MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
PRECAST CONCRETE CULVERTS UTILIZING SELF-CONSOLIDATING CONCRETE

STR:MJF 1 of 6 APPR:DMG:REL:01-23-24
FHWA:APPR:02-06-24

a. Description. This work consists of fabricating and erecting precast (prestressed and non-prestressed) concrete culverts using self-consolidating concrete (SCC) in accordance with the plans and section 406 of the Standard Specifications for Construction, except as modified in this special provision. Ensure all cast-in-place elements of the culvert are constructed with conventional concrete in accordance with section 406 of the Standard Specifications for Construction. The Contractor may elect to forego the use of SCC and use conventional concrete as specified in section 406 of the Standard Specifications for Construction and all relevant special provisions.

Ensure all fabrication is performed in facilities approved in accordance with the contract.

b. Submittals.

1. Job Mix Formula (JMF). Submit a JMF for the SCC in accordance with 20SP-708A - Quality Control and Acceptance of Structural Precast Concrete and this special provision to the Engineer for approval 21 calendar days prior to production. Approval of the JMF by the Engineer does not relieve the Contractor of the contractual obligation to meet the requirements of the contract, including this special provision.

2. SCC Quality Control (QC) Plan. Submit a SCC QC plan for the production and placement of SCC in accordance with 20SP-708A - Quality Control and Acceptance of Structural Precast Concrete and this special provision to the Engineer for approval 21 calendar days prior to production. Approval of the QC plan by the Engineer does not relieve the Contractor of the contractual obligation to meet the requirements of the contract, including this special provision. The SCC QC plan must additionally include, at a minimum:

A. Development of the mix design, which must include all the SCC mix design qualification requirements shown in Table 1 of this special provision.

B. Maximum time between charging mixer and placing concrete for mix designs utilizing retarding and non-retarding admixtures and different placing units (open-top truck, open-top agitating units, close top agitating units, and truck mixers).

C. Trial placement plan including a shop drawing of the mock-up.

D. SCC production procedure.

E. SCC placement procedure.

F. SCC Certified Testing Technician. Ensure all testing of SCC is performed by an

ACI certified self-consolidating concrete technician.

G. Establish QC action and suspension limits for all fresh concrete tests. Ensure a QC inspector is present to witness all concrete placement and have the responsibility and authority to direct production personnel to meet the requirements of this special provision and the fabricator's SCC QC Plan.

H. Technical Representative(s) Qualifications. Submit documentation demonstrating that the technical representative(s) has(have) a minimum of 5 years of experience designing and placing SCC and has successfully completed a minimum of 3 similar projects in that time.

Ensure the technical representative is completely competent in all aspects of the work, including mix design, batching procedure, placement, curing, and testing of the SCC. The documentation must contain, at a minimum, the following:

(c) Years of experience with SCC.

(2) Project location.

(3) Project construction date.

(4) SCC quantities and culvert dimensions.

(5) Reference name and contact information for owner representative.

Ensure the technical representative is on site during the SCC trial batches and trial placement, and all SCC productions and placements. After a minimum of three successful projects, the technical representative may perform these duties remotely.

Ensure the fabricator's admixture company's technical representative is present for the trial placement.

c. Materials. Furnish materials in accordance with subsection 406.02 of the Standard Specifications for Construction and project special provisions (e.g., 20SP-708A – Quality Control and Acceptance of Structural Precast Concrete, 20SP-406B – Revisions to Precast Three-Sided, Arch, and Box Culverts, etc.), except as modified in this special provision.

Optimize aggregate gradation in accordance with the contract.

1. Cementitious Materials. The fabricator may use supplementary cementitious materials meeting the requirements of section 901 of the Standard Specifications for Construction.

2. Fine Aggregates. Use natural sand (2NS) in accordance with section 902 of the Standard Specifications for Construction and this special provision. Ensure variations in fineness modulus do not vary by more than ±0.20 from the approved mix design. Ensure fine aggregate is a minimum of 45 percent of the total aggregate content.

3. Intermediate Aggregate. Use intermediate aggregate meeting the physical requirements of coarse aggregates in subsection 406.02 of the Standard Specifications for

Construction.

