

APPROVED:
Division Administrator

By: _____
FEDERAL HIGHWAY ADMINISTRATION

Supplemental Technical Specification for

PCC Pavement Mix Proportioning and Strength

SCDOT Designation: SC-M-501 (01/25)

1. SCOPE

- 1.1. This supplemental technical specification describes materials and proportioning requirements for Portland cement concrete (PCC) pavement. It also describes the strength requirements for PCC pavement and the method of determining the strength during construction.

2. REFERENCED DOCUMENTS

- 2.1. SCDOT Standard Specifications Divisions 500 and 700
- 2.2. ASTM C 31, Standard Practice for Making and Curing Concrete Test Specimens in the Field
- 2.3. ASTM C 39, Compressive Strength of Cylindrical Concrete Specimens
- 2.4. ASTM C 143, Test for Slump of Hydraulic Cement Concrete
- 2.5. ASTM C 231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- 2.6. AASHTO M 201, Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements

3. MATERIALS

- 3.1. Portland Cement
 - 3.1.1. Use Portland cement or blended Portland-limestone cement meeting the requirements of Subsection 701.2.1.
- 3.2. Fly Ash
 - 3.2.1. Use Fly Ash meeting the requirements of Subsection 701.2.2.
- 3.3. Granulated Blast-Furnace Slag
 - 3.3.1. Use Granulated Blast -Furnace Slag meeting the requirements of Subsection 701.2.3
- 3.4. Air -Entraining Admixtures
 - 3.4.1. Unless otherwise specified, use air entrainment in all concrete. Use air-entraining admixtures that comply with the requirements of Subsection 701.2.5.1
- 3.5. Fine Aggregate

3.5.1. Use fine aggregate meeting the requirements of Subsection 701.2.9 except that aggregate derived from limestone is not allowed under any circumstance.

3.6. *Coarse Aggregate*

3.6.1. Use coarse aggregate meeting the requirements of Subsection 701.2.10 except that aggregate derived from limestone or slag is not allowed under any circumstance.

3.7. *Water*

3.7.1. Use water meeting the requirements of Subsection 701.2.11.

4. JOB MIX FORMULA SUBMITTALS

4.1. At least 45 days prior to need, submit at least one job mix formula to the Structural Materials Engineer at the Office of Materials and Research (OMR). Also, provide a copy of the submittal to the RCE. Ensure that the job mix formula submittal minimally contains the following items:

- Sources of supply for all materials included in the job mix, including, but not limited to, coarse aggregate, fine aggregate, water, Portland cement, fly ash, slag, and chemical admixtures.
- Batching weights per cubic yard for fine aggregate, coarse aggregate, water, admixtures, Portland cement, and other supplementary cementitious materials such as fly ash, if applicable.

4.2. The Structural Materials Engineer will review the submittal to determine if the proposed materials are from qualified suppliers and that the water-cement ratio and cement content meet the specification requirements. Review of the job mix formula does not relieve the Contractor of any responsibility for supplying PCC that meets the specification requirements for strength, workability, and air content. Once the job mix formula has been reviewed, make no changes to either the sources of supply or mix proportions (other than limited field adjustments given below) until a revised job mix formula has been submitted to the Structural Materials Engineer and the review of the revised job mix formula has been completed.

5. JOB MIX FORMULA REQUIREMENTS

5.1. *Portland Cement, Fly Ash, and Water Granulated Blast Furnace Slag:*

5.1.1. Use Type I or III Portland cement or a Type IL Portland-limestone cement meeting the requirements of Subsection 701.2.1. Use a minimum of 517 pounds (5.5 bags) of Portland cement per cubic yard. Supplemental cementitious material may be substituted for a portion of the Portland cement as given in Subsection 5.1.2., but ensure that the total of Portland cement and supplemental cementitious material is equivalent to 517 pounds (5.5 bags) of Portland cement.

5.1.2. Fly ash or water-granulated blast-furnace slag may replace allowable percentages of Type I or Type III Portland cement or Type IL Portland-limestone cement. When fly ash is used to replace the Portland cement, replace at a ratio of not less than 1.2:1 by weight, and do not replace more than 20% of the cement by weight. When water-granulated blast-furnace slag is used to replace Portland cement, replace at a ratio of 1:1 by weight, and do not

replace more than 50% of the cement originally called for in the mixture. The use of both fly ash and slag in the same mix is prohibited, unless the slag is a process addition to the Portland cement added at the time of Portland cement manufacture.

5.2. *Aggregate:*

5.2.1. Use coarse aggregate meeting the gradation of #56 or #57. Other gradations may be used with the approval of the Structural Materials Engineer. However, additional trial batch information as specified by the State Pavement Design Engineer may be required to demonstrate that the proposed gradation will provide the desired characteristics of workability and strength. When using blended aggregates each aggregate type/gradation shall have a separate bin on the plant for batching. Other methods of blending may be approved by the State Pavement Design Engineer.

