DIVISION 400 - STRUCTURES

SECTION 401 - CONCRETE STRUCTURES

[NOTE FOR THE DESIGNER:
For LMC overlay finish on rehabilitation and widening contracts use either section 401.17 (F)(2) or 401.17 (F) (3) depending on staging and other considerations. For new construction with no staging use section 401.17(F)(3):]

[NOTE FOR THE DESIGNER:
Contracts containing a large quantity of Class A concrete shall use "Protective Coatings for Concrete Surfaces". For contracts which have a small amount of concrete, water repellant treatment should be used. Water repellant treatment should also be used for the protection of Class B, C, D concrete:]

[Include the following with High Performance Concrete (HPC) Latex Modified Concrete (LMC) work.]

401.16 TEST SPECIMENS.

Delete the paragraph in its entirety and replace with the following:

This Subsection specifies the requirements for the preparation, testing and evaluation of Portland Cement Concrete specimens. Final quality acceptance testing shall be in accordance with Section 905. In order that the Engineer can maintain a record of the strength gain of all concrete placed, the Engineer will make standard test specimens: 6" x 12" concrete test cylinders for compressive strength, 4" x 8" cylinders for AASHTO T277 and 6" x 6" x 3" molds for AASHTO T259/T260 permeability testing, and beams for flexural strength testing. The Contractor shall provide the concrete and molds for the test specimens, shall be responsible for the handling and protection of the specimens on the job site and shall arrange for delivery of the specimens to the designated Testing Laboratory between 24 and 48 hours after casting.

(B) STANDARDS AND FREQUENCY OF TESTING PRIOR TO FINAL ACCEPTANCE TESTING.

Delete the third paragraph in its entirety and replace with the following:

(2) Coulomb Test (AASHTO T277) and Ponding Test (AASHTO T259/T260).

The Coulomb Test (AASHTO T277) and Ponding Test (AASHTO T259/T260) are used to evaluate the permeability of concrete. For each truckload (Sublot) of LMC and silica fume concrete the Engineer will cast two (2) 4" x 8" cylinder specimens for AASHTO T277 testing. For LMC, two (2) 6" x 6" x 3" specimens will be cast for AASHTO T259/T260 testing. Two-inch thick samples will be cut from the center of each cylinder for AASHTO T277 testing, with a maximum of two slices per cylinder utilized. Samples shall be wet cured in water storage containers per ASTM C31 for 2 days, and air cured at the site for 3 days, prior to pickup for testing. For LMC, the two (2) 4" x 8"

cylinders will be tested for 28 day and 56 day permeability in accordance with AASHTO T277 and the two (2) 6" x 6"x 3" molds will be tested for permeability in accordance with AASHTO T259/T260. For silica fume concrete, the two (2) 4" x 8" cylinders will be tested for 28 day and 56 day permeability in accordance with AASHTO T277.

Delete the last paragraph in its entirety and replace with the following:

Refer to Subsection 401.18(I) Acceptance Testing, for requirements for LMC and silica fume concrete overlays prior to final acceptance. Refer to Subsections 905.21, 905.22 and 905.23, including modifications made in the supplementary specifications, for requirements of Quality Acceptance limit, testing, sampling and pay adjustment.

401.17 SURFACE FINISH.

Delete the second paragraph in its entirety and replace with the following:

The final surfaces of Latex Modified Concrete (LMC) overlays, Silica Fume Concrete overlays and High Performance Concrete (HPC) shall be finished in accordance with Subsection 401.17 (F) (3) unless specified otherwise in the contract documents.

401.18 CURING.

(D) General.

Delete the first paragraph in its entirety and replace with the following:

All new bridge deck and overlay concrete shall be wet cured. No curing compound will be permitted.

(I) ACCEPTANCE TESTING.

(2) Permeability (coulombs).

(a) Twenty-Eight (28) Day Test Results

Delete the second and third bullets in their entirety and replace with the following:

- *4000 to 2001 (coulombs) - Acceptance with possible reduction in payment in accordance with Subsection 905.23 based on 56 day test results in accordance with the AASHTO T277 test, and based on the AASHTO T259/T260 test results. Final acceptance and pay adjustments of the LMC for permeability will be determined based on the results of the AASHTO T259/T260 tests.*
- *2000 (coulombs) and below - Acceptance in accordance with Subsection 905.23 based on 56 day test results in accordance with the AASHTO T277 test, and based on the AASHTO T259/T260 test results on the mold samples cured for 42 days. Final acceptance of the LMC for permeability will be determined based on the results of the AASHTO T259/T260 tests.*

SECTION 434 – HIGH PERFORMANCE CONCRETE (HPC)

NOTE FOR THE DESIGNER: Designers shall consider the following when High Performance Concrete (HPC) is placed under staged construction with live load:

Where feasible, lane closures adjacent to the HPC placement should be scheduled for the duration of the HPC placement and curing until early age strength is attained.

Lane closures should be 12 hours minimum plus duration of the HPC pour. If this time frame is not available, permit HPC pours a maximum of 4 hours prior to installation of lane closings based on initial set time of HPC.

