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WEST VIRGINIA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

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MIX DESIGN FOR PORTLAND CEMENT CONCRETE

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- 1.0 PURPOSE
  - 1.1 To establish a procedure for testing the physical properties of a proposed mix design.
  - 1.2 To establish criteria for evaluating the test data to arrive at acceptable batch proportions for an approved mix design.
- 2.0 SCOPE
  - 2.1 This procedure shall apply to the design of all portland cement concrete which is required by the Specifications to be batched in accordance with an approved mix design.
- 3.0 TEST PROCEDURE
  - 3.1 The concrete mix design shall be developed in accordance with the current edition of the American Concrete Institute Standard ACI 211.1, using the absolute volume method. Mixing and testing the physical properties of the proposed design shall be in accordance with AASHTO Designation T 126. To obtain Division approval, a laboratory must demonstrate that they are equipped, staffed, and managed so as to be able to batch and test portland cement concrete in accordance with applicable AASHTO Methods of Test. The most expeditious means of demonstrating such ability is by submission of a copy of their latest report of inspection by the Cement and Concrete Reference Laboratory, National Bureau of Standards, together with a letter detailing the actions taken to correction any deficiencies noted therein. A listing of approved laboratories will be made available to the Contractor upon request.

- 3.2 The concrete for the design shall be batched in four separate batches. Two of the batches shall be proportioned to produce a mix having the target cement factor for the class of concrete being designed. The other two batches shall be proportioned to produce a mix having a cement factor equal to the target plus 60 kg.
- 3.3 Each batch of concrete shall be tested in the plastic state for air, consistency and yield. Each batch shall be adjusted as necessary to produce a plastic concrete having an air content, consistency, and yield equal to the specified value plus or minus a reasonable laboratory working tolerance. The following tolerances shall be used as a guide: Air content,  $\pm 1/2\%$ ; Slump,  $\pm 15$  mm; Yield,  $\pm 2\%$ .
- 3.4 When the properties of a concrete batch have been established within acceptable limits, seven standard concrete cylinders shall be made from each batch and tested in compression at the following ages: one cylinder at age 24 hours  $\pm 4$  hours (the exact age to the nearest hour at time of test shall be noted on the report); one cylinder at age 3 days; one cylinder at age 7 days; one cylinder at age 14 days; and three cylinders at age 28 days. The values of the physical properties of each mix shall be the average of the physical properties established from the two batches.
- 4.0 ACCEPTANCE CRITERIA
- 4.1 If the Standard Deviation of the concrete plant production has been established, the mix design must have an average laboratory compressive strength equal to or greater than the "Design 28-Day Compressive Strength" required by the Specifications plus two times the Standard Deviation. Data used to establish the Standard Deviation shall be taken from the Division's data bank and shall consist of at least 30 individual test results obtained from recent plant production of concrete with proportions similar to the design mix. Information relative to the statistics for a particular plant will be furnished the Contractor upon request.
- 4.2 If the Standard Deviation of the concrete plant production has not been established, the design mix must have an average laboratory compressive strength equal to or greater than the "Design 28-Day Compressive Strength" plus 9 MPa.

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- 4.3 It is noted that the "Design 28-Day Compressive Strength" required by the Specifications is the minimum field strength sought in standard 152 mm X 305 mm cylinders representing the concrete being placed in the field, and should not be confused with the laboratory compressive strengths required for design.
- 5.0 PROPORTIONING DESIGN MIX
- 5.1 If the laboratory mix with the specified minimum cement factor satisfies the acceptance criteria (Paragraph 4), then it will be considered acceptable as the design mix for the class of concrete being designed.
- 5.2 If the laboratory mix with the specified minimum cement factor does not satisfy the acceptance criteria (Paragraph 4), then a compressive strength-cement factor relationship will be established using the data from both laboratory mixes. This relationship will be interpolated to determine a cement factor which would cause the acceptance criteria to be satisfied. This latter cement factor will be considered acceptable for proportioning the design mix for the class of concrete being designed.
- 5.3 Although the Contractor has satisfied all requirements for concrete design and a design mix has been approved by the Engineer, the Contractor may still be required to adjust the approved design mix in the field as necessary to maintain all properties within the limits of the Specification. These field adjustments shall include increasing the cement factor above the value specified in the approved design mix if such an adjustment would be necessary to cause the strength of the field placed concrete to conform to the requirements of the Specification.
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