

**Supplemental Specifications to the  
Standard Specifications for Road and Bridge Construction, 2019 Edition  
Effective with the July 26, 2019 Letting**

<b>Section:</b>	615 PRECAST THREE SIDED STRUCTURES
<b>Revision:</b>	Insert complete Section 615

## SECTION 615 PRECAST THREE SIDED STRUCTURES

**615.01 DESCRIPTION.** This work shall consist of constructing precast concrete three sided units for culverts, storm sewers, tunnels, arch bridges, etc. in accordance with these specifications and in reasonably close conformity with the lines, grades, design and dimensions shown on the plans or as established by the Engineer. In situations where two or more specifications apply to this work, the most stringent requirements shall govern.

**615.02 TYPES.** Precast reinforced concrete units manufactured in accordance with this specification shall be designated by span and rise. Precast reinforced concrete endwalls manufactured in accordance with this specification shall be designated by length and height.

**615.03 MATERIALS – CONCRETE.** The concrete for the structures shall be air-entrained when installed in areas subject to freeze-thaw conditions, composed of Portland cement, fine and coarse aggregates, admixtures and water. Air-entrained concrete shall contain  $6 \pm 2$  percent air. The air entraining admixture shall conform to AASHTO M154.

**615.03.01 Portland Cement.** Shall conform to the requirements of ASTM Specifications C150-Type I, Type II, or Type III cement.

**615.03.02 Coarse Aggregate.** Shall consist of stone having a maximum size of 1 inch. Aggregate shall meet requirements for ASTM C33.

**615.03.03 Water Reducing Admixture.** The manufacturer may submit for approval by the Engineer, a water-reducing admixture for the purpose of increasing workability and reducing the water requirement for the concrete.

**615.03.04 Calcium Chloride.** The addition to the mix of calcium chloride or admixtures containing calcium chloride will not be permitted.

**615.04 MATERIALS – STEEL REINFORCEMENT AND HARDWARE.** All reinforcing steel for the structures shall be fabricated and placed in accordance with the detailed shop drawings submitted by the manufacturer.

**615.04.01 Steel Reinforcement.** Reinforcement shall consist of welded wire fabric conforming to ASTM Specification A 185 or A 497, or deformed billet steel bars conforming to ASTM Specification A 615, Grade 60. Longitudinal distribution reinforcement may consist of welded wire fabric or deformed billet-steel bars.

**615.04.02 Hardware.** Inserts for endwall connections shall be AISI Type 304 stainless steel, F-58 Expanded Coil inserts. Coil rods and nuts used in endwall connections shall be AISI Type 304 stainless steel. Washers used in endwall connections shall be AISI Type 304 stainless steel plate washers. Or Equals  
Reinforcing bar splices shall be made using the Dowel Bar Splicer System, and shall consist of the Dowel Bar Splicer (DB-SAE) and Dowel-In(DI) or equal system.

Hook Bolts used in endwall connections shall be ASTM A 307.

### 615.05 MANUFACTURE.

**615.05.01 Mixture.** The aggregates, cement and water shall be proportioned and mixed in a batch mixer to produce a homogeneous concrete meeting the strength requirements of this specification. The proportion of Portland cement in the mixture shall not be less than 564 pounds (6 sacks) per cubic yard of concrete.

**615.05.02 Curing.** The precast concrete units shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength in 28 days or less. Any one of the following methods of curing or combinations thereof shall be used:

**A) Steam Curing.** The units may be low pressure, steam cured by a system that will maintain a moist atmosphere.

**B) Water Curing.** The units may be water cured by any method that will keep the sections moist.

**C) Membrane Curing.** A sealing membrane conforming to the requirements of ASTM Specification C 309 may be applied and shall be left intact until the required concrete compressive strength is attained. The concrete temperature at the time of application shall be within  $\pm 10$  degrees F of the atmospheric temperature. All surfaces shall be kept moist prior to the application of the compounds and shall be damp when the compound is applied.

**615.05.03 Forms.** The forms used in manufacturing shall be manufactured steel forms and accurate to maintain the structure dimensions within the permissible variations given in Section 7 of these specifications. All casting surfaces shall be of a smooth material.

**615.05.04 Handling.** Handling devices or holes shall be permitted in each unit for the purpose of handling and setting.

**615.05.05 Storage.** The precast elements shall be stored in such a manner to prevent cracking or damage. The units shall not be moved until the concrete compressive strength has reached a minimum of 2500 psi, and they shall not be stored in an upright position until the concrete compressive strength is a minimum of 4,000 psi.

