July 9, 2014
(DESIGN BUILD)

GEORGIA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

PROJECT NO.

P.I. NO.

SECTION 500 – CONCRETE STRUCTURES

Add the following to Subsection 500.1.02:

B. Referenced Documents

"Guide to Mass Concrete" ACI 207.1R-05
"Report on Thermal and Volume Change Effects on Cracking of Mass Concrete" ACI 207.2R-07
"Cooling and Insulating Systems for Mass Concrete" ACI 207.4R-05
"Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete" ACI 211.1-91
"Control of Cracking Concrete Structures" ACI 224R-01.
"Control of Cracking Concrete Structures", ACI 224R-01.
"Specification of Structural Concrete", Section 8, ACI 301-10.
"Compressive Strength of Cylindrical Concrete Specimens", AASHTO T 22-10
"Making and Curing Concrete Test Specimens in the Laboratory", ASTM C192

Add the following to Subsection 500.3.05:

AM. Mass Concrete

a. Mass concrete is defined as "Any large volume of cast-in-place concrete with dimensions large enough to require measures be taken to cope with the generation of heat and attendant volume change to minimize cracking".

b. Any substructure concrete element whose least dimension is greater than 5 feet (excluding drilled shafts) shall be designated as mass concrete and will use this specification.

c. The introduction of a construction joint (other than as shown on the plans and as approved by the Engineer) at a dimension less than 5 feet must provide a volume-to-surface area ratio less than or equal to 1.0 feet for the element not to be classified as mass concrete. The volume is in cubic feet and excludes embeds such as piles and conduits. The surface area in square feet for this ratio includes the summation of all surface areas of the element being considered, including the full underside bottom contact surface of footings, columns, caps, construction joints, etc. and the contact surfaces of embeds. If $V/S \leq 1.0$ feet then the element is not to be classified as mass concrete.

d. Temperature specifications for placing and curing mass concrete:

1. The maximum allowable internal temperature of mass concrete shall not exceed 165°F unless the percentage of Fly Ash (Class F only) is 35% to 50%, or the percentage of Grade 100 or Grade 120 slag is 50% to 70%, in which case the allowable maximum internal temperature of mass concrete is 180°F.
2. The maximum temperature differential between the interior core temperature and the exterior surface portions of the mass concrete element shall not exceed 50°F.
3. The maximum temperature of the concrete when delivered and prior to placement shall be 95°F.

4. Monitor and maintain records of the concrete temperatures, beginning when the casting is complete and continuing until the maximum temperature is reached and begins dropping to a differential of no more than 70°F from the mean monthly minimum ambient temperature of the surrounding environment.
5. When or if the temperature differential between the interior core temperature and the exterior surface portions exceeds 40°F, take immediate corrective actions to retard further growth of the temperature differential so as to limit it to the 50°F maximum.

e. At least 30 days prior to placing any mass concrete, submit to the Engineer for approval a Thermal Control Plan. The Thermal Control Plan shall include the following details as a minimum:

1. Proposed concrete mix design showing proportions and sources for all materials.
2. 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.
3. Proposed methods to control concrete placing temperature, such as pre-cooling aggregates.
4. Duration and method of curing.
5. Calculations of the maximum concrete temperatures for the range of expected project air and concrete temperatures.
6. Proposed methods to control maximum temperature during curing. A mechanical cooling system may be used to control the internal concrete temperature of mass concrete during curing. If used, details of the mechanical cooling system operations and final grouting after grouting shall be included in the Thermal Control Plan (TCP). If a mechanical cooling system is used, the plans for the cooling system operation and final grouting after cooling shall be submitted to the Engineer for approval.
7. Actions to be taken when the maximum concrete temperature exceeds 155°F (or 170°F depending on the approved mix design) to retard further increase in the temperature to limit it to 165°F (or 180°F depending on the approved mix design).
8. Proposed methods to control the temperature differentials during and after curing. Contractor must take actions that prevent the exterior surfaces of the concrete from getting too cool such as using insulation or heaters or by preventing the core from getting too hot.
9. Actions to be taken when the temperature differential exceeds 40°F during curing, plus actions to prevent thermal shock to the concrete surfaces after curing is completed.
10. Proposed temperature monitoring and recording system, that shall consist of temperature sensors connected to a data acquisition system, including sensor type and sensors locations.
11. The TCP shall be developed by a Engineer, licensed in the State of Georgia,.
12. Calculations of maximum temperature gradients within each concrete element during curing. Calculations shall include maximum possible temperature induced tensile stress in the concrete in addition to tensile stresses at 1 day, 3 days, 7 days, 28 days, and 56 days after placement. The thermal calculation model and/or computational software shall be submitted to the Engineer for approval.
13. Results of strength tests of sample cylinders. The concrete shall attain the specified strength at an age (28 or 56 days) as specified by the Engineer.

