

SECTION 434 - HIGH PERFORMANCE CONCRETE (HPC)

434.02 MATERIALS.

Materials shall conform to the following Sections and Subsections:

Aggregates	902
Concrete, Mortar and Grout	905
Portland Cement Concrete	905.05
Concrete Admixtures and Curing Materials.....	906
Joint Materials	907
Reinforcement Steel	908.01
Permanent Metal Bridge Deck Forms	909.07
Concrete Penetrating Sealer Treatment.....	923.06(F)
Epoxy Bonding Compound.....	923.08
Epoxy Resin Mortar	923.09
Waterstops	923.17
Methacrylate Crack Sealer	923.06(I)

Materials, admixtures and methods of construction not specifically covered in the Plans and these Specifications shall conform to the latest edition of the AASHTO LRFD Bridge Design Specifications and the Standard Specifications of the New Jersey Turnpike Authority, Sixth Edition, dated 2004.

The ratio of coarse aggregate to fine aggregate shall be a minimum of 1.5 with a total coarse aggregate content not lower than 1800 lbs.

The total amount of cementitious material should be limited to 700 lbs./cu.yd.

In order to achieve the desired resistance to chloride penetration, an appropriate proportion of pozzolanic material of silica fume and fly ash shall be provided in the mix design.

Proportions of pozzolanic materials shall be such that silica fume will replace a maximum of 5% of ~~portland cement~~ *the total cementitious material* by weight and fly ash a maximum of 20% of the ~~portland cement~~ *total cementitious material*.

Silica Fume. Prior to submitting a mix design, a sample of the silica fume admixture shall be submitted to the Authority's testing laboratory and tested for conformity against the requirements of the latest AASHTO M 307 or ASTM C 1240 standard and shall be accompanied by a copy of the manufacturer's recommendations. Silica fume admixture shall be approved by the Engineer prior to its use on the Contract. Only one brand of silica fume admixture shall be used for the entire duration of the Contract. Silica fume admixture may be supplied either in dry or in slurry form. If the slurry form is used, it shall be homogeneous and agitated to prevent separation. The Contractor shall submit a procedure for the introduction of the silica fume into the mix for the Engineer's approval.

Fly Ash. Fly ash for HPC shall conform to ASTM C 618, Class F except that the loss on ignition shall not be more than 2.5 percent. Fly ash used to control alkali-silica reactivity

shall be Class F and shall contain not more than 1.5 percent available alkali in accordance with ASTM C 618, Table 1A. Before each source of fly ash is approved, certified results of tests conducted by a testing agency shall be submitted to and verified by the Engineer. Accompanying the certification shall be a statement from the supplier listing the source and type of coal, the methods used to burn, collect, and store the fly ash, and the quality control measures employed. Fly ash, Class C will not be permitted for use.

Conformance to the requirements for loss on ignition and fineness shall be determined by the supplier for each truck load of fly ash delivered to the mixing site. The test values determined shall be included on the delivery ticket. The Engineer may require that the fly ash not be used until the Authority has performed tests for loss on ignition and fineness.

Fabrication Requirements. For the construction of the HPC item of work, the HPC shall be fabricated in accordance with the requirements of Section 401, or as stated within this Section.

Mix Design Verification. In the development of the HPC mix design, the following performance requirements, in accordance with the indicated test method, shall be achieved. The verification mix shall be produced in the batching plant using those materials and equipment to be used for production. A minimum of 8 cubic yards shall be produced for each of the two (2) required mix designs for verification of the HPC. The Authority's testing laboratory shall cast samples from each of the two concrete batches. A report to document these results shall be provided to the Engineer. The Contractor shall obtain the results of these standard tests from an AASHTO accredited testing agency, that is approved for the portland cement concrete testing methods specified in the below table. The Contractor shall submit a list of their testing laboratory's accreditations.

The mix design verification testing shall be accomplished by the Contractor at no cost to the Authority.

The Authority's testing laboratory's lab results will govern the acceptance of the mix design.

NOTE FOR THE DESIGNER: The Early Age Concrete strength performance characteristic shall be utilized for bridge decks built under staged construction with live load, with the Authority's approval.

Additional Early Age Concrete strength specifications may be required as related to a minimum concrete temperature to be maintained. Designers shall consult with the Authority on a project by project basis.

