directed to be removed. No payment will be made for the removal of the deficient PCCP.

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.

The cost of all cores for determination of pavement thickness shall be included in the cost of other items.

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The cost of incorporating formed corrugations in PCCP shoulders shall be included in the cost of PCCP.

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

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:

10	Dowel Bars.....	910.01(b)10
	Epoxy Coated Reinforcing Steel	910.01(b)9
	Joint Filler	906.01
	Joint Materials	906
	Reinforcing Steel.....	910.01

Tie bars shall be epoxy coated reinforcing steel.

Rapid setting patch materials shall be selected from the Department's approved list of Rapid Setting Patch Materials.

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

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All joints shall be cut to the required dimensions and sealed. All sawed joints shall be made by concrete saws in accordance with 507.07 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 5.5 m (18 ft).

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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 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.

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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.

60 **(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 5.0 m (16 ft). Tie bars shall be placed by mechanical equipment in accordance with 507.04(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.

70 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 503.01(a), except the initial saw cut shall be omitted. All other transverse construction joints shall be located at least 2 m (6 ft) from an adjacent D-1 contraction joint.

80 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 507.04(a) or other approved methods. Longitudinal construction joint saw cuts may be made as soon as the PCCP has sufficiently hardened.

90 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 10 m (30 ft) during straightening.

100

The longitudinal construction joint for shoulder widths less than 1.8 m (6 ft) 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.

110 **(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 150 Fm (6 mils) or greater. The HMA materials shall be in accordance with 402 for HMA Surface 9.5 mm and HMA Intermediate 19.0 mm mixtures for 15,000,000 ESAL except 904.02(d) does 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.

120 The joint filler shall be held in a position which is normal to the surface. Finished joints shall deviate no more than 6 mm (1/4 in.) 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 space.

(g) Retrofitted Tie Bars. Retrofitted tie bars shall be secured at right angles to the pavement with a chemical anchoring system. The chemical anchoring system shall be selected from the Department's approved list of Chemical Anchors.

130 **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.
- 140 (b) The assembly shall have two continuous parallel spacer bars and two continuous parallel bearing members of 7 mm (size W 7.5) 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.

150 (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 7 mm (size W 7.5) or greater wire. Otherwise, the support shall be 6 mm (1/4 in.) or greater in diameter.

160 (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 300 mm (12 in.) below the dowel bar assembly. Pins shall be 7 mm (size W 7.5) 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 3.0, 3.4, or 3.7 m (10, 11, or 12 ft) section of assembly. A minimum of 10 pins shall be used for assembly sections greater than 3.6 m (12 ft) and less than or equal to 5.0 m (16 ft).

(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.

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

180 Preformed elastomeric joint seals shall be installed in one continuous piece by means of an approved machine. The seal shall not be stretched more than five percent 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.

190 **(a) Transverse.** Random cracks within 1 m (3 ft) of a transverse joint shall be corrected by PCCP replacement. Random cracks outside 1 m (3 ft) of a transverse joint shall have load transfer established with retrofit load transfer or by PCCP replacement. Random cracks where differential movement has occurred shall be corrected by PCCP replacement.

1. Retrofit Load Transfer. Retrofit load transfer installation shall be in accordance with 305.07.

200 **2. PCCP Replacement.** PCCP replacement shall be full lane width and a minimum of 1.8 m (6 ft) 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 450 mm (18 in.) 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 selected from the Department's approved list of Sealer/Healers, or a bonding agent in accordance with ASTM C 881, grade 1.

210

Random cracks outside 450 mm (18 in.) 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)2.

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

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

Retrofit load transfer for the remediation of random cracking will not be measured.

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

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

230

Payment will be made under:

Pay Item

Pay Unit

D-1 Contraction Joint.....	m (LFT)
Retrofitted Tie Bars	EACH
Terminal Joint	m (LFT)

240 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.

250 The cost of retrofitted tie bars, retrofit load transfer, 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. Materials shall be in accordance with the following:

10 Curing Materials 912.01

CONSTRUCTION REQUIREMENTS

504.03 Finishing. PCCP shall be finished with equipment in accordance with 507.04. 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.

20 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 507.08(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.

30 The PCCP surface shall be textured with a turf drag or a double thickness burlap drag. Facilities with design speeds equal to or greater than 75 km/h (45 mph) shall be textured with a turf drag.

40 The textured surface of PCCP shall be tined, unless otherwise specified. Tining shall consist of transverse grooves that are between 2.3 and 3.3 mm (3/16 and 1/8 in.) in width, between 3 and 4.8 mm (1/8 and 3/16 in.) in depth, and be spaced as follows: 22 mm, 13 mm, 25 mm, 16 mm, 19 mm, 28 mm, 13 mm, 16 mm (7/8 in., 1/2 in., 1 in., 5/8 in., 3/4 in., 1 1/8 in., 1/2 in., 5/8 in.). 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.

50 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 19 mm (3/4 in.) center to center and be 3.0 mm (1/8 in.) 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.

