

SECTION 8 – PORTLAND CEMENT CONCRETE PAVEMENT, PCCP

8.1 INTRODUCTION *(Rev. 04-30-09)*

INDOT has specifications for both QC/QA PCCP (Section 501) and non-QC/QA PCCP (Section 502). The specifications for QC/QA PCCP require a QCP in accordance with ITM 803. The major differences between the two specifications are the testing and documentation requirements. The planned quantity of concrete pavement will determine whether the pay items are 501 or 502. There must be at least 7,200 syd of a concrete pavement item for section 501 to be applied. If a contract starts as a section 502 pavement, but a significant increase in the quantity is authorized, then the DMTE should be contacted to determine if the pavement should be tested under section 501.

The contractor is responsible for designing the concrete mixes in accordance with the specifications. All mix designs are reviewed for compliance with specifications. Section 501 mixes also require a trial batch procedure.

These instructions apply to both 501 and 502 concrete pavements unless specifically indicated otherwise.

8.2 PERSONNEL AND EQUIPMENT *(Rev. 04-30-09)*

When concrete mix is to be provided from a captive plant and the contractor has the mixer and the aggregate batchers ready for operation, notify the DMTE to arrange for inspection and testing of the water meter on the mixer and the scales on the batchers. The checking of all other equipment and tools is to be done by the project personnel. Give particular attention to the finishing machine screed crown, the screed and float pan crown of the finisher-float, if used, or the crown, in the rails of the mechanical longitudinal float, and the subgrade scratch template.

Equipment for making plastic concrete tests should be obtained through the DMTE before paving operations are started and must be properly calibrated prior to use as outlined in Section 45 of these instructions. Prior to a trial batch demonstration, a discussion should be held with the CCT on the operation to ensure they understand their responsibilities and documentation requirements. Prior to the start of the paving, a pre-paving meeting should be held with the contractor and all INDOT personnel who will be inspecting the paving operations to outline everyone's responsibilities and review the paving plan and schedule.

Keep in mind that all materials must be approved before being used in the concrete mix. The specifications do not allow the use of fly ash or granulated ground blast furnace slag (GGBFS) as an additive in concrete pavements after October 15th and prior to April 1st of the following year without approval from the Construction Management Division. This requirement is due to the possibility that the use of fly ash or GGBFS in pavements that do not have sufficient cure time prior to the application of deicing chemicals in the winter months are susceptible to scaling or other durability distresses. However, Construction Memorandum 05-14, issued on September 6, 2005 does allow for the use of fly ash or GGBFS through November 15th if the following conditions are met:

- The contractor must agree that the contract will not be accepted until after May 30th of the following year
- The PE/S must identify the sections of pavement placed with fly ash or GGBFS between October 15th and November 15th
- The AE must inspect the identified pavement sections after May 30th to determine if there is any scaling or other distress

If after the spring inspection, no pavement distress is found in the identified sections, the contract may be accepted. If problems are found, the contractor must correct them, including removal and replacement if necessary, before the contract is accepted.

For QC/QA PCCP, the contractor is required to have an ACI certified concrete field testing technician, grade 1, on-site to supervise the QC testing for the contractor. Trial batches are to be run for each mix design with INDOT and contractor present and performing independent tests. The contractor is required to provide a common testing facility for both the contractor and state personnel for use during the contract. The specification outlines the specific requirements for the lab to be provided by the contractor. A good communication process should be in-place between the INDOT field CCT at the paving site and the INDOT lab technician to accurately document the station of the random load of concrete and communicate problems if they occur.

8.3 SUBGRADE AND SUBBASE *(Rev. 09-25-09)*

Prior to the start of paving operations, the subgrade and subbase must be completed in accordance with the specifications. Checking of subgrade and subbase must be done well in advance of the paving operations. In general, the contractor should keep a minimum of 500 ft. of subbase prepared ahead of the paving operation to allow time for proper inspection before concrete is placed.

8.4 SETTING FORMS *(Rev. 04-30-09)*

Almost all concrete paving, including shoulders, is done by the slipform method. However, the contractor has the option to set forms and use various types of form riding paving equipment. Short gaps and tight areas will most likely be done by the formed method. This section applies only when the contractor uses the formed method of paving.