5.2.2. Provide a target gradation of the coarse and fine aggregates given in the mix design submittal that meet the Tarantula Curve defined below.

Sieve Size	Maximum Percent Retained, % Vol	Minimum Percent Retained, % Vol
2"	0	
1-1/2"	5	0
1"	16	0
3/4"	20	0
1/2"	20	4
3/8"	20	4
#4	20	4
#8	12	0
#16	12	0
#30	20	4
#50	20	4
#100	10	0
#200	2	0

5.3. *Water-Cementitious Materials Ratio:*

5.3.1. Ensure that the water-cementitious materials ratio is no more than 0.42. Use additional cement or chemical admixtures as necessary to maintain this ratio.

5.4. *Air Content:*

5.4.1. Ensure that the entrained air voids in the mix ranges from 3% to 6% at the point of placement in the roadway when tested in accordance with AASHTO T 152.

5.5. *Slump:*

5.5.1. When tested in accordance to ASTM C 143, ensure that the slump is in the range of 1 to 2.5 inches for slip-form paving and no greater than 4 inches for fixed-form or other means of paving. If additional slump is needed, use chemical admixtures while maintaining the reviewed job mix formula water-cementitious material ratio. However, under no circumstance provide material with a slump outside the limits given herein.

5.6. *Strength:*

- 5.6.1. The minimum 28-day compressive strength requirement is 4000 psi when tested in accordance with ASTM C 39. The compressive strength obtained under laboratory conditions should be substantially higher than 4000 psi to account for sampling and testing variation in the field.

6. FIELD OFFICE AND LABORATORY REQUIREMENTS

6.1. *General:*

- 6.1.1. Provide and maintain a fully equipped field office and laboratory for performing the quality assurance testing at the central mix concrete plant for the exclusive use of the RCE at no cost to the Department. For jobs supplied by a ready mix concrete plant, a field laboratory is not required. However, the Department must approve the laboratory testing plan prior to production.

6.2. *Building:*

- 6.2.1. Provide a building with satisfactory electric lighting and electrical outlets. Ensure that the building has at least 300 square feet of combined office and work space and a minimum of seven feet of inside height, along with workbenches, chairs, and sufficient water supply for tests and cleaning test equipment. Ensure that, when the windows and doors are closed, the building has sufficient heating and cooling to maintain a temperature between 65° F and 80° F under all ambient conditions. Locate the building in close proximity to and with a full view of the concrete plant. At the entrance to the building, provide a concrete slab of approximately 10 feet by 10 feet, level and true, with a light broomed finish for preparing cylinders and testing slump and air. Ensure that the building has lockable doors and windows to provide adequate physical security to equipment and specimens. The Department may, at its sole discretion, choose to place supplemental locks on the doors to restrict access to the building when Department employees are not present. Provide an analog telephone line compatible with standard computer modems or other means of connecting a computer with the internet.

6.3. *Equipment:*

- 6.3.1. At the field laboratory building, furnish and maintain in good condition all required equipment as given herein.

6.3.2. *Curing Equipment:*

- 6.3.2.1 Furnish tanks of sufficient size to hold approximately 225 cylindrical concrete test specimens measuring 6 inches by 12 inches under conditions of standard curing and meeting the requirements of AASHTO M 201. Additionally, provide sufficient storage for approximately 15 specimens under conditions of initial curing as given in ASTM C 31.

6.3.3. *Compression Testing Equipment:*

- 6.3.3.1 SCDOT will provide a concrete compression testing machine meeting the requirements of ASTM C 39.

6.3.4. *Coarse Aggregate Testing Equipment:*

6.3.4.1 Furnish a Gilson-type shaker with appropriate sieves, a sample splitter with openings approximately 50% greater than the largest particle size, and an appropriate calibrated scale apparatus for weighing materials.

6.3.5. *Fine Aggregate Testing Equipment:*

6.3.5.1 Furnish a mechanical sieve shaker, appropriate sieves in good condition, and an appropriate calibrated balance for weighing.

6.4. *Assistance:*

6.4.1. Furnish the necessary labor to assist the RCE in obtaining samples of concrete and aggregate, testing, making, handling, and curing the specimens.

6.5. *Pre-paving Inspection:*

6.5.1. At least 14 days prior to need, contact the Structural Materials Engineer at OMR to arrange for an inspection of the field office and laboratory. Correct any deficiencies noted during inspection prior to commencement of paving. A field laboratory checklist is included for information in Appendix A. However, the checklist is not all-inclusive and does not represent all possible deficiencies.

7. ACCEPTANCE OF CONCRETE

7.1. *Slump:*

7.1.1. The RCE's representative will take at least four slump tests per day in accordance with ASTM C 143, as well as each time compressive strength test specimens are made. Any material found to be outside the slump range given in Section 5.5, above, will be rejected and additional slump tests will be made on subsequent material to determine its suitability until such time that acceptable slump is achieved.