60 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 300 mm (12 in.) 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.

70 **(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 L/3.7 m² (1 gal./150 ft²). It shall be applied in one or two applications. The second application, where required, shall follow the first within 30 min. The curing compound may be warmed in a water bath during cold weather at a temperature not exceeding 38EC (100EF). Thinning with solvents will not be permitted. Non-uniform film rates will result in the discontinuance of that application method.

80 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.

90 **(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 300 mm (12 in.) or more and the laps held securely in place.

100 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.

110 **(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 75 mm (3 in.) 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.

120 **504.06 Basis of Payment.** The cost of finishing, furnishing curing materials, 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*
10	Sampling Fresh Concrete	AASHTO T 141
	Sieve Analysis of Aggregates	AASHTO T 27
	Slump	AASHTO T 119
	Specific Gravity and Absorption, Coarse Aggregate	AASHTO 85
	Specific Gravity and Absorption, Fine Aggregate.....	AASHTO 84
	Thickness of PCCP	ITM 404
	Unit Weight and Relative Yield	AASHTO T 121*
20	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.

30 **(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.

40

(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 1.0 mm (1/16 in.).
2. The test result shall be discarded when the break occurs outside the middle third of the beam.

50 **(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. Mass (weight) shall be determined to the nearest 0.005 kg (0.01 lb).

(d) Exceptions to AASHTO T 141. The exceptions to AASHTO T 141 for sampling fresh concrete shall be as follows.

- 60
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.

- 70
1. The aggregate correction factor test shall be re-run for confirmation if the test results for gravel is greater than 0.4 percent or if the test results for crushed stone is greater than 0.6 percent.
 2. 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:

10	Admixtures	912.03
	Calcium Chloride	913.02
	Coarse Aggregate, Class A or Higher, Size No. 11	904.02
	Coarse Aggregate, Class AP, Size No. 8.....	904.02
	Dowel Bars.....	910.01(b)10
	Fine Aggregate, Size No. 23.....	904.01
	Portland Cement.....	901.01(b)
	Water	913.01

20 The material for anchoring the dowel bars shall be a chemical anchor system selected from the Department's approved list of Chemical Anchors.

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 approved list of Non-Vapor Barrier Type Bonding Agents.

30 **506.03 Concrete Mix Design.** The CMD shall be in accordance with 506.04, and shall be submitted, prior to placement, in a format acceptable to the Engineer and 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 mass (weights)
- (g) the names of all admixtures
- 40 (h) the admixture dosage rates and the manufacturer's recommended range

A change to any source of material or proportions of aggregate requires a new CMD. A change to the dosage amount of an admixture will be permitted; however, a new CMD will be required for the addition or deletion of an admixture.

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

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

	Minimum portland cement content	390 kg/m ³ (658 lbs/yd ³)
	Maximum water/cement ratio.....	0.40
	Slump	50 mm (2 in.) to 125 mm (5 in.)
	Air content.....	5.0% to 8.0%
	Minimum flexural strength, third point loading.....	2100 kPa (300 psi) at 24 h
60	Minimum flexural strength, third point loading.....	3500 kPa (500 psi) at 3 days

A water reducing admixture shall be used.

Calcium chloride solution shall be added to the concrete. A maximum of 2%, by mass (weight) of cement, shall be used. The percentage shall be reduced to one if the ambient temperature is above 27EC (80EF).

70 **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. The trial batch may be produced prior to construction in a laboratory, at the plant, or at the project site on the first day of concrete placement. The Engineer will verify the CMD, 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.

80 When the first day's production is used as a trial batch, production may continue until flexural strength tests are completed. If 24 h or three day flexural tests are not in accordance with the specified strengths, production shall stop and a new CMD shall be submitted.

506.06 Job Control. Control of PCCP for air content, slump, or flexural strength 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.

90 The Engineer will notify the Contractor when test results for air content, slump, or flexural strength are outside the requirements of 506.04. Rounding will be in accordance with ASTM E 29 using the rounding method.

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.

100 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 25 mm (1 in.), to a maximum of 75 mm (3 in.). Removal of all unsound concrete to a minimum depth of 25 mm (1 in.) shall be by hand chipping tools or hand held mechanically driven equipment. Mechanical hammers shall not be heavier than a nominal 21 kg (45 lb) 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 25 mm (1 in.) outside the initial saw cut shall be made and the concrete in this
110 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 75 mm (3 in.) shall be cause for a full depth patch in accordance with 506.07(b).

120 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 the 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.

130 Removal areas in the same lane which are closer than 3.0 m (10 ft) shall require the PCCP between these areas to be removed and replaced. If a transverse joint is located within the removal area, the limits of removal shall be increased to a minimum of 0.3 m (1 ft) 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.

140 **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.

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

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

160 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.

(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.

170 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 charged 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.

180 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 manufacture. 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.

190 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 completed prior to 300 revolutions of the drum.