Form stakes used to set forms to line and grade should be set not more than 50 ft apart on the outside of each form line. The offset distance from the form line is usually 2 ft. Stakes are tacked for line on one side only.

In setting forms, the most important factor in maintaining a true line and grade is a full and complete bearing of the form base on the subbase. Tamping under the forms after they are set, or shimming with stones, loose material, or blocks of wood to bring them up to proper elevation should not be permitted. A form that is too low must be removed, suitable material added and tamped, and the form reset and checked. This operation must be repeated until the correct line and grade is obtained.

Forms must be anchored in place with a minimum of 3 pins per 10 ft section of form.

Check for tight and complete closure of all form keys, wedges, and latches. All forms should be inspected for proper support and should be checked with a 10 ft straightedge. Variations of 1/8 in. or more in 10 ft. must be corrected before concrete is placed.

Forms that will not straightedge to the above tolerance, which are bent, twisted, or that will not match adjacent forms satisfactorily must be removed from the work.

8.5 ACCEPTANCE TESTING *(Rev. 04-30-09)*

As previously noted, the primary difference between QC/QA PCCP and non-QC/QA PCCP is the procedure for testing the concrete. These differences are outlined below:

a. PCCP

A standard concrete series of tests (air, slump, and yield) must be taken immediately after the paving starts and any necessary adjustments of the batch weights made. Adjustments should be made by the contractor as work continues. Tests are reported on Form IT-652. The specifications clearly state the limits on all tests and the frequency testing is outlined in the Manual for Frequency of Sampling and Testing.

A water/cementitious ratio test is also made as soon as practicable and the results reported on Form IT-628B (See Attachment 'A' ITM 403T). The water/cementations ratio shall not exceed the limits set out in the specifications.

b. QC/QA PCCP

Testing is based on random sampling of Lots and Sublots as defined in the specifications. The testing is performed by the CCT at the field lab. Standardized forms are available through the district office. Accurate and timely documentation are necessary to ensure proper application of the specification and quality assurance adjustment factors. Daily review of this data is necessary to ensure proper tracking of lot and subplot quantities. The contractor's control charts should be reviewed and any problems discussed with the contractor weekly by the PE/S. Opening to traffic test beams are separate beams from those cast for acceptance purpose.

8.6 PLACING CONCRETE *(Rev. 01-01-02)*

The subbase must be kept uniformly moist in front of placing the concrete mix to prevent the dry subbase from removing moisture from the mix.

The concrete is placed on the subbase and spread by means of a mechanical spreader. Strike-offs that do not have sufficient weight or that are of such design that will not level off the concrete at the correct elevation, shall not be used.

Concrete must be kept in front of the strike-off at all times while it is moving forward in order to prevent depressions. Where such depressions do occur, it is necessary that they be filled.

The contractor must place the concrete at joints so that the dowel bar assemblies are not

displaced.

For formed paving, the edges of the pavement at the form line must be well vibrated to prevent honeycombing. Care must be taken to see that the machine operator uses these vibrators only while the machine on which they are mounted is moving forward. Inspect the pavement edge after removal of forms and have any honeycombed patched before the edges are banked with earth or sprayed with curing compound. Patching of honeycomb must be done immediately after removing the forms.

8.7 PAVEMENT JOINTS *(Rev. 09-25-09)*

Joints are placed in concrete pavements primarily to control cracking and to permit placing of adjacent slabs. Poorly constructed joints constitute one of the greatest sources of trouble in concrete pavement construction. For example, poor construction of transverse joints causes bumps at each joint which negatively impacts the life of the concrete as well as the traveling public. Regular and consistent inspection is important to achieve proper placing and finishing of joints.

When placing fresh concrete adjacent to a joint within a pavement, the existing joint must be protected to prevent mortar and fines from entering the joint. If this is not done, the joint will fail prematurely.

Each type of pavement joint is discussed in detail below.

8.7.1 Longitudinal Joints

Longitudinal joints permit a hinge action between slabs and may be either of the types shown on the plans or specified in the contract.

