



**DEVELOPMENTAL SPECIFICATIONS  
FOR  
PRECAST REINFORCED CONCRETE THREE-SIDED CULVERT**

**Effective Date  
October 17, 2023**

**THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.**

**23010.01 DESCRIPTION.**

This specification is for precast concrete three-sided culverts constructed on site-cast concrete footings or a full width site-cast concrete floor. Precast reinforced concrete three sided culvert shall be fabricated in accordance with [Materials I.M. 445](#) by an approved source in accordance with [Materials I.M. 445.02, Appendix A.](#)

**A. Designation.**

Precast reinforced concrete three-sided culvert units manufactured in accordance with this specification shall be designated by span and rise. Precast reinforced concrete culvert wingwalls and headwalls manufactured in accordance with this specification shall be designated by length, height, and deflection angle.

**B. Shop Drawings.**

1. Contractor shall submit design computations and shop drawings for review. These documents shall be signed and sealed by a Professional Engineer licensed in the State of Iowa and shall include the following:
  - Reactions at base of arch legs, and base of wingwalls,
  - Quantity and weight of anchor blocks at wingwalls,
  - Dimensions of arch, wingwalls, and anchor blocks at wingwalls,
  - Connection details at base of arch to footing and base of wingwall to footing,
  - Connection details of wingwall to arch, headwall to arch, and
  - Connection details between arch sections.
2. Fabrication shall not begin until review by Engineer is completed.

**23010.02 MATERIALS AND DESIGN.**

**A. Materials.**

Refer to [Section 2407](#) of the Standard Specifications.

**1. Steel Reinforcement.**

Reinforcing steel shall be in accordance with [Section 2404](#) of the Standard Specifications. Reinforcing steel for precast elements shall be fabricated and placed according to detailed shop drawings submitted by manufacturer.

**2. Hardware.**

Bolts and threaded rods for wingwall connections shall conform to ASTM A 307. Nuts shall conform to AASHTO M 292 (ASTM A 194) Grade 2H. Bolts, threaded rods, and nuts used in wingwall connections shall be mechanically zinc coated in accordance with ASTM B 695 Class 50. Structural Steel for wingwall connection plates and plate washers shall conform to AASHTO M 270 (ASTM A 709) Grade 36 and shall be hot dip galvanized as per AASHTO M 111 (ASTM A 123). Wingwalls shall be connected with bolted steel plates meeting the above specifications. Hook Bolts used in attached headwall connections shall be ASTM A 307. Mechanical splices for reinforcing bars shall be in accordance with [Materials I.M. 451 Appendix E](#).

**B. Design.**

**1. Minimum Stresses.**

Precast element dimensions and reinforcement details shall be as prescribed in plans and shop drawings provided by manufacturer, subject to provisions of Article DS-23010.02, C. Minimum concrete compressive strength shall be 4000 psi. Minimum steel yield strength shall be 60,000 psi.

**2. AASHTO Specification.**

Precast elements shall be designed in accordance with "AASHTO LRFD Bridge Design Specifications", 5th Edition, adopted by AASHTO, 2010. Minimum of 1 foot cover above crown of culvert units is required in the installed condition (unless noted otherwise on the shop drawings and designed accordingly). Design live load shall be HL-93.

**3. Placement of Reinforcement in Precast Culvert Units.**

Cover of concrete over outside circumferential reinforcement shall be 2 inches minimum. Cover of concrete over inside circumferential reinforcement shall be 1.5 inches minimum, unless otherwise noted on shop drawings. Clear distance of end circumferential wires shall not be less than 1 inch or more than 2 inches from ends of each section. Reinforcement shall be assembled utilizing single or multiple layers of welded wire reinforcing (not to exceed three layers) supplemented with a single layer of deformed billet-steel bars, when necessary. Welded wire reinforcing shall be composed of circumferential and longitudinal wires meeting spacing requirements of Article DS-23010.02, B, 6, and shall contain sufficient longitudinal wires extending through culvert unit to maintain shape and position of reinforcement. Longitudinal distribution reinforcement may be welded wire reinforcing or deformed billet-steel bars and shall meet spacing requirements of Article DS-23010.02, B, 6. Ends of longitudinal distribution reinforcement shall not be more than 3 inches or less than 1.5 inches (38 mm) from ends of culvert unit.

