Section 9.4
Volume I

MASS CONCRETE

9.4.1 PURPOSE

This document provides guidance to those Florida Department of Transportation (Department) personnel who are involved in activities related to mass concrete planning and placement. The purpose of these guidelines is to standardize the activities associated with the mass concrete used for Department projects statewide.

9.4.2 AUTHORITY

Sections 20.23(3)(a), 334.044(2), 334.044(10)(a), and 334.048(3) Florida Statutes.

9.4.3 SCOPE

The principal users of this document are the Construction Engineering and Inspection Consultants (CEIs), Construction Project Administrators (PAs), District Structural Materials Engineers (DSMEs), District Managers – Concrete Production (DM-CPs), the State Materials Office (SMO) Concrete Materials Engineer, and the SMO Mass Concrete Specialist.

9.4.4 REFERENCES

American Society for Testing and Materials (ASTM) Standard Test Methods and Specifications

American Association of State Highway and Transportation Officials (AASHTO), Part II Tests

American Concrete Institute (ACI), Reports of the Technical Committees

Code of Federal Regulations (CFR), Federal-Aid Policy Guide (FAPG), Subchapter G – Engineering and Traffic Operations, Part 637 – Construction Inspection and Approval, Subpart B – Quality Assurance Procedures for Construction.

Florida Department of Transportation Approved Products List (APL).

Florida Department of Transportation Construction Project Administration Manual (CPAM).

Florida Department of Transportation Standard Specifications for Road and Bridge Construction (Specifications).

Florida Department of Transportation Section 9.4 - Volume II Materials Manual Mass Concrete.

Florida Department of Transportation Structural Design Guideline.

Florida Department of Transportation Sampling and Testing Methods (FSTM).

ACI PRC 207.1 Mass Concrete – Guide.

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

ACI 207.4R Report on Cooling and Insulating Systems for Mass Concrete.

ACI 224R Control of Cracking in Concrete Structures

ASTM C157/C157M Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete. ASTM International, West Conshohocken, PA.

FM 5-621 Florida Method of Test for Optimizing Aggregate Gradation for Portland Cement Concrete. Florida Sampling and Testing Methods, Florida Department of Transportation, Gainesville, FL.

Gajda, John and Feld, Jon (2015), When Should Mass Concrete Requirements Apply, Aspire Vol. 9, No. 3, Summer 2015, pp. 44-45.

Zayed, Abla et al. (2021), Correlation of Slag Cement Composition with Durability of Portland Cement-Slag Concrete, BDV25-977-63, Florida Department of Transportation, 335 pages.

9.4.5 GENERAL INFORMATION

The ***Contract Documents*** identify all structural elements considered to be mass concrete. The Contractor's Specialty Engineer must develop a Mass Concrete Control Plan (***MCCP***) in accordance with ***Specifications Section 346***, ***Materials Manual Section 9.4, Volume II***, and ***CPAM Section 10.3.5***.

This document outlines the Department requirements for the ***MCCP*** review and approval process. These guidelines have been provided to ensure that the implementation of the ***MCCP***s result in the production of mass concrete elements that meet the specified temperature control requirements. All Concrete plants providing mass concrete mixes for Department mass concrete projects are required to meet the requirements of ***Section 9.2 - Volume II Materials Manual*** and to be included on the Department's Structural Concrete Production Facility Listing.

9.4.6 MASS CONCRETE CONTROL PLAN REVIEW AND APPROVAL PROCESS

After receipt of the ***MCCP***, the Project Administrator (PA), District Structural Materials Engineer (DSME), District Manager – Concrete Production (DM-CP), the State Materials Office (SMO) Concrete Materials Engineer, and the SMO Mass Concrete Specialist will review the submitted document to ensure that it meets the requirements of ***Specifications Section 346***, ***Materials Manual Section 9.4, Volume II***, and ***CPAM Section 10.3.5***.

MCCPs shall be reviewed, approved or rejected, and then returned to the Contractor within 10 working days from the date of receipt. If revisions are needed, the ***MCCP*** shall be returned to the Contractor, with reviewer comments, for revision and resubmission. This process shall be repeated as needed until the ***MCCP*** is approved, with an additional 10 working days allowed for each resubmission.

