



**DEVELOPMENTAL SPECIFICATIONS
FOR
HIGH PERFORMANCE CONCRETE FOR STRUCTURES**

**Effective Date
July 21, 2015**

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

12071.01 DESCRIPTION.

- A.** Develop and provide high performance concrete (HPC) for bridge substructures and decks when called for in the contract documents. HPC is defined as a concrete mix providing the following:
- Desired workability.
 - Maximum 28 day permeability of 2000 coulombs for the substructure (or greater than 20 K ohm-cm surface resistivity by Wenner probe) and 1500 coulombs for the deck (or greater than 30 K ohm-cm surface resistivity by Wenner probe), as a target.
- B.** Apply Sections 2403, 2412, and Division 41 of the Standard Specifications with the following modifications.

12071.02 MATERIALS.

Contractor may use other mixes than those described below provided they meet the requirements of this specification and are approved by the District Materials Engineer.

A. Substructure:

1. Apply the following conditions for substructure HPC mixes:
 - Coarse aggregate meeting Class 3i durability.
 - Basic water to cementitious material (w/c) ratio of 0.42, with a maximum w/c ratio of 0.45.
2. HPC mix for substructure may be a HPC-S or CV-HPC-S. Apply the following conditions:
 - a. Use one of the following cement combinations:
 - Type IS.
 - Type ~~III~~ I or II with a minimum of 30% weight (mass) substitution with GGBFS.
 - Type IP, except with an absolute volume of 0.126 for HPC-S mix.
 - b. Fly ash substitution not to exceed 20% by weight (mass) of the cement.
 - c. Maximum total substitution of 50%
 - d. A high range water reducer may be used with a maximum allowable slump of 8 inches (200 mm) and target air content of 7.5% ± 2.0%.

B. Deck.

1. Apply the following conditions for deck HPC mixes:

- a. Use coarse aggregate meeting Class 3i durability.
 - b. Basic w/c ratio of 0.40, with a maximum w/c ratio of 0.42.
2. The HPC mix for the deck may be a HPC-D or a CV-HPC-D. Apply the following conditions:
- a. Use one of the following cement combinations:
 - Type IS.
 - Type ~~III~~ I or II with a minimum of 30% weight (mass) substitution with GGBFS.
 - Type IP, ~~except use an absolute volume of 0.126 for the HPC-D mix.~~
 - b. Fly ash substitution not to exceed 20% by weight (mass) of the cement.
 - c. Maximum total substitution of 50%.
 - d. Combined aggregate gradation optimized according to Materials I.M. 532 and meeting the limits in Article 2513.03, A, 2, b, 3, of the Standard Specifications.

C. Contractor Designed HPC.

Other mixes meeting the above requirements may be approved by the District Materials Engineer.

12071.03 CONSTRUCTION.

A. Production Concrete.

1. Notify the Engineer at least 48 hours prior to placement of production concrete. Use only approved HPC mixes for production concrete. If a mix other than mix described in Article DS-12071.02, A or B is to be used, ensure it has same materials, proportions, and properties (including slump, air content, and w/c ratio) as approved by the District Materials Engineer.
2. District Materials Engineer will obtain random verification strength samples on a minimum of one deck placement. Strength samples will be tested at District Materials Laboratory according to AASHTO T 22. A set of four cylinders will be cast, cured, and handled according to Materials I.M. 315. Three cylinders will be tested for strength at 28 days. One cylinder will be tested for permeability on a random basis by Central Materials Laboratory or Wenner probe resistivity testing by the District Materials Engineer. Permeability testing will not be evaluated on footings or drilled shafts.

B. Placing Concrete.

1. If concrete is to be placed by pumping, use a pump line with a section reduction to reduce exit velocity of pumped concrete and minimize damage to epoxy coated reinforcement. Submit measures for reducing exit velocity of concrete to Engineer for approval prior to placement by pumping.
2. Protect epoxy coated reinforcement from damage caused by placing and handling equipment.
3. For the deck, placing of concrete floors shall not begin if the theoretical rate of evaporation exceeds 0.1 pounds per square foot per hour (0.5 kg/m² per hour). Monitor theoretical evaporation rate at a maximum interval of every three hours during placement at a location as near the deck as possible. If the rate exceeds 0.15 pounds per square foot per hour (0.75 kg/m² per hour) cease placement at next location acceptable to Engineer.

C. Curing.

1. Substructure.

- a. Leave forms in place for 96 hours of curing.
- b. Leave wet burlap covering in place for 96 hours.

2. Deck.

- a. Leave forms in place for 168 hours of curing.
- b. Apply water to the burlap covering for 168 hours of continuous wet sprinkling system curing.
- c. Do not place curing compound on floor.
- d. ~~Prewet burlap with sufficient water, prior to placement, to prevent absorption of moisture from concrete surface.~~ Use burlap that is prewetted by fully saturating, stockpiling to drain, and covering with plastic to maintain wetness prior to placement. Place two layers of prewetted burlap on floor immediately after artificial turf drag or broom finish with a maximum time limit of 10 minutes after final finishing. Apply water to burlap covering for entire curing period by means of a continuous wet sprinkling system that is effective in keeping burlap wet during moist curing period.
- e. Use evaporation retardant only in situations where equipment and/or labor delays, or environmental conditions, prevent adequate protection of concrete until prewetted burlap is in place. Have an evaporation retardant, including Confilm, Conspec Acquafilm, Evapre, or Sure Film, readily available during placement for application as directed by the Engineer. Do not work evaporation retardant into concrete surface or use as a finishing aid.

D. Cold Weather Protection.

1. Monitor surface temperature of concrete continuously during curing period using electronic recording type thermometers capable of recording a minimum of one reading per hour. Furnish results to Engineer in electronic format as required.
2. If supplemental housing and heating is used, locate temperature monitors in the concrete at the furthest and closest point from heat source. Verify maximum temperature at monitor point closest to heat source does not exceed 150°F (65°C).
3. After required curing period, gradually reduce temperature of air surrounding concrete to outside air temperature according to Article 2403.03, I, of the Standard Specifications.
 - a. **Substructure.**
Ensure concrete and its surface temperature are maintained at a temperature of no less than 50°F (10°C) for the first 120 hours after placing. Curing time will not be counted if concrete temperature falls below 50°F (10°C).
 - b. **Deck.**
 - 1) Covering with plastic will not be allowed as a substitute for continuous wet sprinkling system curing.
 - 2) Ensure concrete and its surface temperature are maintained at a temperature of no less than 50°F (10°C) for 168 hours of continuous wet sprinkling system curing. Curing time will not be counted if the concrete temperature falls below 50°F (10°C).

12071.04 METHOD OF MEASUREMENT.

Measurement for High Performance Concrete will be the cubic yards (cubic meters) shown in the contract documents.

12071.05 BASIS OF PAYMENT.

Payment for High Performance Concrete will be at the contract unit price per cubic yard (cubic meter). Payment includes cost for testing production concrete.