**615.05.06 Weep holes.** Place weep holes consisting of 4-inch pipe or formed to 4 inches in diameter in each precast unit. Fabric wrapped perforated pipe drains may be used in retaining walls in place of weep holes. Place the outlet invert elevation of weep holes in box culverts 4 inches above the flowline of the structure. Raise weep holes to accommodate significant silting when the Engineer directs. Make adequate provisions for thorough drainage of backfill and embankment according to Subsection 603.03.

## **615.06 DESIGN.**

**615.06.01.** Obtain the precast concrete 3-sided structure and endwalls from a pre-approved manufacturer list maintained by the Division of Highway Design. The precast element dimension and reinforcement details shall be as prescribed in the plan and the shop drawings provided by the manufacturer, subject to the provisions of Section 7, below. The minimum concrete compressive strength shall be as shown on the shop drawings. The minimum steel yield strength shall be 60,000 psi, unless otherwise noted on the shop drawings.

The manufacturer shall submit a pdf copy of the Working Drawings, Shop Drawings, and Structural Design Calculations to the Department for review and approval prior to manufacturing the precast 3-Sided units or endwalls.

**615.06.02.** The precast elements shall be designed in accordance with KYHL-93. A minimum of one foot of cover is required. "Cover" is defined as the area from the top of structure to the top of finished roadway, along the entire length of structure over the driving lanes and shoulder. (Unless noted otherwise on the shop drawings, designed accordingly, and approved by this Department). The ends of units shall be normal to walls and centerline except exposed edges shall be beveled  $\frac{3}{4}$  inch.

**615.06.03 Placement of Reinforcement in Precast 3-Sided Units.** The cover of concrete over the outside circumferential reinforcement shall be 2 inches minimum. The

cover of concrete over the inside circumferential reinforcement shall be 1 1/2 inches minimum, unless otherwise noted on the shop drawings. The clear distance of the end circumferential wires shall not be less than one inch nor more than two inches from the ends of each section. Reinforcement shall be assembled utilizing single or multiple layers of welded wire fabric (not to exceed 3 layers), supplemented with a single layer of deformed billet-steel bars, when necessary. Welded wire fabric shall be composed of circumferential and longitudinal wires meeting the spacing requirements of 615.06.06, below, and shall contain sufficient longitudinal wires extending through the vault unit to maintain the shape and position of the reinforcement. Longitudinal distribution reinforcement may be welded wire fabric or deformed billet-steel bars and shall meet the spacing requirements of 615.06.06, below. The ends of the longitudinal distribution reinforcement shall be not more than 3 inches and not less than 1 1/2 inches from the ends of the unit.

**615.06.04 Placement of Reinforcement for Precast Endwalls.** The cover of concrete over the longitudinal and transverse reinforcement shall be 2 inches minimum. The clear distance from the end of each precast element to the end transverse reinforcing steel shall not be less than one inch nor more than two inches. Reinforcement shall be assembled utilizing a single layer of welded wire fabric, or a single layer of deformed billet-steel bars. Welded wire fabric shall be composed of transverse and longitudinal wires meeting the spacing requirements of 615.06.07, below, and shall contain sufficient longitudinal wires extending through the element to maintain the shape and position of the reinforcement. Longitudinal reinforcement may be welded wire fabric or deformed billet-steel bars and shall meet the spacing requirements of 615.06.07, below. The ends of the longitudinal reinforcement shall be not more than 3 inches and not less than 1 1/2 inches from the ends of the walls.

**615.06.05 Bending of Reinforcement for Precast 3-Sided Units.** The outside and inside circumferential reinforcing steel for the corners of the structure shall be bent to such an angle that is approximately equal to the configuration of the structures outside corner.

**615.06.06 Laps, Welds, and Spacing for Precast 3-Sided Units.** Tension splices in the circumferential reinforcement shall be made by lapping. Laps may not be tack welded together for assembly purposes. For smooth welded wire fabric, the overlap shall meet the requirements of AASHTO 2012 Bridge Design Guide Section 5.11.2.5.2 and AASHTO 2012 Bridge Design Guide Section 5.11.6.3. For deformed welded wire fabric, the overlap shall meet the requirements of AASHTO 2012 Bridge Design Guide Section 5.11.2.5.1 and AASHTO 2012 Bridge Design Guide Section 5.11.6.2. The overlap of welded wire fabric shall be measured between the outer most longitudinal wires of each fabric sheet. For deformed billet-steel bars, the overlap shall meet the requirements of AASHTO 2012 Bridge Design Guide Section 5.11.2.1. For splices other than tension splices, the overlap shall be a minimum of 12" for welded wire fabric or deformed billet-steel bars. The spacing center to center of the circumferential wires in a wire fabric sheet shall be no less than 2 inches and no more than 4 inches. The spacing center to center of the longitudinal wires shall not be more than 8 inches. The spacing center to center of the longitudinal distribution steel for either line of reinforcing in the top slab shall be not more than 16 inches.