The following Subsections provide roles and responsibilities of the entities in the review and approval process of the submitted ***MCCP***:

9.4.6.1 PA Roles and Responsibilities

Within two working days of the receipt of an ***MCCP***, the PA shall review and forward the ***MCCP***, with comments, to the DSME or DM-CP, the SMO Concrete Materials Engineer, and the SMO Mass Concrete Specialist. The PA shall ensure that no concrete is placed until the ***MCCP*** has been approved.

9.4.6.2 DSME or DM-CP Roles and Responsibilities

The DSME or DM-CP shall review the submitted ***MCCP*** within 5 working days of receiving it and forward the ***MCCP***, along with any comments, to the SMO Mass Concrete Specialist and the Concrete Materials Engineer.

9.4.6.3 SMO Mass Concrete Specialist and Concrete Materials Engineer Roles and Responsibilities

The SMO Mass Concrete Specialist and Concrete Materials Engineer shall review the ***MCCP*** along with the review comments from the PA and the DSME or DM-CP. The Mass Concrete Specialist shall ensure that the following components are included in the ***MCCP***.

(1) A table that lists all the structures by groups of elements that have identical structure types, dimensions, exposure conditions, and concrete mix design (Appendix A).

(2) Insulating system including product/material, R-value, installation, and use.

(3) Instrumentation and monitoring equipment specification. Indicate sensor locations, equipment installation, and the monitoring procedure.

(4) Action plan to avoid thermal shock and thresholds.

(5) Temperature model calculations including equivalent cementitious materials contents, concrete, and ambient temperatures at time of concrete placement,

(6) Core and surface-core differentials temperatures of the elements at the time of form removal.

(7) If post cooling is included, review water inlet and outlet temperatures, flow rates, pipe layout, pipe material, running times, pump capacity and system operation, pipe layout drawings, grouting operations.

Respond to Contractor's proposed ***MCCP*** and request for modifications of ***MCCP*** if needed. If an addendum or revision to the ***MCCP*** is submitted, the review process shall be repeated. Approve the ***MCCP*** if it is acceptable as received, or when all comments have been addressed.

Appendix B includes a checklist for review and approval of the ***MCCP***.

9.4.7 IMPLEMENTATION OF ACCEPTED MASS CONCRETE CONTROL PLANS

The PA shall ensure that the Contractor's execution of the approved ***MCCP***, as well as corrective actions if needed, follows ***CPAM*** instructions. Within 3 working days after the forms are removed from a mass concrete element, the Contractor will send the PA a Mass Concrete Field Report that contains the recorded core and surface temperatures, core-surface temperature differentials, ambient temperatures, and the core-ambient temperature differentials. The PA shall review the report and verify that there were no unreported temperature exceedances and that the forms remained in place until the core-ambient temperature differential was below 50°F for 24 consecutive hours.

9.4.8 EXCEEDANCE OF MAXIMUM ALLOWABLE TEMPERATURE OR TEMPERATURE DIFFERENTIAL

The SMO will take the following actions when the elements' maximum core temperatures or core-surface differential temperatures exceed maximum allowable values.

(1) Revoke the ***MCCP*** approval and notify the PA to instruct the Contractor to stop concrete placement. The Department may waive revocation of the ***MCCP*** when the exceedance of the element's maximum core temperature or core-surface differential temperature is not related to an inadequacy of the ***MCCP***.

(2) Review the Engineering Analysis Scope, submitted by the Contractor in response to the exceedance, in accordance with ***Specification Section 346***. Send comments and any suggested revisions of the proposed analysis to the PA.

(3) Review the revised ***MCCP*** submitted by the Contractor to ensure that it incorporates all the revisions required by the approved Engineering Analysis Report.

9.4.9 MASS CONCRETE FIELD REPORTS

The SMO will review the temperature data in the Mass Concrete Field Report for each mass concrete element and enter the data in the ***MCCP*** log maintained by the Mass Concrete Specialist.

9.4.10 FORMS

The Appendices of ***Materials Manual Section 9.4, Volume II*** contain the following ***MCCP***-related forms:

(1) Appendix A lists the required contents of the ***MCCP*** and contains the following table:

  (a) Table A-1. Maximum Concrete Placement Temperatures, Maximum Peak and Differential Temperatures, and Estimated Formwork Removal Ages

(2) Appendix B.1: Project Contact Information Table.