7.2. *Air Content:*

7.2.1. The RCE's representative will take at least four air content tests per day in accordance with ASTM C 231, as well as each time compressive strength test specimens are made. Any material found to be outside the air content range given in Section 5.4, above, will be rejected and additional air content tests will be made on subsequent material to determine its suitability until such time that acceptable air content is achieved.

7.3. *Strength:*

7.3.1. *Test Specimens:*

7.3.1.1 The RCE's representative will prepare at least one set of six compressive strength test specimens in accordance with ASTM C 31 for every 1500 cubic yards of concrete produced, with a minimum of one set each production day. Payment will be made on a lot basis for each 1500 cubic yard increment or production day, whichever is less.

7.3.1.2 Three of the six specimens will be tested for compressive strength at 72 hours, plus or minus 30 minutes, after casting. The remaining three specimens will be tested for compressive strength at 28 days. All compressive strength testing will be in accordance with ASTM C 39.

7.4. *28-Day Acceptance:*

7.4.1. All concrete produced will be accepted based on the results of 28-day compressive strength testing. The compressive strength for each lot will be determined based on the average of the three specimens tested at 28 days. If the measured compressive strength of any one specimen varies from the other two by more than 10 percent, the results from that specimen is discarded. If all three specimens vary from each other by more than 10 percent, the Structural Materials Engineer will estimate the 28-day compressive strength for the lot based on the results of the 72-hour test results for that lot and the relationship of those results to the 28-day results for other lots using the same job mix formula. If the 28-day specimens exhibit low compressive strength and the 72-hour specimens are consistent with other lots of the same job mix formula that have been satisfactory, the District Construction Engineer may waive the pay adjustment for that lot at the Department's sole discretion.

7.4.2. When the 28-day compressive strength for a lot falls below 4000 psi, the unit price for Concrete Pavement will be adjusted according to Table 1.

Table 1. – Schedule for Adjusted Payment Based on 28-day Compressive Strength	
Compressive Strength	Adjusted Unit Price
Greater than 3750 psi	100%
3749 psi to 3600 psi	90%
3400 psi to 3599 psi	70%

7.4.3. If the 28-day compressive strength is less than 3400 psi, the District Construction Engineer may either require that the lot be removed and replaced or accepted at an adjusted unit price of 50%. Selection of corrective action for this condition is at the sole discretion of the Department.

7.5. *Field Mix Adjustments:*

7.5.1. The approved job mix formula may be adjusted, if necessary. However, before making any adjustments, the aggregate moisture content adjustments should be verified. If the moisture adjustments are correct, the mix design proportions of coarse and fine aggregate and water may be adjusted provided the following conditions are met:

- The total amount of cement and cementitious materials is not decreased.
- The water-cementitious materials ratio is not increased.
- The adjustments provide concrete meeting the requirements of this specification and Section 500 of the Standard Specifications.
- The RCE and the Structural Materials Engineer are notified of the change in advance of use.

**Appendix A.
PCC Field Laboratory and Office Inspection Checklist**

<i>Contractor Information</i>	
Paving contractor:	Plant location:
Contractor's representative:	
Date inspected:	Inspected by:
Next inspection:	District:

<i>Lab Structure</i>			
Floor space:		Ceiling height:	
Type of structure:			
	Yes	No	Comment
Satisfactory electric lighting			
Sufficient electrical outlets			
Sufficient floor space			
Suitable concrete pad outside of building			
Sufficient water supply			
Suitable workbenches, tables, desk, chair, and filing cabinet.			
Air temperature controlled between 65°F and 80°F			
Located near plant with plant in full view			

Equipment and Records (Concrete)			
	Yes	No	Comments
Sufficient tank capacity for specimens to be stored correctly and completely covered with water			
Specimens in curing tank shielded from direct sunlight			
Initial Curing: Water at 60°F to 80°F			
Standard Curing: Water controlled at 23°C ± 3°C (73°F ± 5°F)			
Water saturated with lime and circulated by appropriate pumping system			
Water temperature monitored by recording thermometer in working condition			
Adequate location for compression testing machine and neoprene capping pads			
Scales, thermometers, and other equipment, as applicable, show evidence of recent calibration			

Equipment and Records (Aggregate)			
	Yes	No	Comments
Gilson shaker and sieves (1½", 1", ¾", ½", 3/8", #4, #8, #16, #100) in good condition			
Sample splitter with 2¼ inch opening size			
Appropriate scales for coarse and fine aggregate samples showing recent calibration			
Mechanical sieve shaker for fine aggregate			
Sieves (3/8, #4, #8, #16, #30, #50, #100, #200) in good condition			

Remarks