MICHIGAN

DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

FOR

**MASS CONCRETE STRUCTURES**

BRG:JST 1 of 4 APPR:JAB:CRB:08-28-23

**a. Description.** This work consists of forming, finishing, and curing mass concrete placements including development of mass concrete placement plans and thermal monitoring and management during construction. Mass concrete structures are defined as having a minimum dimension of 7 feet or greater. All work must be in accordance with the standard specifications, except as modified herein.

**b. Materials.** The materials must meet the requirements described in the following sections of the Standard Specifications for Construction:

Material Section

Portland Cement 901

Slag Cement 901

Fine Aggregate 902

Coarse Aggregate 902

Admixtures 903

Water 911

Furnish concrete meeting the slump and strength requirements for Grade 4500HP from Table1004-1 of the Standard Specifications for Construction.

Furnish a mass concrete containing a minimum of 500 pounds of cementitious material per cubic yard of concrete. Ensure the slag cement content is no more than 75 percent by mass of the total cementitious material.

**c. Mass Concrete Placement Plan.** Submit a mass concrete placement plan, for each individual element to be placed, to the Engineer and the MDOT Bureau of Bridges and Structures Bridge Construction Engineer, a minimum of 21 days prior to proposed mass concrete placement. Ensure the mass concrete placement plan is reviewed and approved or permission to place mass concrete will not be authorized. The Engineer’s review and approval of the mass concrete placement plan does not relieve the Contractor of the responsibility for achieving compliance with this special provision. Ensure the plan is developed by a Professional Engineer licensed in the State of Michigan who has completed a minimum of 10 mass concrete placements within the last 5 years. The mass concrete placement plan must contain, but is not limited to, the following:

1. References for all completed mass concrete placements that the Contractor’s engineer has modeled and overseen.

2. Mix design and proportions.

3. Information on the modeling software used. Ensure software is proprietary or commercially available. Free software will not be allowed for modeling.

4. Thermal Modeling of Mass Concrete Elements. Ensure the modeling is 3-dimensional (3D).

5. Procedures to control concrete temperature at time of placement.

6. Duration and method of curing.

7. Methods for controlling maximum concrete temperature and temperature differentials and ensuring conformance to temperature requirements.

8. Temperature sensor types and locations.

9. Temperature monitoring and recording system.

For all mass concrete placements, the maximum allowable concrete temperature at the time of placement is 70 °F. The maximum allowable placement temperature may only be exceeded if the Contractor has documented the higher temperature in the mass concrete placement plan and has obtained approval of the mass concrete placement plan in accordance with the requirements of this special provision. The maximum allowable concrete temperature during curing is 150 °F, and the maximum allowable temperature differential within the concrete during curing is 35 °F.

**d. Mechanical Cooling System.** If the Contractor elects to use a mechanical cooling system, ensure the mechanical cooling system is designed in conformance with the mass concrete placement plan and the following requirements:

1. The mechanical cooling system is embedded within mass concrete elements and surface connections to cooling pipes are removable to a depth of 4 inches from the surface.

2. Forms are designed so that their removal does not disrupt the cooling or temperature monitoring.

3. Cooling pipes must not break, nor deform during mass concrete placement and are secured to prevent movement. Immediately remove and replace damaged cooling pipes.

4. Pressure test the mechanical cooling system at 30 psi for 30 minutes for leaks prior to mass concrete placement. Begin coolant circulation prior to beginning concrete placement.

5. After cooling is completed, ensure cooling pipes are fully grouted under pressure with a non-shrink grout mixture in accordance with subsection 1005.02.B of the Standard Specifications for Construction.

6. After surface connections to the cooling pipes are removed, ream the holes out to a minimum depth of 3 inches and fill with a non-shrink grout mixture in accordance with subsection 1005.02.B of the Standard Specifications for Construction.

**e. Construction.** Perform all construction in accordance with standard specifications, except as modified herein. Prior to construction, the registered Professional Engineer that prepared the mass concrete placement plan for the Contractor must inspect and test the temperature monitoring and recording system. The Contractor’s engineer must be present at the jobsite when the mass concrete operation is in progress and must report to the Engineer in writing, daily, the progress of the operation.

The temperature monitoring and recording system for mass concrete must consist of temperature sensors connected to a data acquisition system capable of storing and downloading data to a computer. Locate temperature sensors so that the maximum temperature differential within a mass concrete element can be monitored. As a minimum, ensure concrete temperatures are monitored at the calculated hottest location, on at least 2 outer faces, 2 corners, and top surfaces. Place all surface sensors approximately 4 inches below the surface of the mass pour element.

Record temperature readings automatically at 30-minute intervals. Install a redundant set of sensors near the primary set. Make provisions for recording the redundant set, but records of the redundant sensors need not be made if the primary set is operational. The temperature recording may be discontinued when the maximum internal temperature has reached its maximum and is decreasing, the difference between the maximum interior concrete temperature and the average daily air temperature is less than 35 °F for three consecutive days, and there are no adjacent mass concrete elements to be cast. Submit the data to the Engineer daily.

Ensure that the methods of concrete consolidation do not damage the temperature monitoring and recording system. Protect wiring from temperature sensors cast into the concrete to prevent movement. Keep wire runs as short as possible. The ends of the temperature sensors must not come into contact with supports, concrete forms, or reinforcing steel. Immediately correct failures of the temperature monitoring and recording system that occur during the mass concrete construction operation, as specified in the mass concrete placement plan.

Failure to conform to any of the temperature requirements may result in the mass concrete element being rejected by the Engineer. Remove and replace rejected mass concrete at the Contractor’s expense. Submit a revised mass concrete placement plan and design calculations, for each rejected element, to the Engineer and the MDOT Bureau of Bridges and Structures Bridge Construction Engineer. Ensure the revised mass concrete placement plan is reviewed and approved or permission to place mass concrete will not be authorized. Allow for a 14 day review period. No extension of time or other compensation will be made for any rejected mass concrete element or revisions of the mass concrete placement plan.

Do not allow concrete to freefall more than 12 inches above the bottom of the placement.

Ensure all work progress specimens are tested for compressive strength.

During placement operations prevent concrete from adhering to reinforcement, ducts, forms, or accessories of subsequent pours.

**f. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

**Pay Item Pay Unit**

Conc, Grade 4500HP, Mass Pour Cubic Yard

Thermal Management, Sub-Track Level, Pier 1 (Structure Identification) Lump Sum

Thermal Management, Sub-Track Level, Pier 2 (Structure Identification) Lump Sum

1. **Conc, Grade 4500HP, Mass Pour** includes forming, furnishing, placing, finishing and curing. Payment also includes all costs associated with the development of an approved concrete design. Cofferdams, excavation, reinforcement steel, and dredging are not included with this item.

2. **Thermal Management, Sub-Track Level, Pier 1 (Structure Identification)** will be measured as a lump sum for each mass concrete element. Payment includes a complete mass concrete placement plan, cooling system, and monitoring system work as specified in this special provision and on the plans.

3. **Thermal Management, Sub-Track Level, Pier 2 (Structure Identification)** will be measured as a lump sum for each mass concrete element. Payment includes a complete mass concrete placement plan, cooling system, and monitoring system work as specified in this special provision and on the plans.