**615.06.07 Laps, Welds, and Spacing for Precast Endwalls.** Splices in the reinforcement shall be made by lapping. Laps may not be tack welded together for assembly purposes. For smooth welded wire fabric, the overlap shall meet the requirements of AASHTO 2012 Bridge Design Guide Section 5.11.2.5.2 and AASHTO 2012 Bridge Design Guide Section 5.11.6.3. For deformed welded wire fabric, the overlap shall meet the requirements of AASHTO 2012 Bridge Design Guide Section 5.11.2.5.1 and AASHTO 2012 Bridge Design Guide Section 5.11.6.2. For deformed billet-steel bars, the overlap shall meet the requirements of AASHTO 2012 Bridge Design Guide Section 5.11.2.1. The

spacing center-to-center of the wire fabric sheet shall not be less than 2 inches or more than 8 inches.

## **615.07 PERMISSIBLE VARIATIONS.**

### **615.07.01 Precast 3-Sided Units.**

**A) Internal Dimensions.** The internal dimension shall vary not more than 1% from the design dimensions nor more than 1-1/2 inches whichever is less. The haunch dimensions shall vary not more than 3/4 inch from the design dimension.

**B) Slab and Wall Thickness.** The slab and wall thickness shall not be less than that shown in the design by more than 1/4 inch. A thickness more than that required in the design shall not be cause for rejection.

**C) Length of Opposite Surfaces.** Variations in laying lengths of two opposite surfaces of the vault unit shall not be more than 1/2 inch in any section, except where beveled ends for laying of curves are specified by the purchaser.

**D) Length of Section.** The underrun in length of a section shall not be more than 1/2 inch in any vault unit.

**E) Position of Reinforcement.** The maximum variation in position of the reinforcement shall be  $\pm 1/2$  inch. In no case shall the cover over the reinforcement be less than 1 1/2 inches for the outside circumferential steel or be less than 1 inch for the inside circumferential steel as measured to the external or internal surface of the vault. These tolerances or cover requirements do not apply to mating surfaces of the joints.

**F) Area of Reinforcement.** The areas of steel reinforcement shall be the design steel areas as shown in the manufacturer's shop drawings. Steel areas greater than those required shall not be cause for rejection. The permissible variation in diameter of any reinforcement shall conform to the tolerances prescribed in the ASTM Specification for that type of reinforcement.

### **615.07.02 Endwalls.**

**A) Wall Thickness.** The wall thickness shall not vary from that shown in the design by more than 1/2 inch.

**B) Length/ Height of Wall sections.** The length and height of the wall shall not vary from that shown in the design by more than 1/2 inch.

**C) Position of Reinforcement.** The maximum variation in the position of the reinforcement shall be  $\pm 1/2$  inch. In no case shall the cover over the reinforcement be less than 1 1/2 inches.

**D) Size of Reinforcement.** The permissible variation in diameter of any reinforcing shall conform to the tolerances prescribed in the ASTM Specification for that type of reinforcing. Steel area greater than that required shall not be cause for rejection.

## **615.08 TESTING AND INSPECTION.**

**615.08.01 Type of Test Specimen.** Start-up slump, air content, unit weight, and temperature tests will be performed each day on the first batch of concrete. Acceptable start-up results are required for production of the first unit. After the first unit has been established, random acceptance testing is performed daily for each 50 yd<sup>3</sup> (or fraction thereof). In addition to the slump, air content, unit weight, and temperature tests, a minimum of one set of cylinders shall be required each time plastic property testing is performed.

**615.08.02 Compression Testing.** Cylinders shall be made and tested as prescribed by the ASTM C 39 Specification.

**615.08.03 Acceptability of Cylinder Tests.** When the average compressive strength of all cylinders tested is equal to or greater than the design compressive strength, and not more than 10% of the cylinders tested have a compressive strength less than the design concrete strength, and no cylinder tested has a compressive strength less than 80% of the design compressive strength, then the lot shall be accepted. When the compressive strength of the cylinders tested does not conform to this acceptance criteria, the acceptability of the lot may be determined as described in section 8.4, below.