The submission and durations required for the mix designs and verification testing requirements shall be accounted for in the Contract Schedule.

Variable Message signs should be used to direct trucks away from lanes adjacent to where HPC is being placed.

Use State Police to check for overweight vehicles and enforce via fines. Consider placing portable load sensors on bridge during design phase to confirm presence of overweight vehicles.

434.01 DESCRIPTION.

This work shall consist of the construction of portland cement concrete deck slabs with the use of High Performance Concrete (HPC). HPC is defined as concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedures and typical curing practices. Construction shall be as specified in Section 401 except as modified herein.

This work shall also consist of furnishing and installing methacrylate crack sealer for the sealing of cold joints as shown on the Plans.

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*
Crack Sealer *923.37*

Materials, admixtures and methods of construction not specifically covered in the Plans and these Specifications shall conform to the AASHTO Standard Specifications for Highway Bridges 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.

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 by weight and fly ash a maximum of 20% of the portland cement.

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.

434.03 MIX DESIGN AND FABRICATION OF THE HPC.

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	*ASTM C 157*	*450 microstrains maximum*	*4″ x 4″ x 11¼″ prism*
28 day Compressive Strength (Verification Strength)	*AASHTO T 22 ASTM C 39*	*5,000 PSI minimum*	*6″ x 12″ cylinder*
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*

Note: 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.

434.04 PRODUCTION OF THE HPC.

1. As per the provisions of Subsection 401.11, Subpart C, a plan of operation for placement of the HPC items shall be submitted for review and approval by the Engineer at least 20 days prior to the proposed start of placing bridge deck concrete. In addition to the requirements of Subsection 401.11, Subpart C, the plan shall also include a description of the HPC batching and mixing facilities, a description of the HPC transport equipment, the method of HPC placement, an outline of the curing procedures to be used for the production units and test samples and the quality control tests and procedures that the fabricator will perform.

The plan shall also include the procedures for reducing the atmospheric evaporation rate below 0.75 kilograms per square meter per hour by fog misting, wind shields or other methods.

The following is added to the requirements of Subsection 401.11, Subpart C:

The measurements for air temperature, relative humidity and wind speed shall be taken at the location of the concrete placement. Concrete temperatures shall be taken from the sample used for slump and air content tests. These measurements and calculations shall be performed at least once per hour, beginning with the initial concrete placement and whenever, in the opinion of the Engineer, changes in the atmospheric condition merit such. The Contractor shall supply all the instruments necessary to take these measurements, subject to approval by the Engineer, including two (2) battery operated psychrometers, two (2) concrete thermometers and two (2) wind gauges. These instruments shall become the property of the Contractor after final Acceptance. All instruments shall be certified by an independent laboratory that has been approved by the Engineer. The instruments shall be certified to be in good working order and as having been calibrated within the two months immediately prior to use. No separate payment will be made for providing these instruments.

Placement shall not begin, or shall be discontinued, in the event of rain. The Contractor shall provide a sufficient number of approved covers and take adequate precautions to protect freshly-placed concrete from rain. The Engineer may order the replacement of any material damaged by rain.

2. *The Contractor is advised that curing of the HPC shall be performed in accordance with the provisions of Subsection 401.18. Furthermore, wet burlap, for the curing of the deck slab concrete, shall be placed within ten (10) minutes after the concrete is struck off.*

   If it is anticipated that the ten (10) minute limitation will not be met, the concrete placement operation shall be stopped. A cold joint shall be formed and the Contractor shall submit a revised plan of operation for review and approval by the Engineer before resumption of the HPC placement.

   The curing by wet burlap shall be for a minimum period of fourteen (14) calendar days.

   a. *The finishing machine equipment shall be set up so that the HPC is placed only 5 to 8 feet ahead of the machine.*

   b. *To demonstrate that the Contractor can place, finish and cure the HPC, a trial HPC placement of a minimum of 6 cubic yards of the HPC shall be placed at the project site at a location that is acceptable to the Engineer. A 9.25-inch thick and minimum 15-foot wide slab, cast into structurally-supported stay-in-place forms, shall be constructed to simulate the placement of the HPC bridge deck.*

      The location shall not be a structural element that is to remain in place. The trial HPC shall be placed, finished and cured in accordance with these Specifications at least 7 calendar days prior to the start of the HPC placement. No separate payment will be made for the HPC trial placement.

   c. *Technical Representative(s) of the Contractor's ready-mix concrete supplier/manufacturer shall participate in the meetings between the Contractor and the Authority's Engineer as part of the planning process and prior to concrete placement operations. The Technical Representative(s) shall be on-site for trial slab placement and at least the initial two (2) bridge deck casting operations. The need for further involvement by the Technical Representative(s) shall be as determined by the Engineer.*

   d. *The Contractor shall have ACI grade certified personnel on-site, one of whom is experienced with HPC and shall be responsible for all quality control measures related to curing and placing the HPC. The Contractor's designee for all HPC quality control measures shall be a single point of contact.*

434.05 HPC ACCEPTANCE REQUIREMENTS.

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.*

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.*

434.06 MEASUREMENT.

Measurement shall be made as described in Subsection 401.23.