Tie bars are an integral part of a longitudinal joint, and are installed on suitable chair supports driven in the subgrade, or placed after the concrete has been struck off. Check that the contractor uses the correct size and spacing of the tiebars.

Unless a particular type of longitudinal joint is specified, all longitudinal joints must be sawed under provisions of Section 500. All longitudinal joint sawing should typically be performed within 2 to 12 hours after the pavement is placed. The slurry created by sawing operations must be completely flushed from the joint by a high-pressure water jet. All joints must be entirely open for their entire depth immediately prior to sealing.

8.7.2 Contraction Joints

Contraction joints are placed across the pavement at right angles to the centerline to control cracking, and unless otherwise provided must be sawed.

The maximum allowable contraction joint spacing is specified in the plans. When manholes, utility access ports, catch basins, inlets, etc. are located within the pavement, a contraction joint layout plan needs to be made. No pavement block out section should be closer than 4 ft from a contraction joint unless a contraction joint is incorporated as one side of a block out section. Under no circumstances should the maximum contraction

joint spacing be exceeded. Contraction joint placement is especially critical in urban pavement sections in order to avoid random pavement cracking and deterioration subsequent to construction.

The subbase must be accurately prepared at the joint location when either a welded dowel bar assembly that rests on the subgrade or a full depth separator is used. A template may be required for checking the subbase and position of the dowels if necessary. The position of the dowels must be checked, as described in section 8.10 of these instructions, to ensure that the dowels are parallel with both the pavement section.

Dowel bar assemblies must be pinned securely to the subbase. The concrete must be placed in such a manner that individual dowels or entire assemblies will not be displaced from their true position. Dowels that do not remain parallel with the pavement will cause cracking and spalling of the pavement.

Contraction joints are to be sawed the full pavement width in two separate operations. The initial transverse saw cut must be at a depth of $D/3$ for new pavement sections. This initial saw cut should commence as soon as the concrete has hardened sufficiently to permit sawing without raveling, usually 2 to 12 h after placement. If necessary, the sawing operations must be carried on during day and night, regardless of the weather conditions. After the concrete has sufficiently cured, but before opening the pavement to non-construction traffic, a second saw cut must be made. Immediately upon completion of the sawing operation, the joint must be thoroughly washed to ensure that all the slurry is washed out, and not permitted to remain and harden in the joint.

8.7.3 Sawed Joints

When sawed contraction or longitudinal joints are required, the work must be performed in accordance with all applicable provisions of the contract, plans, and specifications. Contraction joints should be sawed within a period of 2 to 12 h after placing of the concrete to prevent the development of random and premature cracking. Sawing should start as soon as the concrete has hardened sufficiently so that the sawing can be performed without undue raveling or spalling, resulting in a clean, neat groove. Careful detailed inspection is necessary to ensure that the contraction joints are sawed prior to the development of random cracks that result from poor timing. If random cracks develop, contact the AE immediately and secure assistance in determining the cause of the cracks, means of preventing them and any corrective measures that may be required.

During the placing of concrete the contractor must accurately reference the location of the contraction joint assembly in order that the subsequent saw cut is made directly over the center of the dowel bars.

The inspector assigned to the sawing operation should be thoroughly familiar with the applicable specification requirements and in addition give detailed attention to the following:

1. Check width of saw cut.

2. Check depth of saw cut.
3. Ensure that saw cut is straight.
4. Ensure that transverse saw cuts are at right angles to the pavement lanes.
5. Ensure that saw cuts are clean.

8.7.4 Expansion Joints

Expansion joints are used only where specifically called for on the plans. Expansion joints are indicated on the intersection detail sheets in the plans as to kind and width. A careful study should be made of all detailed intersections, and if in your opinion, the joint arrangement as shown will not function properly, the layout should be discussed with the AE and the designer.

Expansion joints labeled as terminal joints at bridges, railroad grade crossings, or abutting existing jointed pavement, consist of a concrete sleeper slab installed below the joint and the joint itself is filled with HMA mixture. Care should be exercised to ensure that the sleeper slab is constructed in the same plane as the pavement that will be placed on it.