**615.09 JOINTS.** Precast 3-sided units shall be produced with flat butt ends. The ends of the units shall be such that when the sections are laid together they will make a continuous line with a smooth interior free of appreciable irregularities, all compatible with the permissible variations in Section 7, above. The joint width shall not exceed 3/4 inches. Flat-top units with less than 2 ft. of cover shall be produced with a minimum 4" deep by 1.5" wide key way joint. Mortar in accordance with section 15.2 shall be placed in the keyway.

When the installed height of cover measures 2.0-feet or less, the precast 3-sided end units shall be connected by tie plates to the adjacent interior unit.

**615.10 WORKMANSHIP AND FINISH.** The precast units and endwalls shall be substantially free of fractures. The ends of the units shall be normal to the walls and centerline of the section, within the limits of the variations given in section 7, above, except where beveled ends are specified. The faces of the endwalls and units shall be parallel to each other, within the limits of variations given in section 7, above. The surface of the precast elements shall be a smooth steel form or troweled surface. Provide an ordinary surface finish.

**615.11 REPAIRS.** Precast elements may be repaired, if necessary, because of imperfections in manufacture or handling damage and will be acceptable if, in the opinion of the purchaser, the repairs are sound, properly finished and cured, and the repaired section conforms to the requirements of this specification.

**615.12 INSPECTION.** The quality of materials, the process of manufacture, and the finished structures shall be subject to Department guidelines, specifications, manuals, and other contract documents. Units will arrive at jobsite with the "Kentucky Oval" stamped on the unit which is an indication of acceptable inspection at the production facility. Units shall be inspected upon arrival for any evidence of damage resulting from transport to the jobsite.

**615.13 REJECTION.** The precast elements shall be subject to rejection on account of any of the specification requirements. Individual precast elements may be rejected because of any failure to meet specification and contract document requirements.

**615.14 MARKING.** Each unit shall be clearly marked by waterproof paint. The following shall be shown on the inside of the vertical leg of the section: Unit Span, Unit Rise, Date of Manufacture, and Name or trademark of the manufacturer. Units must also be stenciled as outlined in Standard Drawing BGX-006, current revision.

**615.15. CONSTRUCTION REQUIREMENTS.** Perform structure excavation in accordance with Section 603 except as noted in this Section.

**615.15.01 Site Preparation.** Perform Structure Excavation according to Section 603. The foundation design must be in accordance with the appropriate Geotechnical Notes in the project bid documents. Construct foundations in accordance with the foundation design as determined by the Engineer.

**615.15.02 Footings.** The precast 3-Sided units and endwalls shall be installed on either precast or cast-in-place concrete footings. The design size and elevation of the footings shall be as determined by the Engineer based on KYHL-93, the applicable Geotechnical Notes in the project bid documents such as bearing capacity requirements, specified scour countermeasures, and minimum differential settlement tolerance. In cases where a minimum differential settlement tolerance is not specified in the bid contract documents, the minimum differential settlement tolerance for the precast 3-sided structure shall be 1-inch. A minimum three inch deep keyway shall be formed in the top surface of the precast 3-sided unit footing at least three inches clear of the inside and outside faces of the bridge units, unless specified otherwise on the plans. The completed footing surface shall be constructed in accordance with grades shown on the plans. When tested with a 10 foot straight edge, the keyway surface shall not vary more than 1/4 inch in 10 feet. If a precast concrete footing is used, the contractor shall prepare a 4 inch thick base layer of compacted granular material the full width of the footing prior to placing the precast footing. The foundations for precast concrete 3-sided units and endwalls must be connected by reinforcement to form one monolithic body. Expansion joints shall not be used in lieu of a continuous foundation. Compressive cylinders must reach 2,000psi before precast units shall be set on the foundation. Compressive cylinder strength must reach 80% design strength before backfill operations shall begin.

**615.15.03 Placement of the Units and Endwalls.** The manufacturer shall provide a Technical Representative. The Technical Representative shall be available onsite while the contractor is setting the precast 3-sided structure and thereafter as determined necessary by the Engineer.

The units and endwalls shall be placed as shown on the Engineer's plan drawings. Special care shall be taken in setting the elements to the true line and grade. The units and endwalls shall be set on 6" x 6" masonite or steel shims. A minimum gap of 1/2 inch shall be provided between the footing and the bottom of the unit's vertical legs or the endwall. The gap shall be filled with non-shrink cement grout (Portland cement and water or cement mortar composed of Portland cement, sand and water). If units have been set with temporary ties (cables, bars, etc.) all pieces in the current phase must be completely grouted before ties may be removed.

