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# 5 Quality Control Procedures

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# ***CHAPTER FIVE:***

## ***QUALITY CONTROL PROCEDURES***

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The foundation for a successful Quality Assurance program is the control maintained by the Contractor to assure that all materials submitted for acceptance conform to the contract requirements. To accomplish this, the Contractor is required to have a functional Quality Control Plan (QCP) to keep the process in control, quickly determine when the process goes out of control, and respond adequately to bring the process back into control.

This chapter includes the minimum requirements for maintaining quality control during production of QC/QA Portland Cement Concrete Pavement. Acceptance test results by INDOT are shared with the Contractor; however, results of these tests are not used for quality control purposes.

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### **CONTRACTOR PERSONNEL**

The Contractor personnel required to provide quality control on a QC/QA PCCP contract includes a QCP Manager, QCP Field Manager, and a Quality Control Technician. One quality control person may perform the duties of more than one position.

#### ***QCP MANAGER***

The QCP Manager is responsible for the overall administration of the QCP on the contract.

#### ***QCP FIELD MANAGER***

The QCP Field Manager is responsible for the execution of the QCP and is the liaison with the PE/PS. This person is often also the QCP Manager.

#### ***QUALITY CONTROL TECHNICIAN***

The quality control technician is required to be an American Concrete Institute (ACI) certified field testing technician, grade 1.

### **TESTING FACILITY**

The Contractor is required to designate the location of the testing facility and a list of test equipment. The testing facility shall be in accordance with the following:

- 1) The 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
- 2) Water shall be conveniently available for cleaning testing equipment and for serving other tasks at the facility.
- 3) Office space, having suitable heat and air conditioning, shall be provided to INDOT within the testing facility.
- 4) A telephone shall be provided in the testing facility
- 5) Floor space shall be provided for an INDOT furnished beam breaker.
- 6) A current set of AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II Tests, and ASTM C 173 shall be provided.

A statement of accessibility of the testing facility is required that will allow INDOT personnel to witness the quality control activities and review quality control tests.

#### ***TESTING EQUIPMENT***

A list of the testing equipment proposed for quality control testing, and the test methods and frequency of calibration or verification of the equipment is required. The equipment shall be provided to perform production control testing and shall be maintained in suitable working order. The equipment is required to be in accordance with AASHTO requirements where applicable. The Contractor is also required to provide a spud vibrator with a power source in suitable working order.

The Contractor is required to maintain a record of all equipment calibration or verification results at the testing facility. The minimum frequency and procedures shall be as follows:

<b>Equipment</b>	<b>Requirement</b>	<b>Minimum Frequency</b>	<b>Procedure</b>
Air Meter	Calibration	3 months	AASHTO T 152 or ASTM C173
Balances	Verification	12 months	ITM 910
Sieves	Check Physical Condition	6 months	ITM 902
Slump Cones	Verify Dimensions	12 months	ITM 911
Thermometers	Verification	6 months	ITM 909
Unit Weight Measure	Calibration	12 months	AASHTO T 121

## **MATERIALS**

The source, transportation, handling, and storage procedures, as applicable, are required for the following materials to be used in the PCCP.

- 1) Admixtures – type
- 2) Aggregates – size
- 3) Curing Materials
- 4) Dowel Bars – size
- 5) Dowel Bar Assemblies – size
- 6) Fly Ash – class
- 7) Ground Granulated Blast Furnace Slag – grade
- 8) Joint Fillers – type
- 9) Joint Materials – type
- 10) Portland Cement – type
- 11) Reinforcing Steel - size and type
- 12) Water - Potable or non potable. If non-potable, the sampling and testing procedures shall be designated.

## **PROCESS CONTROL OF AGGREGATES**

A plan for control of the gradation and moisture in the aggregate stockpiles, identification of stockpiles by signing or other acceptable methods, techniques for construction of proper stockpiles, and loading procedures is required.

The gradation control band tolerances on each sieve for aggregates not in accordance with the gradations of 904.02 and 904.03 shall be included.

Gradation tests for each aggregate size shall be conducted daily when concrete paving operations exceed 200 yd<sup>2</sup> (200 m<sup>2</sup>) per day. The procedure for determination of the combined aggregate gradation shall be included. Gradation tests shall verify the maximum size of the aggregates and the mathematically combined amount passing the No. 200 (75 μm) sieve of fine and coarse aggregates which have been proportioned in accordance with the CMD. Gradation tests shall also verify compliance with intermediate sieves in accordance with 904.02 and 904.03 or with sieve band tolerances as stated.