506.09 Weather Limitations. Placement of PCCP patches between May 15 and September 15 shall be after 1:00 P.M. The 1:00 P.M. restriction will apply outside this calendar period when the expected ambient temperature is 21EC (70EF) or greater, unless otherwise directed.

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

200 **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.

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 100 mm (4 in.) 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.

210 **(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.

220 **(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 an approved chemical anchoring system in accordance with the manufacturer's recommendations.

Patches constructed adjacent to transverse contraction joints 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 the joint. Patches greater than 5.5 m (18 ft) shall have type D-1 contraction joints in accordance with 503.03(a).

230 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.

T	H	HT	T	H	HT
4 - 5EC (40 - 42EF)	30	26	16 - 17EC (61 - 63EF)	14	9
6 - 7Ec (43 - 45EF)	27	23	18 - 19EC (64 - 66EF)	14	9
8 - 9EC (46 - 48EF)	24	21	20 - 21EC (67 - 69EF)	14	8
10 - 11EC (49 - 51EF)	21	19	22EC (70 - 72EF)	14	7
12EC (52 - 54EF)	19	16	23 - 24EC (73 - 75EF)	14	6
13 - 14EC (55 - 57EF)	16	14	Above 24EC (Above 75EF)	14	5
15EC (58 - 60EF)	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.

A patch may be opened to traffic sooner than permitted by the above table if test beams indicate a modulus of rupture of 2100 kPa (300 psi) or greater.

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

PCCP removal, subbase and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, dowel bars, reinforcing steel, chemical anchoring 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 meter (square yard) 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 meter (square yard) for PCCP patching, partial depth, plus 80% of the contract unit price per square meter (square yard) for PCCP patching, full depth.

Payment will be made under:

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
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PCCP Patching, Full Depth	m2 (SYS)
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PCCP Patching, Partial Depth	m2 (SYS)
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270 The cost of PCCP removal, subbase and subgrade excavation, when required, subbase and subgrade recompaction, non-vapor barrier bonding agent, dowel bars, reinforcing steel, 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 – EQUIPMENT

507.01 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.

507.02 Mixing Plant.

10 **(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 mass (weight) by means of automatic and interlocked proportioning devices. PCCP produced in accordance with 500 shall document each ingredient in each batch.

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

 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	$\pm 3\%$
aggregates.....	$\pm 2\%$
cementitious materials	$\pm 1\%$
30 water, volume or mass (weight).....	$\pm 1\%$

The plant shall be equipped with a recording device capable of permanently recording the batch number, time of day, mass (weight) of all materials in the mix, volume or mass (weight) 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.

40 **(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.

50 **3. Admixtures.** Separate tanks for each admixture shall be provided.

(d) Hoppers. Weighing hoppers shall be constructed to eliminate accumulations 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 weigh hopper in one cumulative operation provided that the portland cement is weighed in first.

60 **(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.

70 **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.

507.03 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.

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(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.

507.04 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 mass (weight) 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.

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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 0.6 mm (0.025 in.) and 1.5 mm (0.06 in.). 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.

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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.

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(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 3 m (10 ft) 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 3.0 mm in 3 m (1/8 in. in 10 ft) and the upstanding leg shall not vary by more than 6 mm (1/4 in.). 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 4.2 m (14 ft). The length of the float shall be approximately 50 mm (2 in.) 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 be 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 0.6 m (2 ft). 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 3 m (10 ft) or greater in length. Forms shall be capable of being staked in three locations or more for each 3 m (10 ft) 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 3.0 mm in 3 m (1/8 in. in 10 ft).

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.

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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 0.6 m (2 ft.) 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.

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A vibratory screed finisher shall consist of a truss frame with a minimum base width of 0.3 m (1 ft) which extends across the transverse width of the PCCP. The frame shall extend 0.6 m (2 ft) beyond the width of the PCCP and shall hold its shape when moved forward. The screed shall move forward with either hydraulic or manual wenchers 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.

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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.

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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 32 to 64 mm (1 1/4 to 2.5 in.).

507.05 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 L/3.7 m² (1 gal./150 sq ft) 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.

200 **507.06 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 mechanized equipment.

210 **507.07 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.

507.08 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 1.5 m (5 ft) in length and 150 mm (6 in.) in width. Equipment made of or coated with aluminum or aluminum alloys shall not be used.

220 Straight edges shall be 3 m (10 ft) in length and mounted on a long handle. The handle shall be 1 m (3 ft) 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 550 kPa (80 psi).

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

(c) **Grinding.** The machine used to remove the bumps shall be capable of producing a uniform texture on the pavement surface. The pavement surface after cutting shall not be smooth or polished. Tearing or dislodging of aggregates will not be permitted.

507.09 Testing Facility and Equipment.

240 **(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.

250 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. A spud vibrator with power source in suitable working order shall be provided by the Contractor.

260 **(c) Profilograph.** The profilograph shall be in accordance with ITM 901.

(d) Straightedge - 4.9 m (16 ft). A 4.9 m (16 ft) straightedge shall be a rigid beam mounted on two solid wheels on axles 4.875 m (16 ft) 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.

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