S T A T E **O F** **T E N N E S S E E**

April 10, 2026 April 1, 2026

SPECIAL PROVISION

REGARDING

MASS CONCRETE

Description

This work shall consist of furnishing and placing hydraulic cement concrete for massive cast-in-situ concrete bridge components, with the smallest dimension of a concrete component exceeding 5 feet and being designated in the plans as mass concrete. The introduction of a construction joint at a dimension less than the minimum dimension noted in the plans does not remove the mass concrete requirements of this special provision. Proposals for large-volume concrete shall thus be evaluated based on heat development and a Thermal Control Plan. This shall include footings, drilled shaft and pile caps, piers, abutments, and other work that meets this criterion as designated in the plans. Work shall be performed in accordance with this Special Provision, the Plans, and as directed by the Engineer.

References

"Mass Concrete - Guide", ACI PRC-207-21.

"Report on Thermal and Volume Change Effects on Cracking of Mass Concrete", ACI 207.2R.

"Cooling and Insulating Systems for Mass Concrete", ACI 207.4R.

"Selecting Proportions for Normal-Density and High-Density Concrete - Guide", ACI 211.1-22.

"Control of Cracking Concrete Structures", ACI 224R.

"Specifications for Structural Concrete", Section 8 Mass Concrete, ACI 301-10.

"Compressive Strength of Cylindrical Concrete Specimens", AASHTO T 22.

Temperature Specifications for Mass Concrete

Mass concrete shall conform to the concrete acceptance criteria and the following temperature requirements to prevent delayed ettringite formation (DEF) and thermally induced stress cracks:

1. The maximum allowable internal temperature of the concrete shall not exceed 160 °F.

2. The maximum temperature of the concrete when delivered and before placement shall be 85 °F.

3. The maximum temperature differential between interior and exterior portions of the designated mass concrete element shall not exceed 35 °F unless otherwise allowed by the provisions of the approved project-specific Thermal Control Plan (TCP).

Materials Selection and Mix Design Development

Materials used for mass concrete shall conform to the provisions in Section 604-Concrete Structures of TDOT *Standard Specifications for Road and Bridge Construction* and the following requirements. When in conflict, materials shall conform to the special provisions below rather than those in Section 604.

1. Use Class F fly ash (no Class C fly ash is allowed), granulated iron blast-furnace slag, or other pozzolans, if approved by the Department, in all mass concrete. Slag may comprise no more than 75% by mass of total cementitious and pozzolanic materials. Class F fly ash may contain no more than 40% by mass of total cementitious and pozzolanic materials. When a combination of multiple pozzolans is used, the total amount may not exceed 75% by mass of the total cementitious and pozzolanic materials.

2. High-early-strength (ASTM C150 Type III or ASTM C1157 HE) cement, metakaolin, silica fume, calcium chloride, and accelerating type admixtures shall not be used unless an adiabatic temperature study is completed showing a temperature rise significantly less than that of plain unmodified concrete.

3. A retarding admixture, pretested with the job materials under job conditions, may be permitted to prevent cold joints due to the quantity of concrete placed, as approved by the Engineer.

4. Coarse aggregate larger than #5 stone, maximum size aggregate, is permitted to be used for mass concrete.

5. Other materials and/or mix designs may be proposed to the Engineer for approval, with documentation that the proposed mix designs meet temperature specifications from Section 604.

6. Laboratory-designed mix proportions of materials are permitted for commonly used combinations of materials. Request these mixes in writing from the State Materials Engineer, specifying the class of concrete and the source of ingredients.

7. The mixture will be capable of demonstrating a laboratory compressive strength at 28 days for the Concrete Class selected. Compressive strength will be determined based on the results of six cylinders prepared and tested in accordance with AASHTO T 22.

Thermal Control Plan (TCP)

At least 30 calendar days before placing any concrete defined as mass concrete, submit to the Engineer for review a Thermal Control Plan (TCP). The TCP shall provide a complete analysis of the anticipated thermal developments in the mass concrete elements for all expected project pour temperature ranges, using the proposed mix design, casting procedures, and materials. A primary focus of the TCP is actions to take when any of the temperature controls noted in these provisions are exceeded or are anticipated to be exceeded. As a minimum, the TCP shall include details about the following:

1. Concrete mix design showing composition, proportions, and sources for all components.

2. Batch plant location and travel time to the pour site.

3. Proposed methods to control concrete temperature at the time of placement, such as pre-cooling of raw materials or concrete.

4. Provisions for remedial actions during placement should issues occur.

5. Chain of command for pour decisions.

6. Duration and method of curing.

7. Calculations of maximum concrete temperatures for the range of expected air, water (for underwater construction), and delivered concrete temperatures.