The procedure for determination of the water absorption of the aggregate shall be included. The minimum frequency is required to be two tests for each aggregate used during the concrete paving operations.

## **TRIAL BATCH DEMONSTRATION**

The procedures, location, and type of equipment to be utilized during the trial batch demonstration(s) are required. The identification and intended use of each mixture shall be included.

## **CONCRETE BATCHING**

The techniques and controls of the concrete batching operations are required. A description of the plant, including the capacity and intended batch size, and the methods and sequence by which the plant produces a batch shall be included. The minimum mixing time shall be stated.

The initial and routine equipment checks, including those conducted on mixers, scales, water meters, and admixture dispensers, shall be included. All material checks, including frequencies of testing, shall be identified. The methods to monitor the ingredients used, and the record of each batch shall be included.

## **PROCESS CONTROL OF CONCRETE**

The procedures for sampling and testing the concrete mix for flexural strength, air content, unit weight, and water/cementitious ratio shall be designated. The frequency of tests shall be included and as a minimum shall meet the following:

### ***FLEXURAL STRENGTH***

The minimum frequency of tests for determination of the flexural strength shall be one set of two beams for each subplot.

### ***AIR CONTENT***

The minimum frequency of tests shall be one air content determination for each subplot.

### ***UNIT WEIGHT***

The minimum frequency of tests shall be one unit weight determination for each subplot.

### ***WATER/CEMENTITIOUS RATIO***

The minimum frequency of determination of the water/cementitious ratio shall be one per week or one for every five lots, whichever is more restrictive by frequency.

## **PROCESS CONTROL OF PAVEMENT**

The procedures for determining the pavement depth, surface profile, and surface smoothness shall be as follows:

### ***PAVEMENT DEPTH***

The procedure for monitoring the depth of the concrete pavement shall be included.

### ***SURFACE PROFILE***

The procedure for measuring the surface profile and correcting profile non-compliance of the concrete pavement shall be included.

## ***SURFACE SMOOTHNESS***

The procedure for measuring the smoothness and correcting smoothness non-compliance of the concrete pavement shall be designated. The certification of the profilograph in accordance with ITM 901 shall be included.

## **CONTROL CHARTS**

The procedures for charting quality control results for tests for flexural strength, unit weight, and air content of the concrete shall be designated. The control charts shall indicate process control limits for each subplot and lot, 100 percent payment limits, and have a legend. The charts shall be maintained at a readily accessible location at the common testing facility. The control chart legend shall be as follows:

- 1) The target value, if applicable, shall be the center of the chart and shall be represented by a heavy long dash followed by a short dash line.
- 2) Control limits shall be represented by heavy solid lines.
- 3) One hundred percent payment limits shall be indicated by short dashed lines.
- 4) The horizontal lines on the chart indicating the 100 percent payment limits, control limits, and target value, if applicable, shall be numerically identified in the left margin.
- 5) The vertical distance between upper and lower control limits shall be no less than 2 in. (50 mm).
- 6) The plot point for the test results shall be surrounded by a small circle, and each consecutive point shall be connected by a solid straight line.
- 7) Test results shall be plotted left to right in chronological order, and dates corresponding to each test shall be shown along the horizontal axis.

Any proposed deviation from these procedures shall be identified in the QCP.

## **RESPONSE TO TEST RESULTS**

The response to process control tests shall include as a minimum the following:

### ***WATER ABSORPTION***

The procedure for corrective action when the absorption test results for a particular size of aggregate differs from the design mix value by more than 0.5 percent. A statement that production shall be discontinued when this tolerance is exceeded shall be included.

### ***OTHER QUALITY CONTROL TESTS***

The procedure for corrective action for results outside of satisfactory limits for each type of test shall be designated.

## **CONCRETE HAULING**

The equipment and methods for delivery to the paver shall be designated. The description or plan drawing of the traffic patterns in the vicinity of the plant and for delivery of the concrete mix to the site of work shall be stated. Information concerning temporary adjustments to traffic flow shall be included. When using transit mixers, the procedures for adding water to the PCC and the required mixing time to increase workability shall be included.

## **CONCRETE PAVING**

The procedures for placement of the concrete shall include as a minimum the following.

### ***PAVING PLAN***

The general sequence of construction, the widths and methods of placement for all areas, and the planned date for paving to begin and to be completed on each phase of the contract shall be designated.

### ***COLD WEATHER PAVING***

The procedures to be utilized when ambient temperature is below 35°F (2°C) shall be designated. The procedures shall address protection of the subgrade, treatment of the concrete components, and protection of the PCCP. ACI 306 may be used for additional guidance.

