ITEM 557.7101 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK REQUIRED - TYPE 1 FRICTION

ITEM 557.7102 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK REQUIRED - TYPE 2 FRICTION

ITEM 557.7103 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK REQUIRED - TYPE 3 FRICTION

ITEM 557.7109 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK REQUIRED - TYPE 9 FRICTION

ITEM 557.7201 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK NOT REQUIRED - TYPE 1 FRICTION

ITEM 557.7202 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK NOT REQUIRED - TYPE 2 FRICTION

ITEM 557.7203 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK NOT REQUIRED - TYPE 3 FRICTION

ITEM 557.7209 08 LOW CEMENT CONCRETE FOR SUPERSTRUCTURE SLABS WITH INTEGRAL WEARING SURFACE- BOTTOM FORMWORK NOT REQUIRED - TYPE 9 FRICTION

ITEM 557.7401 08 LOW CEMENT CONCRETE FOR STRUCTURAL APPROACH SLAB WITH INTEGRAL WEARING SURFACE- TYPE 1 FRICTION

ITEM 557.7402 08 LOW CEMENT CONCRETE FOR STRUCTURAL APPROACH SLAB WITH INTEGRAL WEARING SURFACE- TYPE 2 FRICTION

ITEM 557.7403 08 LOW CEMENT CONCRETE FOR STRUCTURAL APPROACH SLAB WITH INTEGRAL WEARING SURFACE- TYPE 3 FRICTION

ITEM 557.7409 08 LOW CEMENT CONCRETE FOR STRUCTURAL APPROACH SLAB WITH INTEGRAL WEARING SURFACE- TYPE 9 FRICTION

ITEM 557.7504 08 LOW CEMENT CONCRETE TEST SLAB

DESCRIPTION.

Furnish and place reinforcing steel and Low Cement (LC-HP) High-Performance concrete to construct superstructure slabs and a test slab as shown in the contract plans. LC-HP is a modified Class HP concrete with a lower total cementitious content and an optimized aggregate gradation to reduce the potential for premature bridge deck cracking

MATERIALS.

Use materials meeting the requirements of 557-2 A & B. Perform additional work as follows:

Manufacture LC-HP in accordance with Section 501 and the following modifications:

1. Design a LC-HP concrete mixture proportioned according to the American Concrete Institute Manual of Concrete Practice, ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete and as specified in this document. Produce a homogeneous mixture of cement, pozzolan (fly ash or GGBFS), microsilica, fine aggregate, coarse aggregate, air entraining agent, normal range set-retarding, water-reducing admixture, and water as designed.

2. Use Type 1, I/II, 2 or Type SF cement. Use a total cementitious content of 500 - 540 lb/cy. Use 15-20% pozzolan (fly ash or GGBFS) and 6-10% microsilica.

3. Develop a composite gradation, consisting of a mixed blend of coarse and fine aggregates in conformance with Section 703, and meet the requirements of the following table. Use a proven optimization method, such as the Shilstone method or the Kansas University (KU) Mix method to meet these requirements.

GRADING REQUIREMENTS FOR MIXING AGGREGATES FOR CONCRETE BRIDGE DECKS													
Usage	Percent Retained on Individual Sieves - Square Mesh Sieves												
	1.5" (37.5 mm)	1" (25.0 mm)	3/4" (19.0 mm)	1/2" (12.5 mm)	3/8" (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm)	No. 16 (1.18 mm)	No. 30 (600 µm)	No. 50 (300 µm)	No. 100 (150 µm)	No. 200 (75 µm)	Pan
Optimized for LC-HP Bridge Decks*	0	2-6	5-18	8-18	8-18	8-18	8-18	8-18	8-18	8-15	0-5	0-5	0-2

* Note: Contractor shall be aware that different types of aggregate will affect the ability to pump concrete using optimum gradations.

4. Proportion all ingredients of the concrete mixture to meet the following:
   - Water/Cementitious materials (by weight) = 0.41 - 0.45
   - Slump Range (in.) = 1.5 – 3.0
   - Air Content % desired (Range) = 6.0 to 10.0

5. Uniformity of Combined Aggregate – When the fineness modulus of the combined aggregate gradation has changed by more than 0.20 from the value used in the accepted concrete mix design, contact the Director of Materials Bureau to make appropriate adjustments to the concrete mix design.

6. Engage a qualified independent testing laboratory, subject to approval of the Materials Bureau, to perform mix development testing in accordance with ASTM C143, C231, C192 and C39, to assure all performance criteria can be achieved during production and placement. In addition, also test shrinkage according to ASTM C157. The shrinkage test is for research purposes only, and must be in progress prior to pouring any deck slabs, but need not be complete. Require the independent testing laboratory to submit shrinkage test results directly to Deputy Chief Engineer of Structures.

   At least 1 month prior to the start of any concrete placement, provide a copy of the proposed mixture design(s) and trial batch test results to the Director, Materials Bureau, submitted through the Regional Materials Engineer, for evaluation. Submit sufficient data to permit the Director to offer an informed evaluation. Include at least the following:

   - Concrete mix proportions, including ranges for admixture dosages.

- Material sources. Also include the combined aggregate fineness modulus and specific gravity for all aggregates.
- Air content of plastic concrete.
- Slump of plastic concrete.
- Compressive strength at 7, 14, and 28 days.
- The temperature of the plastic concrete, measured according to 557-3.04, must be maintained to within 55° - 70° F. The recommended method or procedure to maintain this temperature during the time of actual placement must be provided.

Do not interpret having a valid mixture design as approval of the mixture. Also, resubmit any proposed mixture design change to the Director, Materials Bureau, for evaluation. Multiple mixture designs may be used to address performance and placement issues as deemed necessary by the Contractor. Submit each mixture for evaluation, as indicated above, prior to use.