8. Proposed methods to control the maximum temperature during curing. A mechanical cooling system may be used to control the internal temperature of mass concrete during curing but shall be designed in conformance with the Thermal Control Plan. 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.

9. When the maximum concrete temperature nears 140 °F, notify the Engineer and take corrective measures immediately to retard further increase in the temperature to limit it to the 160 °F maximum. Utilize the mechanical cooling system, if installed, to lower the overall temperature. Cease placement of concrete until the maximum temperature has been lowered.

10. Proposed methods to control temperature differentials during curing could include insulation for the forms and exposed portions of concrete. Actions must be taken to prevent the exterior surfaces of the concrete from cooling too quickly.

11. When the internal concrete temperature differential between interior and exterior concrete nears 30°F, notify the Engineer and take corrective measures immediately to retard further increase in the temperature differential to limit it to the 35°F maximum or as allowed by the project specific thermal control plan. Use the mechanical cooling system, if available, to lower the internal temperature. Other active measures may include but are 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.

12. Calculations of maximum temperature gradients within each concrete element during curing. Calculations shall include the maximum possible temperature-induced tensile stress in the concrete, as well as 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. Temperature monitoring and recording system, which shall consist of temperature sensors connected to a data acquisition system. The types and locations of the temperature sensors shall be specified and meet the minimum requirements listed below.

14. 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. Match curing of concrete is required. Match curing shall be conducted according to the temperature history obtained using thermocouples, typically 4 inches from the surface and at the centroid of the concrete pour. The thermocouple depth may need to be determined based on the depth of the rebar or other anchoring structure.

15. For all mass concrete construction, the TCP shall be developed by a Professional Engineer, licensed in the State of Tennessee, who shall be competent in the modeling, design, and temperature control of mass concrete with at least three mass concrete projects of experience that the Department can verify.

    Place no concrete until the mass concrete mix design and the proposed TCP are reviewed and approved by the Engineer. If the concrete design mixture is changed, the TCP must be updated and approved by the Engineer.

Temperature Monitoring and Recording System

1. Install within the concrete placed in each mass pour and in the surrounding environment of the concrete, temperature sensing devices (thermocouples) of a type approved by and at locations based on the plan approved by the Engineer.

2. The sensing system will contain a minimum of two independent sets of sensing devices at each location to ensure readings if one of the systems fails. The sensing devices shall be accurate to within 2°F.

3. Thermocouples shall be placed at the centroid of the pour, or wherever the point of expected maximum temperature is anticipated. Additional thermocouples shall be placed near the exterior surfaces to monitor the maximum temperature differential. Ensure the thermocouples are placed at a depth of 2 to 6 inches below the surface.

4. 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. Data shall be printed and submitted to the Engineer daily.

5. Two independent sets of sensing devices shall be placed at each of the following locations and readings to be recorded 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; (4) midpoint of the bottom surface; and (5) corner of the mass pour which is furthest distance from the center.

Placing and Curing Mass Concrete

When placing and curing mass concrete, do the following:

1. Maintain a temperature differential of 35 °F or less or as allowed by the TCP 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 35°F or as allowed by the TCP from the mean annual ambient temperature of the surrounding environment, for three consecutive days.

3. Suggest consolidation techniques based on the placement technique to be used for mass concrete. The consolidation technique shall be reviewed and approved by the Engineer before the start of mass concrete placement. Slump tests or slump-flow (ASTM C 1611) tests, as applicable, shall be used to provide quality control from batch to batch.

4. Maintain a minimum concrete placement rate of 30 cubic yards per hour or as designated on the plans or in the Special Provisions. The Engineer must approve any requested change to this placement rate.

5. The minimum curing period shall be 7 days.

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.

If failure to conform to any of the above temperature requirements in any one pour occurs, any additional mass concrete pours will cease. The Engineer may, at its sole discretion, direct that the concrete be removed or otherwise mitigated, at no cost to the Department. Revise the Thermal Control Plan and design calculations to address the problem and resubmit the revised Plan. Mass concrete placement shall not begin until the Engineer has approved the revised Thermal Control Plan. No extension of time or compensation will be granted for any rejected mass concrete element

or for revisions to the Thermal Control Plan.

For concrete left in place, all crack widths over 0.01 inch shall be epoxy-injected. Epoxy bonding compounds shall be in accordance with Standard Specifications. All ports and mastic compounds shall be removed from portions of the structure that will remain visible when construction is complete.

All remedial work required, including coring and crack sealing, shall be incidental to the Concrete (Class) used as Mass Concrete.

Basis of Payment

The Department will not measure or make payment to meet the requirements of this provision to place mass concrete.

The Department will measure and make payment for actual quantities of work completed as described for the specific contract item unit prices in accordance with the standard specifications.