### ***NIGHT PAVING***

The procedures to be utilized for artificial lighting when natural light is insufficient shall be designated. The procedures shall include the number and type of units with respect to the paving operations.

### ***PAVING***

The techniques used to place concrete throughout the project with specific details pertaining to difficult locations, such as joining existing pavement, gaps, headers, crossovers, approaches, or tapers shall be designated.

### ***EQUIPMENT***

Identification of the equipment used in the paving operations on each phase of the contract shall be designated.

### ***ALIGNMENT AND PROFILE***

The methods of controlling the alignment and profile shall be designated.

### ***PLACEMENT AND CONSOLIDATION***

Methods of depositing plastic concrete from the hauling equipment to the grade shall be designated. The proposed methods of spreading and consolidating shall be included.

## **JOINTS**

The type of sealant to be used and the manufacturer's recommended installation procedure for each type of joint construction shall be designated. The measures to be taken to prevent the flow of cementitious material into previously placed and sawn joints, when placing adjacent concrete pavement shall be included.

### ***D-1 CONTRACTION***

The procedure for identifying the contract conditions so that the joints are continuous from edge of pavement to edge of pavement shall be designated. Methods of installation, alignment, timing of sawing, and protection shall be included.

### ***LONGITUDINAL***

The method of construction to include details of how the reinforcing steel is to be placed and when the joints are to be sawed at identified planned locations shall be designated.

### ***TRANSVERSE CONSTRUCTION***

The method of construction, which shall include details of the type of header and reinforcing used, when paving operations are suspended shall be designated.

### ***LONGITUDINAL CONSTRUCTION***

The method of construction and proposed spacing if other than shown on the plans shall be designated.

### **FINISHING, TEXTURING, AND CURING**

The methods for finishing, texturing, and curing the PCCP shall be designated. The equipment to be used shall be identified.

### **DOCUMENTATION**

A statement that the test results for control shall be maintained for a period of three years upon completion of the contract shall be included. The records, either electronic and/or hard copies, shall be maintained at a readily accessible location for review by the Department at any time. The documentation shall include results for the aggregate tests, mixture tests, and the profile, smoothness, and depth of pavement tests.

### **QUALITY CONTROL PLAN**

The Contractor is required to submit a QCP that is contract specific and states how the process control of materials, equipment, and operations are maintained. As a minimum, the QCP is required to include the following information for each contract.

- 1) The name, telephone number, duties, and employer of all quality control personnel necessary to implement the QCP. The minimum number of quality control personnel is required to include a QCP Manager, QCP Field Manager, and Quality Control Technician.
- 2) The location of the test facility, list of test equipment, the test methods and frequency of test equipment calibration/verification, and a statement accessibility of the testing facility
- 3) The source, transportation, handling, and storage procedures of the materials used in the concrete
- 4) The procedures for the control of the gradation and moisture of the aggregates, and the procedures for stockpiling, identification of the stockpiles, and plant loading

- 5) The procedures, location, and type of equipment to be utilized during the trial batch demonstration, and the intended use of each mixture
- 6) The techniques and controls of the concrete batching operations, and the initial and routine checks of the equipment
- 7) The procedures for the process control of the concrete to include the sampling and testing procedures to determine the flexural strength, air content, unit weight, and water/cementitious ratio
- 8) The procedures for process control of the pavement for determining the pavement depth, surface profile, and surface smoothness
- 9) The procedures for charting quality control results for tests for flexural strength, unit weight, and air content of the concrete
- 10) The response to process control tests not within the established requirements for water absorption, flexural strength, unit weight, and air content
- 11) The procedures for delivery of the concrete to the paver and the equipment required
- 12) The procedures for the concrete paving to include a paving plan, cold weather paving, night paving, equipment, alignment and profile, and placement and consolidation
- 13) The procedures for installation for each type of joint and the type of sealant to be used
- 14) The procedures for finishing, texturing, and curing the concrete
- 15) The procedures for documentation of the quality control tests and the equipment used on the contract

#### ***QCP APPROVAL***

The QCP is required to be submitted to the PE/PS for review at least 15 calendar days prior to commencing PCCP operations. The Contractor is required to sign and date the QCP at the time of submittal to the PE/PS. The PE/PS signs and dates the QCP if the contents of the QCP are in compliance with the above-noted requirements. PCCP operations are not allowed to begin before the QCP has been accepted.

***QCP ADDENDA***

The QCP is required to be maintained to reflect the current status of the operations, and revisions are required to be provided in writing prior to initiating the change. The change may not be implemented until the revision has been accepted.