**615.15.04 External Protection of Joints.** The butt-joint made by two adjoining units shall be covered with a 7/8" x 1 3/8" preformed bituminous joint sealant and a minimum of a 9 inch wide joint wrap. The surface shall be free of dirt before applying the joint material. A primer compatible with the joint wrap to be used shall be applied for a minimum width of nine inches on each side of the joint. The external wrap material shall meet AASHTO M198. The joint shall be covered continuously from the bottom of one unit section leg, across the top of the and to the opposite unit section leg. Any laps that result in the joint wrap shall be a minimum of six inches long with the overlap running downhill.

In addition to the joints between unit units, the joint between the end unit and the endwall shall also be sealed as described above. Also, if lift holes or lift inserts are formed in the units, they shall be plugged and grouted. During the backfilling operation, care shall be taken to keep the joint wrap in its proper location over the joint.

Internal Protection of Joints – In applications where the traveling public will be expected to cross under the structure (roadways, mixed use paths, sidewalks, etc.), or where specified in the contract documents, provide additional joint protection to ensure that the structure is water-tight. Various joint sealing details including elastomeric, urethane, or liquid sealing may be shown on the plans. Any internal joint sealing shall be performed as indicated on the shop drawings.

**615.15.05 Backfill.** Critical Backfill shall be clean, durable stone backfill that conform to the Structural Granular backfill requirements Section 805. Critical Backfill shall be paid as Structural Granular Backfill. The limits of Critical Backfill shall be 2 feet to the outside of each structure and from the top of the footing to 2 feet over the top of the structure for spans up to 24 feet. For spans greater than 24 feet, the limits of Critical Backfill shall be 4 feet to the outside of each structure and from the top of the footing to 2 feet over the top of the structure. Backfill shall be considered as all other replaced excavation and new embankment adjacent to the precast units and endwalls. The project construction and material specifications which include the specifications for excavation for structures and roadway excavation and embankment construction, shall apply except as modified in this section. Any backfill requirements of the manufacturer that are beyond the limits of the Department-specified critical backfill requirements shall be binding upon the Contractor but will not be measured for payment as they shall be considered incidental to the critical backfill quantity.

No backfill shall be placed against any structural elements until they have been approved by the Engineer. Backfill against external joint material or waterproofed surface shall be placed carefully to avoid damage to the waterproofing material. Mechanical tampers or approved compacting equipment shall be used to compact all backfill and embankment immediately adjacent to each side and over the top of each precast 3-sided unit until it is covered to a minimum depth of one foot, unless the design fill height is less than 1'-0". The backfill within the Critical Backfill Zone, as defined above, shall be placed in lifts of six inches or less (loose depth). Heavy compaction equipment shall not be operated in this area or over the bridge until it is covered to a depth of one foot, unless the design fill height is less than 1'-0".

Lightweight dozers and graders may be operated over precast units having one foot of compacted cover, but heavy earth moving equipment (larger than a D-4 Dozer weighing in excess of 12 tons and having track pressures of eight psi or greater) shall require two feet of cover unless the design cover is less than two feet. In no case shall equipment operating in excess of the design live load (KYHL-93) be permitted over the precast 3-sided units unless approved by the producer. Any additional fill and subsequent excavation required to provide this minimum cover shall be made at no additional cost to the project. As a precaution against introducing unbalanced stresses on the precast 3-sided units, when placing backfill at no time shall the difference between the heights of fill on opposite sides of the vault exceed 24". Once fill heights reach two feet over the top of structure, backfill as specified in Kentucky Standard Specifications Division 200.

**615.16 QUALITY ASSURANCE.** The Precast Supplier shall conform to the requirements for precast structures in Section 605 and the KYTC Division of Materials Precast & Prestress Concrete Manual.

The Precast Supplier shall be listed on the KYTC Division of Materials list of Approved Precast Concrete Producers.

**615.17 PAYMENT.** The Department will make payment for the completed and accepted quantities under the following:

<u>Code</u>	<u>Pay Item</u>	<u>Pay Unit</u>
21804EN	3-Sided Culvert Linear Foot	Linear Foot
02231	Structure Granular Backfill	Cubic Yard
08100	Concrete-Class A	Cubic Yard

08150	Steel Reinforcement	Pound
08003	Foundation Preparation	See Section 603
08002	Structure Excavation Solid Rock	See Section 603
08001	Structure Excavation Common	See Section 603
02203	Structure Excavation Unclassified	See Section 603
02200	Roadway Excavation	See Subsection 204.05
02230	Embankment in Place	See Subsection 206.05

The Department will consider payment as full compensation for all work required under this section.