DESCRIPTION:

The work will consist of creating a mix design for, making a trial placement for, and placing High Performance Fiber Reinforced Concrete (HPFRC) as shown on the Plans. All materials shall meet the “Buy America” requirement.

MATERIALS:

High Performance Fiber Reinforced Concrete

Timeline:

Mix Design Testing must begin a minimum of 90 days prior to use.
Mix Design Submittal must occur a minimum of 45 days prior to use.
Trial Placement must occur a minimum of 30 days prior to use.

The Contractor shall engage an AASHTO-accredited testing laboratory for testing of all preproduction concrete specimens.

The material shall be High Performance Fiber Reinforced Concrete. Materials commonly used in HPFRC follow:

Light Weight Fine Aggregate §703-10
Coarse Aggregate (Type CA 1) §703-02
Portland Cement §701-01
Blended Portland Cement §701-03
Microsilica §711-11
Admixtures §711-08
Fly Ash §711-10
Water §712-01
Steel Fibers, deformed minimum tensile 225 ksi 1” max ASTM A820
GGBFS * §711-12
HRP ** §711-14

* Ground Granulated Blast Furnace Slag
** High Reactivity Pozzolan

Water/cementitious materials ratio <.25
Minimum steel fiber content (by volume) ≥ 1.5%
100% of fine aggregate shall be light weight
Light weight aggregate shall be soaked for

HPFRC material shall meet the following, 28 days unless otherwise noted:

Minimum Compressive Strength (ASTM C39)
28 Day ≥ 15 ksi
4 day ≥ 7 ksi

Scaling Resistance (ASTM C672) y < 3
Freeze-Thaw Resistance (ASTM C666A; 600 cycles) RDM > 96%
DESIGN A MIX

1) Design an HPFRC concrete mixture with lightweight fine aggregate, proportioned according to the American Concrete Institute Manual of Concrete Practice, ACI 211.2, Standard Practice for Selecting Proportions for Structural Lightweight Concrete. Produce a homogeneous mixture of cement, pozzolan (fly ash or GGBFS), microsilica, lightweight fine aggregate, coarse aggregate, air entraining agent, water-reducing and set-retarding admixture, and water as designed.

2) Use Type I, I/II, II or Type SF cement. Use a minimum total cementitious content of 675 lb/yd³. Use 12% Microsilica and other pozzolans as needed.

3) Construct lightweight fine aggregate stockpile(s) at the production facility so as to maintain uniform moisture throughout the pile. Using a sprinkler system approved by the Materials Engineer. continuously and uniformly sprinkle the stockpile(s) with water for a minimum of 48 hours, or until the “Absorbed Moisture content” of the stockpile is at least 15% by weight (as determined by Test Method NY 703-19E). If a steady rain of comparable intensity occurs, turn off the sprinkler system at the direction of the Materials Engineer, until the rain ceases. At the end of the wetting period, or after the rain ceases, allow stockpiles to drain for 12 to 15 hours immediately prior to use, unless otherwise directed by the Materials Engineer.

4) After the materials have been accepted for this work, determine the proportions for concrete and equivalent batch masses based on trials made with materials to be used in the work. Make appropriate adjustments to the specific gravity (Bulk SSD) and fineness modulus of the combined fine aggregate when developing the mix design. At least 1 week prior to concrete placement, provide the Materials Engineer with a copy of the trial mix design with the following data:

   a. Fine and coarse aggregate content in lb/yd³, based on saturated surface dry (SSD) condition of all aggregates*.
   b. Cementitious content (lb/yd³).
   c. Water content, (lb/yd³).
   d. 28-day compressive strengths, (psi)
   e. Batch weights/ quantities of all intended materials including admixtures.

* The moisture content of the lightweight fine aggregate must be determined immediately prior to batching, using Materials Procedure 703-19E. If the supplied mix design is based on “oven dry” weight of lightweight fine aggregate, a corresponding adjusted weight must be supplied to account for the actual absorbed moisture content, so that the mix design entered in to the automated batching system is based on SSD weight. After the adjusted mix design is entered into batching system, additional adjustments must be made to the fine aggregate and water quantities to account for the “surface” moisture of the fine aggregates. The Materials Engineer, or his representative, will approve the batch weights prior to use.
Use these values to manufacture all HPFRC for this project, and periodically correct the batch weights to account for changes in the fine aggregate fineness modulus and aggregate moisture contents.

5) Achieve a minimum 28-day compression strength of 15000 psi. The Contractor shall verify the mix meets the strength requirements prior to requesting a trial placement.