4. Coarse Aggregate. Use coarse aggregate meeting the requirements of subsection 406.02 of the Standard Specifications for Construction and project special provisions. Do not use slag aggregate. The use of Class 26A coarse aggregate in the concrete mix design requires 25 to 40 percent of the cement, by weight, to be replaced with Grade 100 slag cement.

5. Self-Consolidating Concrete (SCC). The mix design for SCC is the responsibility of the fabricator and their technical representative. Follow the mix design and documentation procedure as specified in subsection c.5 of 20SP-708A – Quality Control and Acceptance of Structural Precast Concrete. Proportion and mix cementitious materials, aggregate, admixtures, and water in a batch mixer producing homogeneous concrete. The SCC must meet the requirements of Table 1 of this special provision and the strength requirements of the contract. Do not exceed a water/cementitious materials ratio of 0.45.

A. Job Mix Formula. Use Method 1 described in subsection c.5.B.1.(a) of 20SP-708A – Quality Control and Acceptance of Structural Precast Concrete for verification of the JMF prior to production and include the additional testing specified in Table 1. SCC must meet all the specification requirements to pass mix design verification.

Table 1: SCC Mix Design Specifications

Characteristic	Test Method	Specification
Slump Flow (inches)(b)	*ASTM C1611/C1611M* (including Appendix)	26 ±2
Flow Rate, T_{20} (seconds)	*ASTM C1611/C1611M* (including Appendix)	2-7
Visual Stability (max)©	*ASTM C1611/C1611M* (including Appendix)	1
J-Ring Flow (max, inches)(b)	*ASTM C1621/C1621M*	2
Column Segregation, Static (max, %)(a)	*ASTM C1610/C1610M*	10
Static Segregation Resistance, Penetration (max, mm)	*ASTM C1712*	10
a. Test only required for JMF verification, Trial Batching and first load of trial placement. b. Use the inverted slump cone method. c. Provide photographic documentation to the Engineer.		

Culverts with a clear span length measured parallel to the roadway centerline 20 feet and greater will be accepted based on “Fabrication Inspection” in accordance with the *MQAP Manual*. Culverts with a clear span length measured parallel to the roadway centerline from 10 feet up to 20 feet may be accepted based on “Fabrication Inspection” in accordance with the *MQAP Manual*.

d. Trial Batches and Mock-Up. Prior to fabrication of the culvert, provide trial batches and construct a trial placement to verify the mix production, equipment, materials, placement, consolidation, appearance, and fabrication. The Contractor must provide the Engineer and the Bureau of Bridges and Structures Structural Fabrication Unit at least 21 calendar days prior to the date and time of trial batching and trial placement.

Send notification to the Structural Fabrication Unit using the following email resource:

MDOT-StructuralFabrication@michigan.gov

Successfully complete all trial batches and trial placement, as determined by the Engineer, at least 30 calendar days prior to production. Do not begin production without the trial batches and trial placement being approved by the Engineer.

No extension of time will be issued for an inability to obtain an approved trial batch and trial placement.

1. Trial Batches. Furnish trial batch concrete in accordance with the approved JMF. Conduct at least two batches of SCC for verifying slump flow limits. One batch is to be at the lower specification limit for slump flow and one batch is to be at the upper specification limit for slump flow.

Trial batching is a one-time requirement for each mix design and for each fabricator location. Additional trial batching is not required for each project unless the mix design has changed in accordance with 20SP-708A - Quality Control and Acceptance of Structural Precast Concrete.

All trial batch concrete must meet the requirements of Table 1 and pass all applicable fresh concrete test requirements in the contract to be approved.

2. Trial Placement. Ensure culvert products are qualified through a successful trial placement. Include information about the mock-up in the trial placement plan. Design the mock-up to meet plant safety and destructive testing (saw cutting and coring) requirements specified in this special provision.

Trial placement is a one-time requirement to qualify the fabricator for a specific culvert geometry (shape), height, and length combination as specified below. Additional trial placements are not required for each project unless the project requirements are outside of the previous trial placement qualifications.

All trial placed concrete must meet the requirements of Table 1 and pass all applicable fresh concrete test requirements in the contract to be approved.

Construct the mock-up to comply with the following requirements:

A. Product.

(1) Geometry. Ensure one culvert shape (box, three-sided, box-arch, arch, etc.) is successfully qualified by trial placement. Approval of any culvert shape qualifies the fabricator for the other shapes.