**4. Placement of Reinforcement for Precast Wingwalls and Headwalls.**

Cover of concrete over longitudinal and transverse reinforcement shall be 2 inches minimum. Clear distance from end of each precast element to end transverse reinforcing steel shall not be less than 1 inch or more than 2 inches. Reinforcement shall be assembled using a single layer of welded wire reinforcing or single layer of deformed billet-steel bars. Welded wire reinforcing shall be composed of transverse and longitudinal wires meeting the spacing requirements of Article DS-23010.02, B, 6, and shall contain sufficient longitudinal wires extending through the element to maintain shape and position of reinforcement. Longitudinal reinforcement may be welded wire reinforcing or deformed billet-steel bars and shall meet spacing requirements of Article DS-23010.02, B, 6. Ends of longitudinal reinforcement shall be not more than 3 inches or less than 1.5 inches from the ends of the walls.

**5. Laps, Welds, and Spacing for Precast Culvert Units.**

Tension splices in circumferential reinforcement shall be made by lapping. Overlap shall meet requirements of AASHTO 5.11.2. Overlap for welded wire reinforcing shall be measured between outermost longitudinal wires of each fabric sheet. For splices other than tension splices, Overlap shall be a minimum of 12 inches for welded wire reinforcing or deformed billet-steel bars. Spacing center-to-center of circumferential wires in a wire reinforcing sheet shall be not less than 2 inches or more than 4 inches. Spacing center-to-center of longitudinal wires shall not be more than 8 inches. Spacing center-to-center of longitudinal distribution steel for either line of reinforcing in top slab shall be not more than 16 inches.

**6. Laps, Welds, and Spacing for Precast Wingwalls and Headwalls.**

Splices in reinforcement shall be made by lapping. Overlap shall meet requirements of AASHTO 5.11.2. Spacing center-to-center of wires in a wire reinforcing sheet shall be not less than 2 inches or more than 8 inches.

**7. Structural Design.**

Structural design shall consider the following assumptions:

- Foundation design shall consider lateral forces caused by arching action.
- Culvert leg to footing connection shall not transfer design moments. Vertical and horizontal force components shall be resisted by the footing.
- Wingwall to footing connection shall not transfer design moments. Anchor block system shall resist soil overturning forces. Wingwall footings shall not be designed to resist soil overturning forces.
- Headwall connections and wingwalls shall be designed for sliding and overturning.
- Continuity shall exist between main structure footing and wingwall footing.

**C. Tolerances.****1. Culvert Units.****a. Internal Dimensions.**

Internal dimensions shall vary not more than 1% from design dimensions or more than 1.5 inches, whichever is less. Haunch dimensions shall vary not more than 0.75 inches from design dimension.

**b. Slab and Wall Thickness.**

Slab and wall thicknesses shall not be less than that shown in the design by more than 0.25 inch. A thickness more than that required in the design will not be cause for rejection.

**c. Length of Opposite Surfaces.**

Variations in laying lengths of two opposite surfaces of culvert unit shall not be more than 0.50 inch in any section, except where beveled ends for laying of curves are specified on the contract documents.

**d. Length of Section.**

Underrun in laying length of a section shall not be more than 0.50 inches in any culvert unit.

**e. Position of Reinforcement.**

Maximum variation in position of reinforcement shall be  $\pm 0.50$  inches. In no case shall cover over reinforcement be less than 1.50 inches for outside circumferential steel or less than 1 inch for inside circumferential steel as measured to external or internal surface of culvert. These tolerances or cover requirements do not apply to mating surfaces of joints.

**f. Area of Reinforcement.**

Areas of steel reinforcement shall be the design steel areas shown on manufacturer's shop drawings. Steel areas greater than those required will not be cause for rejection. Permissible variation in diameter of reinforcement shall conform to tolerances prescribed in the ASTM specifications for that type of reinforcement.