7. Achieve an average 28-day compression strength of 4000 psi, or greater, with no individual cylinder compressive strength less than 3600 psi.

CONSTRUCTION DETAILS.

Apply the provisions of §557-3 and the following modifications:

Test Slab. Using the approved mix design, construct a test slab 15 to 45 days prior to placing LC-HP in the bridge deck. Construct the test slab to comply with the Contract Documents, using the same LC-HP that is to be placed in the deck and that was approved in the test batch. Submit the location of the test slab for approval by the Engineer. Place, finish and cure the test slab according to the Contract Documents, using the same personnel, methods, temperature control, and equipment (including the concrete pump, if used) that will be used on the bridge deck. The test slab shall be a minimum of 30 feet wide, 33 feet long and 9 ½ in. thick. Plain reinforcement shall be placed in the slab using the same bars, spacing and cover as on the permanent bridge deck.

A minimum of 1 day after construction of the test slab, core 4 full-depth 4 inch diameter cores, one from each quadrant of the test slab, and forward them to the Engineer for visual inspection of degree of consolidation.

Do not commence placement of LC-HP in the deck until approval is given by the Bureau of Materials and Research. Approval to place concrete on the deck will be based on satisfactory placement, consolidation, finishing and curing of the test slab and cores, and will be given or denied within 24 hours of receiving the cores from the Contractor. If an additional test slab is deemed necessary by the Engineer, it will be paid for at the contract unit price for Test Slab.

Modifications to Standard Specifications

1. Only removable forms are allowed as per §557-3.03 A.
2. Provide the Engineer with the following documentation:

   - Construction pour sequence
   - Finishing equipment used
   - Timing between final finish and initial placement of curing coverage
   - Ambient temperature at time of pour

3. Add the following to §557-3.05, Handling and Placing Concrete:
   The temperature of the plastic concrete at the time of placement shall be in the range 55º

F to 70º F. When necessary, use of shaved ice, liquid nitrogen, or equal shall be used to maintain plastic concrete temperature. Adjustment to mix water shall be made to maintain the specified water-to-cementitious content. The specific method used by the contractor shall be defined during the pre-placement meeting.

The provisions of Section 555-3.04 E, Vibration apply with the following modifications:

- Accomplish consolidation of the LC-HP on all span bridges that require finishing machines by means of a mechanical device on which internal (spud or tube type) concrete vibrators of the same type and size are mounted *(ie: Gang Vibrator).*
- Provide stand-by vibrators for emergency use to avoid delays in case of failure.
- Operate the mechanical device so vibrator insertions are made on a maximum spacing of 12 inch centers over the entire deck surface.
- Provide a uniform time per insertion of all vibrators of 3 to 15 seconds, unless otherwise designated by the Engineer.
- Provide positive control of vibrators using a timed light, buzzer, automatic control or other approved method.
- Extract the vibrators from the LC-HP at a rate to avoid leaving any large voids or holes in the LC-HP.
- Do not drag the vibrators horizontally through the LC-HP.
- Use hand held vibrators in inaccessible and confined areas such as along bridge rail or curb.
- When required, supplement vibrating by hand spading with suitable tools to provide required consolidation.
- Reconsolidate any voids left by workers.

Do not mount tamping devices or fixtures to drum roller screeds; augers are allowed.

4. Add the following to §557-3.11, Curing:
   Inspect the slab surface every six hours for 7 days.

   Provide the Engineer with a daily inspection set that includes:
   - Documentation that identifies any deficiencies found (including location of deficiency).
   - Documentation of corrective measures taken.
   - A statement of certification that the entire bridge deck is wet and all curing material is in place.
   - Documentation showing the time and date of all inspections and the inspector's signature.
   - Documentation of any temporary removal of curing materials including location, date and time, length of time curing was removed, and means taken to keep the exposed area continuously wet.

5. Curing Membrane At the end of the 14-day curing period remove the wet burlap and polyethylene and within 30 minutes, apply 2 coats of an opaque curing membrane to the LC-HPC. Apply the curing membrane when no free water remains on the surface but
   - while the surface is still wet. Apply each coat of curing membrane according to the manufacturer's instructions with a minimum spreading rate per coat of 1 gallon per 80 square yards (1 liter per 6 square meters) of LC-HP surface. If the LC-HP is dry or becomes dry, thoroughly wet it with water applied as a fog spray by means of approved equipment. Spray the second coat immediately after and at right angles to the first application.
   - Protect the curing membrane against marring for a minimum of 7 days. Give any marred or disturbed membrane an additional coating. Should the curing membrane be subjected

to continuous injury, the Engineer may require wet burlap, polyethylene sheeting or other approved impermeable material to be applied at once.

6. Add the following to §557-3.13, Removal of Forms:
   The forms shall be removed no later than four weeks after the date the slab is poured.

METHOD OF MEASUREMENT.

Apply all the provisions of §557-4.

BASIS OF PAYMENT.

Apply all the provisions of §557-5 and the following:

a. For each day later than four weeks after the slab is poured that the forms have not been removed, payment will be reduced 1% of the total deck surface area.
b. For each twelve hour period in which one or more inspections have been missed, payment will be reduced 1% of the total deck surface area. Each day shall have two twelve hour periods, the first from midnight until noon, the second from noon to midnight. Each twelve hour period will have one inspection in the first six hours, one in the second six hours, with at least three hours between any two inspections in the same day.
c. For each twelve hour period in which curing requirements, including inspections with documentation, are not met, payment will be reduced 1% of the total deck surface area.
d. For each 2º F the placement temperature exceeds 70º F, payment will be reduced 1% of the total deck surface area.