(3) Appendix B.2: Example Mass Concrete Field Report (To be Completed by the Contractor)

  (a) Appendix B.2.1: Example Mass Concrete Field Report.

  (b) Appendix B.2.2: Example Hourly Temperature Data.

  (c) Appendix B.2.3: Example Temperature Profiles.

(4) Appendix C.1: Adiabatic Temperature Data for Type I/II Portland Cement – Mix containing 665 lb/yd^3.

(5) Appendix C.2: Adiabatic Temperature Data for Type IL Portland Cement – Mix containing 665 lb/yd^3.

APPENDIX A

LIST OF ELEMENTS TO BE CAST

Table A-1 shows an example table of information on mass concrete elements to be cast

Table A-1. Elements to Be Cast Grouped by Element Type, Dimensions, Environmental Exposure, and Concrete Mix Design.

Group Element Type	Dimensions (ft) L × W × H or Diameter × H	Environmental Exposure Aggressiveness	Concrete Mix Design	Number of Identical Elements	Element ID
Footer	20'×20'×6'	Extreme	06-1234-12	4	BR12-P4-6-F1 to BR12-P4-6-F4

APPENDIX B
REQUIRED CONTENTS OF A MASS CONCRETE CONTROL PLAN

Table B-1 Shows an Example of the Required MCCP Contents and Shall be Completed by the Contractor.

Table B-1. Checklist for Required Contents of the ***MCCP***.

1. Project Information			
☐	1.01 Project name	☐	1.04 County
☐	1.02 FPID	☐	1.05 Location
☐	1.03 District		
2. Contact information to key personnel related to the project			
☐	2.01 Position	☐	2.04 Office phone
☐	2.02 Company	☐	2.05 Mobile phone
☐	2.03 First and last name	☐	2.06 Email address
3. Description of Mass Concrete elements			
☐	3.01 Sequential ID	☐	3.04 Environmental classification
☐	3.02 Quantity	☐	3.05 Casting procedure
☐	3.03 Dimensions (ft)	☐	3.06 Drawings for each element
4. Insulating System			
☐	4.01 Product/material		
☐	4.02 R-Value (Btu-in/(ft^2-h-°F)		
☐	4.03 Installation and use		
5. Instrumentation and Monitoring			
☐	5.01 Equipment specification		
☐	5.02 Quantity and location		
☐	5.03 Measures to avoid thermal shock		
6. Concrete Mix Design			
☐	6.01 Mix design number	☐	6.04 Name and percentage of each supplementary CM (% of total CM)
☐	6.02 Total cementitious material (CM) (lb)	☐	6.05 Cylinder compressive strength (psi)
☐	6.03 w/CM	☐	6.06 Surface Resistivity (kΩ-cm) - needed for Extremely Aggressive Environments
7. Temperature Model			
☐	7.01 Concrete and ambient temperatures (°F) at time of placement	☐	7.04 Equivalent cementitious materials content (lb/yd^3)
☐	7.02 Maximum core temperature and differential (°F) and times of occurrence (days/hours)	☐	7.05 Concrete diffusivity (ft^2/Day)
☐	7.03 Estimated form removal time (days/hours)	☐	7.06 Number of sensor pairs and their locations in each element type and size
8. Post cooling System			
☐	8.01 Ambient temperature (°F)	☐	8.08 Pipe material
☐	8.02 Water inlet temperature (°F)	☐	8.09 Flow rate (main meter) (gpm)
☐	8.03 Water outlet temperature (°F)	☐	8.10 Running time (days)
☐	8.04 Equivalent cylinder diameter (ft)	☐	8.11 System operation
☐	8.05 Number of loops	☐	8.12 Pipe layout drawings
☐	8.06 Length of each loop (ft)	☐	8.13 System pressure capacity at peak core temperature (psi)
☐	8.07 Nominal inside diameter of pipe (in)	☐	8.14 Pipe grouting specifications and procedure
Notes:			
1) Refer to contract documents for specifications and other requirements before preparing an MCCP.			
2) Verify if all items of the MCCP checklist are addressed before submitting it to SMO.			