8.7.5 Construction Joints

A construction joint is a rigid type joint that joins two sections of pavement together by the use of deformed reinforcing bars.

Construction joints are commonly used at the end of a day's run or whenever the paving is stopped for 30 minutes or more and the location does not fall at a contraction joint. The tie bars are pushed into the concrete through holes or slots in the header board to the required depth. The free ends on the bars must be supported. When starting from a construction joint the inspector must check the vertical face of the existing pavement for right angles and alignment.

The specifications state that the construction joints must be at a minimum spacing from a contraction joint. In fact no two transverse joints, of any kind, should be spaced closer than the specified spacing. This means that headers must be placed exactly at a point half way between preset contraction joint baskets unless a contraction joint is used as a header also.

Contraction joints may be used as a construction joint, but care must be taken to ensure that the dowels are positioned parallel to the plane of the pavement, both horizontally and vertically. A slotted header board is recommended.

8.8 FORMED PAVING *(Rev. 09-25-09)*

It is the inspector's duty to see that the contractor's operation in placing and finishing concrete is done in a manner that will produce a smooth riding pavement. Any variations that exceed the acceptable limits must be corrected either at the time of finishing, which is by far most preferable, or later.

The following are the most important elements in securing a smooth riding pavement:

1. Uniformly compacted subgrade and/or subbase.
2. Straight forms properly aligned and staked or properly aligned stringlines for slipform equipment.
3. Uniform consistency of concrete as specified.
4. Uniform spreading and consolidation of the concrete in front of the finishing machine to produce a constant elevation during the forward movement.
5. Correctly adjusted finishing machinery that is in good condition and operating properly.
6. Correct and constant use of a true 10 ft straightedge which is cleaned and checked frequently.
7. Checking the pavement as far back of the float as concrete setting will permit.
8. Skilled and judicious use of hand tools.
9. Texturing at the proper time in the proper manner.

The following is a discussion of operations and equipment in the order as normally used on paving projects.

- (a) Mechanical Spreader or Strike-off. A properly operating machine spreads the concrete uniformly over the subgrade in a manner that produces a minimum of segregation.
- (b) Finishing Machine. The principal functions of the finishing machine are to uniformly screed and consolidate the concrete mix. The rate of placement of mix in front of the finishing machine must be matched to the finishing machine's capacity. A uniform head of concrete should be carried in front of the finishing machine. The amount of surge under a screed is controlled by the head of concrete in front of it, the consistency of the mix, and the tilt of the screed. When the head is too high, an excess will pass under the screed making a bump in the finished pavement. A deficiency of concrete at any point along the width of the screed will cause a low spot at that point. The rear screed should cut the concrete off to the elevation and section of the finished surface, allowing a slight surplus of mortar for proper operation of the longitudinal float. Tearing of the surface indicates too stiff a mix or too much forward travel as related to transverse motion. A non-uniform surface behind the finishing machine, such as deep or irregular corrugations, indicates improper adjustment or operation of the machine.

Floating of the pavement surface follows the finishing machine and is intended to further smooth and true the pavement.

- (c) Mechanical Float. This is the next mechanically controlled piece of finishing equipment, and poor quality work will leave irregularities that cannot be properly corrected by the hand finishers. A mechanical float may be used to correct minor variations, but anything other than this calls for immediate revision of the finishing machine operation. Low spots shall be corrected.

Even if the mechanical float is performing satisfactorily, changing conditions can affect pavement smoothness. These conditions can be items such as; concrete mix or consistency, working up or down grade, change in the drying conditions, change in the rate of cross slope, and the time interval between placing of concrete and operation of the float. Attention to these changing conditions will make the difference between an excellent pavement surface and a relatively poor one.

Floating prior to the initial settlement of the concrete is frequently the reason why pavements are found rough when straightedged the next day, and require corrective action to remove the variations. Initial settlement of the concrete should take place before passing of the mechanical float. The float must be held back from the paver to allow for this initial settlement.

If the mechanical float is properly operated the surface will require only minor hand finishing after its passage. The straightedgers following the float will have very little to do except remove the slight trail marks and carefully check the surface. If the finishers are working hard at anytime, a careful check should be made of the finishing machine adjustment in addition to a careful check of the float.