f. Place no mass concrete until the mass concrete mix design and the TCP are approved by the Engineer. If the mass concrete mix design is changed after the TCP is approved, the TCP must be updated to include the new mix and re-submitted for approval by the Engineer.

g. Install within each mass concrete placement and in the surrounding environment of the concrete, temperature sensing devices of a type and at locations included in the TCP and as approved the Engineer. At each location where the concrete temperature is to be monitored, include two independent sets of sensing devices shall be placed at each of the following locations and readings to be taken hourly: (1) center of the mass pour; (2) midpoint of the side which is the shortest distance from the center; (3) midpoint of the top surface; and (4) midpoint of the bottom surface. The sensors shall be accurate to within ± 2°F. The sensors shall be placed at the following locations as a minimum:

1. Centroid of the placement or where the point of maximum temperature is anticipated
2. The nearest surface in a horizontal or vertical line with the centroid sensor.

Attach the sensors to reinforcing steel. The surface sensors shall be placed at a depth of 2 to 6

inches below the surface. Utilize an automatic temperature recording system that takes readings hourly and is capable of printing, storing and downloading temperature data to a computer. Temperature data shall be forwarded daily to the Engineer.

h. If the temperature differential exceeds 50°F or if the maximum temperature exceeds 165°F (or 180°F based on the approved mix design) in any one mass concrete placement, any additional mass concrete placements will cease until the TCP is revised to address the exceedance and is reviewed and approved by the Engineer.

i. The Engineer may approve manual observations and recording of temperature data at 6-hour intervals where conditions warrant.

j. If demonstrated to the Engineer that any mass concrete placement is similar in dimensions and placing conditions to one previously made where temperature monitoring occurred and in which the temperature differential and maximum temperature were properly controlled, then the Engineer may approve the elimination of temperature monitoring for that placement.

k. Placing and Curing Mass Concrete. When placing and curing mass concrete do the following:

1. Maintain a temperature differential of 50 °F or less between the interior and exterior portions of the designated mass elements.
2. Monitor and maintain records of the concrete temperature, beginning with casting and continuing until the maximum temperature is reached and begins decreasing to a differential of no more than 50°F from the mean annual ambient temperature of the surrounding environment, for three consecutive days.
3. When the internal concrete temperature differential between interior and exterior concrete nears 40°F, notify the Engineer and take corrective measures immediately to retard further increase in the temperature differential to limit it to the 50°F maximum. Utilize the mechanical cooling system, if being use, to lower the internal temperature. Other active measures may include, but not limited to: chilled water for mixing, precooling aggregate stockpiles, ice for mixing water, nitrogen gas, and shade for aggregate stockpiles. Cease placement of concrete until the temperature differential has been lowered.
4. Maintain a minimum concrete placement rate of 30 cubic yards per hour or as designated on the plans or in the Special Provisions. Any requested change from this placement rate is to be approved by the Engineer.

l. Acceptance: Mass concrete shall conform to the concrete acceptance criteria and the temperature requirements as stated earlier to prevent delayed ettringite formation (DEF) and thermally induced stress cracks.