MIX DESIGN SUBMITTAL

The proposed mix design shall be documented on a Mix Design Sheet with the following information and submitted to the DCES.

Information Required on MDS. The MDS shall include the following information:

A. The source and type of cement.
B. The specific source of the coarse aggregate.
C. The specific source of the fine aggregate.
D. The brand and type of all admixtures that will be used.
E. The complete mix design including all ingredient and quantities proposed for the production concrete.
F. The maximum water-to-total-cementitious-material ratio that is proposed for production.
G. Description of the concrete batching and mixing facilities, including the date of last annual inspection and date of last scale calibration check.
H. Description of the concrete transport equipment.
I. The method of concrete placement.
J. Outline of the curing procedure to be used for the production units and test samples.
K. Quality control tests and procedures that the fabricator will perform.
L. Detailed description of the preproduction testing procedure to establish that concrete made from the proposed mix design meets the required performance criteria.
M. The name and address of the testing laboratory(s) conducting the tests.
N. A fabricator selected identifier for the mix.
O. Test results for the preproduction test mix.
P. Graph of compressive strength versus age.

TRIAL PLACEMENT

A minimum of 12 cylinders 3 X 6 inches shall be cast.

All cylinders shall be cured using the same method of curing proposed to be used in the field. The temperature during curing shall be within 10°F of the low end of the proposed temperature range for curing in the field. 2 cylinders shall be tested each testing day. Testing times are at 4 days, 7 days, 14 days, and 28 days. The compressive strength shall be measured by ASTM C39 and shall meet 7 ksi minimum at 4 days and 15 ksi minimum at 28 days. Only a HPFRC mix design that passes these tests may be used to form the joint.
Cast 12 additional cylinders 12 inches in diameter and 7 ½ inches deep. Each cylinder shall have one 32 inch long epoxy-coated reinforcing bar cast in the center of the circular face. The axis of the bar shall be perpendicular to the formed surface. 6 of the bars shall be #6 bars embedded 6 inches deep and 6 of the bars shall be #4 bars embedded 3 inches deep. These cylinders will be kept wet for four days then delivered to the Materials Bureau for testing according to Test Method No. NY 701-14 E. Contact the Materials Bureau prior to casting for specific instructions on preparing the test specimens. The test will be performed as soon as practical after the corresponding samples reach 7 ksi.

An alternative to pouring the twelve cylinders in the previous paragraph is to cast a slab with the same number of reinforcing bars embedded to the same depth. The distance between any two reinforcing bars shall be 1.5 times the sum of their embedments. The test shall be performed using the same equipment and procedures found in Section 586 for testing of drilled and grouted reinforcing bars.

This test is a pullout test, and is for the information of the Department only. However, no material can be used which has not had the test performed.

CONSTRUCTION:

Pre-Pour Meeting:

Prior to the initial placement of the HPFRC, the contractor shall arrange for an on site meeting between the Contractor's staff, the NYSDOT Engineer and the inspectors. The objective of the meeting will be to clearly outline the procedures for mixing, transporting, finishing and curing of the HPFRC material.

Form Work, Batching and Curing:

The design and fabrication of forms shall follow approved installation drawings and shall follow the recommendations of the manufacturer. All the forms for HPFRC shall be constructed from plywood. The forms shall be coated to prevent absorption of water.

The contractor shall follow the batching sequence approved by the DCES. The HPFRC shall fill the form such that the surface is a minimum of 1/16 inch above the form and a maximum of 3/16 inch above the form.

The HPFRC in the form shall be cured as approved in the installation drawings.

Quality Control:

The contractor shall measure the slump flow on each batch of HPFRC. The slump flow will be conducted using a mini-slump cone. The flow for each batch shall be between 7 inches and 10 inches. The slump flow for each batch shall be recorded in the QA/QC log. A copy of the log shall be given to the Engineer.
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The contractor shall take a sufficient number of compressive strength test samples as approved by the DCES. All sets shall be cured in an environment similar to the material they represent.

The following tests shall be performed:

Compressive strengths shall be according to ASTM C 39. The timing of the testing shall be as required by the contract documents. The second set shall be sent to the Materials Bureau between the 4th day and the 14th day for monitor testing. The third set shall be treated as a reserve set.

**MEASUREMENT FOR PAYMENT:**

Measurement will be by volume of HPFRC placed in cubic feet. The volume of in-place HPFRC shall be calculated to the nearest cubic foot.

**BASIS OF PAYMENT:**

Payment at the contract price for the above item shall be full compensation for all labor, equipment, and material to do the work.