434.07 PAYMENT.

Payment will be made under:

PAY ITEM	***PAY UNIT***
Concrete in Deck, HPC	*Cubic Yard*

No separate payment will be made for the saw cut finish on HPC deck, but all the cost for this work shall be included in the unit price bid for the bid item Concrete in Deck, HPC.

No separate payment will be made for the crack sealer, but all the cost thereof shall be included in the unit price bid for the bid item Concrete in Deck, HPC.

DIVISION 900 – MATERIALS

[Include the following with High Performance Concrete (HPC) and Latex Modified Concrete (LMC) work.]

SECTION 902 - SOIL AGGREGATE

902.04 FINE AGGREGATE.

Add the following:

Fine aggregate for concrete decks shall contain a maximum of 0.06 percent chloride content.

[Include the following with High Performance Concrete (HPC) and Latex Modified Concrete (LMC) work.]

SECTION 905 – CONCRETE, MORTAR AND GROUT

[Include the following with High Performance Concrete (HPC) and Latex Modified Concrete (LMC) work.]

905.01 PORTLAND CEMENT.

Add the following:

Subsections 905.21, 905.22 and 905.23 are applicable to Latex Modified Concrete (LMC) and High Performance Concrete (HPC) with the following noted modifications.

[Include the following with High Performance Concrete (HPC) and Latex Modified Concrete (LMC) work.]

905.21 QUALITY ACCEPTANCE LIMITS FOR PORTLAND CEMENT CONCRETE PAY ADJUSTMENTS.

The following modifications are applicable to HPC and LMC:

(A) QUALITY ACCEPTANCE LIMITS.

Delete subsection (3) in its entirety and replace with the following:

(3) Permeability.

(a) AASHTO T277 – The Upper Quality Limit (UQL) shall be 2,000 Coulomb resistivity for LMC overlays and 1,100 Coulomb for HPC.

(b) AASHTO T259/T260 – The chloride permeability shall be correlated in accordance with the following table:

Chloride permeability	***Charge passed (coulombs)***	***Type of Concrete***	***Total integral chloride to 1.6 in. depth after 90 day ponding test***
High	*> 4000*	*High water-cement ratio, conventional (≥ 0.6) PCC**	*> 1.3*
Moderate	*2000-4000*	*Moderate water-cement ratio, conventional (0.4 to 0.5) PCC**	*0.8 to 1.3*
Low	*1000-2000*	*Low water-cement ratio, conventional (< 0.4) PCC* including LMC*	*0.55 to 0.8*
Very Low	*100-1000*	*Latex-modified concrete Internally sealed concrete*	*0.35 to 0.55*
Negligible	*< 100*	*Polymer impregnated concrete Polymer concrete*	*< 0.35*

** Portland cement concrete.*

[Include the following with High Performance Concrete (HPC) and Latex Modified Concrete (LMC) work.]

905.22 QUALITY ACCEPTANCE TESTING, SAMPLING, AND INSPECTION FOR PORTLAND CEMENT CONCRETE PAY ADJUSTMENT.

Add the following note to the Table I Notes:

(6) The number of Sublots shown in the table, including the requirements in Notes (1) thru (4), may be modified by the Engineer.

(A) QUALITY ASSURANCE TESTING STANDARDS AND FREQUENCY OF TESTING.

(3) Coulomb Test.

The following modifications are applicable to HPC and LMC:

For each Sublot, the Engineer will cast four (4) 4″ x 8″ cylinder specimens for permeability testing in accordance with AASHTO T277 and two (2) 6″ x 6″ x 3″ thick samples for permeability testing in accordance with AASHTO T259/T260. The 4″ x 8″ cylinders shall be tested at 28 day (two cylinders) for LMC only and at 56 day (two cylinders) intervals for LMC and HPC in accordance with AASHTO T277. The 6″ x 6″ x 3″ thick samples for 90 day ponding testing will be tested in accordance with AASHTO T259/T260. The average of the two (2) test specimen result values for each Sublot will be considered the Sublot Coulomb test value.

B) REFERENCES.

(1) *American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges.*

Add the following:

T 259 Resistance of Concrete to Chloride Ion Penetration.

[Include the following with High Performance Concrete (HPC) and Latex Modified Concrete (LMC) work.]

905.23 ADJUSTMENTS TO CONTRACT COMPENSATION.

(B) PERFORMANCE CRITERIA PARAMETERS.

The following modification applies to HPC only:

Performance Parameters	*Minimum PWL*
Compressive Strength	*90*
Permeability	*90*
Air Content	*70*

The following modification applies to LMC only:

Performance Parameters	*Minimum PWL*
Compressive Strength	*90*
Permeability	*90*
Bond Strength	*80*
Water to Cement Ratio	*80*
Air Content	*70*