(2) Rise. Mock-up culvert rise (measured perpendicular to the forms) preapproves the fabricator for a production culvert opening rise equal to two times the mock-up rise or less.

(3) Span. Mock-up culvert span (measured perpendicular to the forms) preapproves the fabricator for a production culvert span equal to two times the mock-up span or less.

(4) Segment Width. Mock-up culvert width (form height for pour) preapproves the fabricator for a production culvert segment width equal to the mock-up height plus 12 inches or less.

(5) Reinforcement. Construct the mock-up using the same reinforcement (bar, wire welded reinforcement, and strand) expected for the project. Mock-up reinforcement density preapproves the fabricator for a production reinforcement density equal to the mock-up plus 20 percent more steel area.

(6) Embeds. Construct the mock-up using the same anchor plates, inserts, lifting devices, and other embeds expected in the project.

B. Concrete. Furnish trial placement concrete in accordance with the approved JMF. Furnish enough trial placement concrete to cast the trial placement element and perform all verification testing. Perform trial placement under the same conditions as anticipated during fabrication.

C. Approval. Construct the mock-up free of defects including, but not limited to:

(1) Honeycombing;

(2) Bugholes;

(3) Inconsistency in appearance;

(4) Lack of consolidation;

(5) Evidence of segregation; and

(6) Cracking.

Furnish coring and saw cutting as directed by the Engineer to investigate consolidation and segregation. Saw cutting must include, at a minimum, a cross-sectional cut 1 foot from the culvert corner.

If the Engineer determines the trial placement is not satisfactory, adjust construction techniques and construct additional trial placements until an acceptable trial placement is produced. All costs associated with trial placements beyond the first will be borne by the Contractor. Use the approved test specimen as a measure of the quality for the remaining work.

e. Construction. Fabricate and erect the culvert in accordance with subsection 406.03 of the Standard Specifications for Construction, except as modified in this special provision.

1. Prior to production, the Department will conduct a one-time preparation assessment of the facility to ensure that the facility is adequately prepared for production of SCC. This may include, but not be limited to, assessment of QC personnel, ensuring adequate supply of materials, and cleanliness of forms.

2. Concrete. Place concrete to avoid material segregation and reinforcement

displacement. Do not allow concrete to freefall more than 12 inches to the top of the forms. Place concrete in a way that ensures new concrete is only placed on concrete already in the forms.

The use of racking, shoveling, pushing, and vibrators (internal and external) are prohibited.

Maintain forms, reinforcing steel, and placing equipment clean and free of hardened concrete. Ensure there is not excessive form oil on the forms prior to placement.

Do not disturb forms or projecting reinforcement after the initial set of the concrete.

Do not perform any repairs until the culvert components (segments, headwall, wingwalls, and anchors) are inspected by Quality Assurance (QA).

Place concrete from the time batching begins to full discharge within the time frame specified in the fabricator's QC Plan.

3. Acceptance of Material.

A. Quality Assurance. Furnish access to the Engineer for fabrication inspection of culvert sections. Notify the Engineer a minimum of 14 calendar days prior to start of fabrication. This inspection is not considered a substitute for the fabricator's QC requirements as stated herein.

B. Testing and Acceptance of SCC. Perform tests for slump flow, flow rate, visual stability, J-ring flow, and static segregation resistance in accordance with Table 1 of this special provision in addition to fresh concrete quality tests (except slump test, *ASTM C143/C143M*) in accordance with 20SP-708A - Quality Control and Acceptance of Structural Precast Concrete for the first load of each production day and each sublot.

Fabricate test specimens in accordance with *ASTM C1758/C1758M*, *Standard Practice for Fabricating Test Specimens with Self-Consolidating Concrete*. Fabricate the number of specimens for each sublot in accordance with 20SP-708A - Quality Control and Acceptance of Structural Precast Concrete.

C. Cold joints are prohibited.

f. Measurement and Payment. The completed work, as described, will not be paid for separately but will be included in the associated pay item(s) in accordance with subsection 406.04 of the Standard Specifications for Construction.

Costs incurred for mix development, providing trial batches, mock-ups, coring and sawing of the mock-ups, providing the technical representative, and all other requirements of this special provision will not be paid for separately.

The Department will not allow additional compensation for costs incurred in the certification of the concrete fabrication plant or claims by the Contractor for delays or costs associated with plant certification.