Performance Characteristic	Standard Test Method	Performance Required	Mold Size
Scaling Resistance (x = visual rating of the surface after 50 cycles)	ASTM C 672	x = 3 maximum	12" x 12" x 3"
Freeze-Thaw Durability (x = relative dynamic modulus of elasticity after 300 cycles)	AASHTO T 161 ASTM C 666 Proc. A	X = 80% minimum	3" x 3" x 10"
Chloride Permeability 56 days (coulombs) 90 day ponding	AASHTO T 277, ASTM C 1202 AASHTO T259/T260	1,000 maximum 0.55 maximum	4" x 8" cylinder 3" thick min. 28 in. ² min. surface area (6" x 6" x 3")
56 days Free Shrinkage (See Note 2 below)	ASTM C 157	450 microstrains maximum	4" x 4" x 11¼" prism
28 day Compressive Strength	AASHTO T 22	5,000 PSI minimum	6" x 12" cylinder

(Verification Strength)	ASTM C 39		
Early Age Concrete (Verification Strength) 3 day Compressive Strength	AASHTO T 22 ASTM C 39	3,500 PSI minimum	6" x 12" cylinder
Flexural Strength	ASTM C 78	700 PSI minimum	See ASTM C 78

Notes:

1. For the Scaling Resistance performance testing, as prescribed in the Standard Test Method, specimens shall be moist cured for 14 days and then air cured for 14 days.
 - a. If the chloride permeability requirement has been achieved in 28 days, the chloride permeability shall be considered acceptable. If the required chloride permeability is not achieved in 28 days, the HPC sample shall be tested at 56 days. Final acceptance of the HPC sample for chloride permeability will be determined by the results of AASHTO T259/T260.
 - b. A minimum of two (2) mix designs shall be submitted for approval and verification in accordance with Subsection 905.05 at the preconstruction conference. To expedite the approval procedure, the Authority will perform verification testing and review concurrently with that conducted by the Contractor. The Contractor shall submit all required samples to the Authority for independent mix design verification testing. If the mix designs are not approved by the Authority, the mix designs shall be modified and resubmitted for approval.
 - c. In accordance with the above referenced AASHTO T277 test, at 28 and 56 day intervals (cure time prior to test), and AASHTO T259/T260 test, the Authority will perform chloride permeability testing to document the quality of the HPC mix design and to verify the results submitted in the above referenced report.
 - d. The Contractor may contact personnel at Rutgers University to obtain guidance in developing the HPC mix design for the project. Dr. Hani Nassif, telephone number 732-445-4414, may be contacted for such guidance.
2. *For the Free Shrinkage Test (ASTM C157) the curing method and duration should be consistent with the NJTA specifications. The test is to be performed on specimens that are cured using a modified curing procedure as per NJTA Specifications by applying wet burlap for 14 days instead of the 28 days cure specified in the ASTM C157 procedure. The following readings as specified by ASTM C157, which is ½ hour after de-molding, another reading at 14 days of curing, and in air storage after curing 4, 7, 14, 28 days and 8, 16, 32 and 64 weeks.*

1. The requirements specified in Subsection 401.16 for control and acceptance testing of Class B concrete shall be adhered to in the fabrication of the HPC elements.
2. Acceptance testing performance measures for production HPC shall consist of the following parameters:

Performance Characteristic	Standard Test Method	Performance Required
Percent Air Entrainment *		6.0 ± 1.5 (#57 Aggregate) 6.0 ± 1.5 (#67 Aggregate) 7.0 ± 1.5 (#8 Aggregate)
Slump *		3" ± 1"
Chloride Permeability ** 56 days (coulombs) 90 day ponding	AASHTO T 277, ASTM C 1202 AASHTO T 259/T 260	1,100 maximum 0.65 maximum. Total integral chloride to 1.6 in depth.
56 days Free Shrinkage ***	ASTM C 157	450 microstrains maximum
28 day Compressive Strength	AASHTO T 22 ASTM C 39	4,500 PSI minimum
Early Age Concrete (Verification Strength) 3 day Compressive Strength	AASHTO T 22 ASTM C 39	3,150 PSI minimum

* As per the guidance stated in Subsection 401.02, and in accordance with Subsection 905.03 and Subsection 905.05, Subparts B and C, when a Superplasticizer (Type F admixture) is used, the Slump and Air Content values for the HPC shall be as follows:

Slump: 6" ± 2".

Air Content: Increase both the target value and tolerance percentages by 0.5.

** For chloride permeability testing, additional cylinders shall be provided in accordance with Subsection 905.22 for AASHTO T259/T260 testing to the Authority.

*** For the Free Shrinkage Test (ASTM C157) the curing method and duration should be consistent with the NJTA specifications. The test is to be performed on specimens that are cured using a modified curing procedure as per NJTA Specifications by applying wet burlap for 14 days instead of the 28 days cure specified in the ASTM C157 procedure. The following readings as specified by ASTM C157, which is ½ hour after de-molding, another reading at 14 days of curing, and in air storage after curing 4, 7, 14, 28 days and 8, 16, 32 and 64 weeks.

3. For quality acceptance limits, testing, sampling and pay adjustments see Subsections 905.21, 905.22 and 905.23.

NOTE FOR THE DESIGNER: The use of admixtures on bridge decks built under staged construction with live load shall be evaluated on a project by project basis. Designers shall consult with the Authority and consider the following minimum requirements:

4. Retarder admixtures shall not be permitted when bridge decks are poured under staged construction with live load.
5. Superplasticizers (Type F water reducing, high range admixtures) and mid-range water reducing admixtures shall be permitted, but the use of such admixtures may not delay the set time beyond 4 hours.