- (d) Hand Finishers. Final checking of the pavement is done as far back as possible, but not so far that good texturing and edging cannot follow. Additional water for finishing purposes shall be limited to such quantity as may be applied by fogging as approved.
- (e) Texturing. The pavement will receive a finish in accordance with the specifications as described in Section 500. Areas of the hardened grooved pavement which do not meet the contract requirements have to be corrected by cutting acceptable grooves in the pavement with an approved mechanical grinder or cutting machine.
- (f) Edging. This operation shall be performed as per Section 500.
- (g) Pavement Smoothness. After the concrete has hardened, the profile of the surface shall be checked as per Section 500.

- (h) Pavement Thickness. The PE/S must always be on the alert for any operation that would contribute to thin pavement. The contractor is responsible to ensure proper pavement thickness as shown in the contract documents. Cores shall be taken as per Section 500. Factors essential to ensure proper thickness are as follows:
1. Checking the correct crown in the equipment screeds, and carefully check actual pavement crown several times each day, both before and after the concrete has set.
 2. Stability of foundation under the forms; give particular attention if paving operations are caught in a hard rain.
 3. Care in checking the removal of crown in the subgrade at transitions from crowned to flat sections and from flat to crowned sections.
- (i) Hand Methods. Hand methods as set out under Section 500 may be used on widened pavement and other locations as permitted.

8.9 SLIPFORM PAVING

Most mainline paving is currently done by the slipform method. Uniformity is the key word in slipform paving and the need for uniformity begins with the subgrade. Uniform and close conformance with both grade-line and cross-section of the subgrade will affect uniform slab thickness, final smoothness, and riding quality of the pavement.

To accomplish this purpose the contractor will utilize an auto-grade machine with automatic grade control from a pre-set grade-line to trim the subbase. This grade-line on each side of the pavement should be set, in or parallel to, the plane of the edges of pavement.

This same rule applies if the contractor uses automatic grade control when slip-forming. If automatic grade control is to be used when paving, a common elevation datum must be used for both subbase and pavement to prevent deviation in pavement thickness and concrete quantities.

After the subbase is complete, contraction joint assemblies for jointed pavement may be set on the subbase. Pre-set pins or other procedures must be used to properly align the joint assemblies, as there are no side forms that can be used for reference.

Uniform concrete mix is also important in slip-form paving, as it will have a pronounced effect on the smoothness of the final pavement. Attention must be paid to using only properly drained aggregate to obtain uniform slump. Uniform consistency and consistent low slump are necessary to minimize problems with edge slump and rough pavement. Inspection should be made for uniform moisture in the subgrade ahead of the paving and water added to the subgrade as necessary.

The best results for controlling edge slump and smooth pavement are attained with uniform concrete, uniform rate of delivery to the paver, and uniform lateral distribution and level of mix maintained at the main screed. Interruption in the truck cycle causing the paver to stop is a possible source of rough pavement; therefore, paving speed should be coordinated with the rate at which concrete is delivered to the paver. The interval between the spreader and the paver should be maintained such that a short delay at the spreader will not cause the paver to stop. A slow continuous paver speed should be used rather than starting and stopping. Since the main screed is in effect making the final profile and cross section of the pavement, a uniform level of concrete must be maintained across the entire width of the screed.

To obtain uniform consolidation and adequate density of the concrete, a series of internal vibrators are installed in front of the main screed. Occasional observation should be made of the vibratory devices to detect failure of individual units. Inspection should be made on the configuration of the main screed after each major move of the paver to check for any change from the required alignment. Immediately behind the paver the pavement should be checked for conformance with the required cross section.

Periodic checks of the pavement thickness should be made and one of the more efficient methods used is to insert a measuring rod down through the slab to a metal plate set at a pre-determined point. A depth check should be made at least every 400 to 500 ft when starting a project, and then as necessary to confirm proper depth. The information should be recorded noting the station, offset, and depth.

Edge slump should be checked after the trailing forms have passed. Minimum edge slump is particularly critical when an adjacent lane is to be constructed. To protect edge slump from possible rainfall, auxiliary side forms and enough plastic sheeting or other material sufficient to cover several hundred feet should be readily available.