**2. Wingwalls and Headwalls.**

**a. Wall Thickness.**

Wall thickness shall not vary from that shown in the design by more than 0.50 inches

**b. Length / Height of Wall sections.**

Length and height of wall shall not vary from that shown in the design by more than 0.50 inches.

**c. Position of Reinforcement.**

Maximum variation in position of reinforcement shall be  $\pm 0.50$  inches. In no case shall cover over reinforcement be less than 1.50 inches.

**d. Size of Reinforcement.**

Permissible variation in diameter of reinforcing shall conform to tolerances prescribed in the ASTM specification for that type of reinforcing. Steel area greater than that required will not be cause for rejection.

**23010.03 CONSTRUCTION.**

**A. Footings.**

Culvert units and wingwalls shall be installed on cast-in-place concrete footings. Design size and elevation of footings shall be as shown on the plans. Keyways shall be compatible with precast arch system. A keyway shall be formed in top surface of footing and 3 inches minimum clear of inside and outside faces of culvert units, unless specified otherwise on the plans. Footings shall be given a smooth float finish and shall reach a compressive strength of at least 2000 psi before placement of culvert and wingwall elements. Completed footing surface shall be constructed in accordance with grades shown on the plans. When tested with a 10 foot straight edge, the surface shall not vary more than 0.25 inches in 10 feet.

**B. Placement of the Culvert Units, Wingwalls, and Headwalls.**

Culvert units, wingwalls, and headwalls shall be placed as shown on the plans. Special care shall be taken in setting elements to true line and grade. Culvert units and wingwalls shall be set on 6 inch by 6 inch steel shims. A minimum of 0.50 inches gap shall be provided between footing and bottom of the culvert's vertical legs or wingwall. This gap shall be filled with non-shrink cement grout with a minimum 28 day compressive strength of 4000 psi and shall comply with [Materials I.M. 491.13](#).

**C. External Protection of Joints.**

1. Butt joints made by two adjoining culvert units shall be covered with a 7/8 inch by 1 3/8 inch piece of preformed bituminous joint sealant and a minimum of a 24 inch wide joint wrap of engineering fabric. Engineering fabric shall be in accordance with [Article 4196.01, B, 3](#), of the Standard Specifications, and centered on joint. Surface shall be free of dirt before applying joint material. A primer compatible with the joint wrap shall be applied for a minimum width of 12 inches to each side of joint. Joint shall be covered continuously from bottom of one culvert section leg, across top of arch and to opposite culvert section leg. Laps that result in joint wrap shall be a minimum of 6 inches long with overlap running downhill.
2. In addition to joints between culvert units, the joint between end culvert unit and headwall shall be sealed as described above. If precast wingwalls are used, joint between end culvert unit and wingwall shall be sealed with a 24 inch wide strip of engineering fabric. If lift holes are formed in arch units, they shall be plugged with a concrete or plastic plug and primed and covered with a 12 inch by 12 inch square of engineering fabric.

**D. Joints.**

Culvert units shall be produced with flat butt ends. Ends of culvert units shall be such that when sections are laid together they make a continuous line with a smooth interior free of appreciable irregularities, all compatible with permissible variations in Article DS-23010.02, C. Joint width shall not exceed 0.75 inches.

**23010.04 METHOD OF MEASUREMENT.**

- A. Precast Concrete Three-Sided Culvert.**  
Linear feet (meters) as shown on plans.
- B. Precast Concrete Wingwalls.**  
Number of wingwalls as shown on plans.

**23010.05 BASIS OF PAYMENT.**

- A. Precast Concrete Three-Sided Culvert.**  
Payment will be the contract unit price per linear foot for the number of linear feet constructed in a satisfactory manner. Bid items will be specified by span and rise. Payment will be full compensation for providing equipment; materials including concrete, reinforcing steel, connecting plates, bolts, non-shrink grout, material testing, tools, and shipping; and incidentals necessary to construct culvert and headwalls.
- B. Precast Concrete Wingwalls.**  
Payment will be the contract unit price for each wingwall constructed in a satisfactory manner. Payment will be full compensation for providing equipment; materials including concrete, reinforcing steel, connecting plates, bolts, non-shrink grout, material testing, tools, shipping, and labor; and incidentals necessary to construct wingwalls.