ITEM 555.02    01 - CONCRETE FOR STRUCTURES CLASS MP (MASS PLACEMENT)

DESCRIPTION:

Furnish and place portland cement concrete with a minimum compressive strength of 21 MPa where specified on the Plans for mass concrete placements of structural elements. Follow §555, except as noted below.

MATERIALS:

§555-2, except as modified herein.

Using materials meeting the requirements of §501-2.02 and as indicated below, design a concrete mixture(s) based on the following criteria.

• Strength - 56 day minimum compressive strength of 21 MPa.
• Slump - 80 mm +/- 25 mm. A high range water reducing admixture may be used upon prior written approval from the Director, Materials Bureau. If adding a high range water reducing admixture, slump will be limited to 80 mm maximum before the addition.

After the addition, slump will be limited to 200 mm maximum.
• Entrained Air - 5 to 8%.
• Water/Total Cementitious Material Ratio - 0.40 maximum.
• Class F Fly Ash - 20% to 50% by weight of cementitious materials.
• Cement, Type II only.
• Total cementitious content - 300 kg/m³ maximum

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.

An equal mix design may be submitted for evaluation to the Director, Material Bureau for approval.

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 Engineer, for evaluation. Submit sufficient data to permit the Director to offer an informed evaluation. Include at least the following:

• Concrete mix proportions.
• Material sources. Also include fineness modulus and specific gravity for all aggregates.
• Air content of plastic concrete.
• Slump of plastic concrete.
• Compressive strength at 7, 14, 28, and 56 days, and at any other age tested or deemed necessary.
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• Temperature/time relation (Interior of concrete with autogenous curing boxes) for 7 days measuring at hourly intervals.

Do not interpret having a valid mixture design as approval of the mixture. 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.

CONSTRUCTION DETAILS:

Follow §555-3, except as modified herein:

Replace §555-3.01 - Concrete Manufacturing and Transporting with:
§501-2.03 Concrete Batching Facility Requirements,
§501-2.04 Concrete Mixer and Delivery Unit Requirements,
§501-3.02 Handling, Measuring, and Batching Materials, and
§501-3.03 Concrete Mixing, Transporting, and Discharging except that the maximum concrete temperature at the point of discharge shall be as specified in the Thermal Control Plan.

The Contractor shall prepare a Thermal Control Plan prior to placement of the mass concrete.

Thermal Control Plan:

The Thermal Control Plan shall at a minimum include a Heat Dissipation Study (Reference ACI 207 or thermal modeling software) as well as to describe the measures and procedures the Contractor intends to use to satisfy the following Temperature Control Requirements for each mass concrete element:

i. The Maximum Temperature Differential shall be limited to 20 degrees C (differential of 35 degrees F). The temperature differential between the interior and exterior portions of the designated mass concrete elements during curing will be maintained to be less than or equal to this Maximum Temperature Differential, and

ii. The Maximum Allowable Concrete Temperature shall be limited to that shown in the approved thermal control plan.

A change to the Temperature Control Requirements specified above can be addressed in the Thermal Control Plan through Heat Dissipation Studies to demonstration that deleterious effects to the concrete can be avoided through adherence to the Thermal Control Plan. Such a change requires approval by the D.C.E.S.
As a minimum, the Thermal Control Plan shall include the following:

A. Mix design. If the mix will be cooled, the Contractor shall define the methodology and necessary equipment to achieve these mix temperatures.

B. Duration and method of curing.

C. Methods of controlling temperature differentials, inclusive of active coolant systems not previously defined within the Engineering Drawings.

D. An analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the proposed mix design, casting procedures, and materials. It shall show complete details and determine the maximum temperature differentials within the concrete mass.

E. Temperature sensor types and locations including installation details.

F. Temperature Monitoring System including system description, operating plan, recording and reporting plan, and remedial action plan.

G. Field measures and documentation procedures to ensure conformance with the maximum concrete temperature and temperature differential requirements.

H. Field methods of applying immediate corrective action should the temperature differential approach the Maximum Temperature Differential and Maximum Allowable Concrete Temperature.

The Contractor shall submit the Thermal Control Plan to the Engineer for approval a minimum of thirty working days prior to concrete placement. Mass concrete placement shall not begin until the D.C.E.S. has approved the Thermal Control Plan.


Modify §555-3.06 - Concrete Joints: Structural elements may be constructed in stages using construction joints if permission is granted by the Deputy Chief Engineer for Structures Design and Construction.

Modify §555-3.10 - Loading Limitations: After the minimum curing period, concrete may receive construction loads after reaching a compressive strength of 15 MPa. Testing will be in accordance with note 3 of Table 555-4.

All concrete for this item shall achieve 21 MPa prior to opening the structure to traffic.
Compressive strengths shall be determined from cylinders stored and cured in the same manner as the concrete it represents. The average compressive strength of each cylinder set shall be greater than the desired compressive strength, with no individual cylinder less than 90% of the desired compressive strength.

Temperature Monitoring System:

The temperature monitoring and recording system for mass concrete shall consist of temperature sensors connected to a data acquisition system capable of printing, storing, and downloading data to a computer. Temperature sensors shall be located such that the maximum temperature difference within a mass concrete element can be monitored. As a minimum, concrete temperatures shall be monitored from the center of the concrete mass, the base of the mass, the surface of the mass, and the center of an exterior outer face that is the shortest distance from the center of the concrete mass.

Temperature readings shall be automatically recorded on an hourly basis or as required by the Engineer. A redundant set of sensors shall be installed near the primary set. Provision shall be made for recording the redundant set, but records of the redundant sensors need not be made if the primary set is operational.

Methods of concrete consolidation shall prevent damage to the temperature monitoring and recording system. Wiring from temperature sensors cast into the concrete shall be protected to prevent movement. Wire runs shall be kept as short as possible. The ends of the temperature sensors shall not come into contact with either a support or concrete form, or reinforcing steel.

When any equipment used in the temperature control and monitoring and recording system fails during the mass concrete construction operation, the Contractor shall take immediate remedial measures to correct the situation as specified in the Thermal Control Plan.

Temperature reading will begin when mass concrete placement is complete. Temperature readings will continue until the maximum temperature differential (not maximum temperature) is reached and a decreasing temperature differential is confirmed as defined in the Thermal Control Plan. Furnish a copy of all temperature readings daily.

If monitoring indicates that the temperature differential is approaching the maximum temperature differential of 20°C the Contractor shall take immediate corrective action as defined in the Thermal Control Plan to retard further increase of the temperature differential. The Contractor will make the necessary revisions to the approved Thermal Control Plan to satisfy the temperature control requirements on future placements. Revisions to the plans must be approved by the Engineer prior to implementation.

§555-3.13 - Damaged or defective concrete, applies with the following additions:
If mass concrete temperature differentials are exceeded, provide all analyses and test results deemed necessary by the D.C.E.S. for determining the structural integrity and durability of the mass concrete element, to the satisfaction of the D.C.E.S. The Department will make no compensation, either monetary or time, for the analyses, tests or any impacts upon the project.

Any cracks in the structural element greater than 0.40 mm resulting from the contractor’s inability to properly maintain concrete temperature differentials, shall be repaired using epoxy injection at no additional cost to the Department. The effectiveness of repairs shall be demonstrated by the contractor using evaluation methods acceptable to the Department. The Engineer-In-Charge will be responsible for accepting or rejecting the repairs after the field evaluation.

**METHOD OF MEASUREMENT:**

Cubic meter as per §555-4.

**BASIS OF PAYMENT:**

§555-5, including the cost of the mix design and Thermal Control Plan in the unit bid price per cubic meter.