8.10 TEST PROCEDURE FOR CHECKING POSITION OF DOWEL BARS

(Rev. 09-28-09)

After placement on the subgrade each dowel bar assembly should be visually checked for proper alignment. The bars must be parallel to the side and top of the pavement. A minimum of three bars in every assembly should be checked and reported. If any one of the bars is out of alignment, every bar in the assembly needs to be checked after the assembly has been adjusted. The check must be performed before the placement of concrete around the bars. At the beginning of a paving operation, several assemblies should be checked after placement of the PCC prior to initial strike off to ensure no movement of the assembly during the PCC placement operation.

A commonly used method is the “dowel bar checker” which may be obtained at the DO. This instrument is essentially a frame having legs of equal length that supports a level dial. It is first set on the side form or string line with the legs at equal distance from the joint, and the level adjusted until the bubble is centered. This is necessary to compensate for the grade of the pavement. Next, the legs of the checker are set on top of each dowel

to be checked. If the bubble is in the center of the vial, the dowel is in the correct vertical position. If not, the dowel bar shall be marked and the contractor should be notified.

8.11 PERMANENT MARKING OF STATIONING ON PAVEMENT *(Rev. 09-28-09)*

Station numbers must be marked on the right hand side of the pavement (facing the higher numbers) with the nearest number about 8 in. from the edge of the pavement. The full station number should be placed every 100 feet. Intermediate points will be placed between full stations. At the beginning of each day's run, the plus of the station and the date should be marked. In the case of a divided lane, the station numbers are to be placed along the outside edge of the pavement, readable from the same direction as the flow of traffic. Cast iron dies of numbers are available from the DMTE.

8.12 CURING *(Rev. 09-28-09)*

All pavements must be cured using an approved method outlined in Section 500. Curing operations must be continuous until specification requirements are met. During the curing period, any defects in the curing method must be repaired immediately. Curing should be checked daily during the entire required period. If there is any possibility of the temperature dropping below freezing after any pavement is placed, the pavement must be protected by the use of insulated blankets or other approved means.

8.13 PAVEMENT SMOOTHNESS *(Rev. 09-28-09)*

The specification requirements for smoothness stipulate that the smoothness may be checked as soon as the concrete has cured sufficiently to permit testing. The Department may require the profile to be checked within 24 h to determine if paving operations are producing a pavement with the minimum desired smoothness. Smoothness is checked either by profilograph operated by the contractor or straightedge operated by the Department. The PE/S or a designated representative should be present to observe the profilograph operations.

8.14 CLEANING PAVEMENT *(Rev. 09-28-09)*

When the paver is supported by an existing pavement while placing widening, adjacent slabs, or incidental construction, care shall be taken that all mortar and concrete drippings are carefully and completely removed from the existing pavement without marring or damaging the existing surface.

8.15 SEALING CRACKS AND JOINTS *(Rev. 09-28-09)*

All cracks and joints must be sealed prior to discontinuing work for the winter or before opening the pavement to traffic.

Sealing of cracks and joints requires inspection and must be performed in accordance with applicable requirements of the specifications.

Joints are to be thoroughly cleaned and inspected prior to sealing in accordance with Section 500 of the Standard Specifications. All excess and unsightly sealing material is to be cleaned from the pavement surface.

8.16 PAVEMENT INSPECTION *(Rev. 09-28-09)*

Prior to opening a new pavement to traffic the contractor and the PE/S must inspect the pavement for any damage, including random cracks. All random cracking must be repaired prior to opening the pavement to non-construction traffic.

8.17 TEST BEAMS AND OPENING PAVEMENT TO TRAFFIC *(Rev. 09-28-09)*

For opening to traffic, the contractor may choose to determine concrete strengths using the maturity meter or test beams.

When test beams are used for opening to traffic, one or more sets of test beams must be made at each intersecting road and at any other location where the contractor requests beams to control the cure period. The purpose of the beams at intersecting roads is to furnish a basis for allowing traffic across the new pavement.

Test beams are also required for trial batches when fly ash is used in the mix design and for all QC/QA PCCP mixtures.