

STATE

OF

TENNESSEE

(Rev. 12-18-14)

January 1, 2021

SPECIAL PROVISION

REGARDING

**THREE SIDED PRE-CAST CULVERT AND BRIDGE STRUCTURES OR PRE-CAST
ARCHES**

Description: This work shall consist of furnishing all materials, labor, tools, equipment and other necessary items required to design, fabricate, and install three sided pre-cast culvert and bridge structures, or pre-cast arches.

Design Submittal Guidelines

The Contractor's three-sided pre-cast culvert or arch culvert structure shall conform to the requirements of this Special Provision and the following design submittal guidelines:

- A. Structural: The Contractor is required to submit to the Division of Structures for approval a foundation report at each site, pre-cast structure design drawings, and design calculations. A Professional Engineer licensed in the State of Tennessee shall stamp all design drawings and calculations

The pre-cast system shall provide an equivalent or greater hydraulic opening as the cast-in-place or pre-cast structure specified in the contract plans along with an equivalent or greater hydraulic efficiency. Structures with less area of opening, a significantly different span to height ratio, submerged by design flood, or requiring an increase in proposed road grade when the design flood or 100 year flood overtops the road or structure located in a FEMA Flood Insurance Study will require submittal of a hydraulic analysis for review and approval. The hydraulic analysis should be submitted to the Hydraulics Section following TDOT Design Procedures for Hydraulic Structures or to the Design Division per TDOT Design Division Drainage Manual, if the 50 year flow is less than 500 cubic feet per second for the subject structure, the hydraulic design should be submitted to roadway design manager.

Roadway Design:

The proposed pre-cast system shall not affect the 13 controlling geometric design elements of the roadway. The proposed structure shall not require a Design Exception or need for any additional ROW or easement.

No changes on the roadway plans shall be made without an approval of the Design Division. Proposed changes on plans shall be prepared and stamped by an engineer prior to submittal to the Design Division for review.

Any minor change in roadside geometry such as, roadway side slopes, the distance from the outside edge of the traveled way to the inlet or outlet face of proposed structure, roadside ditch locations, relocation of guardrail and/or guardrail end terminals as well as any modifications in the clear zone should be submitted to the Design Division for review and approval.

- B. Currently there are five (5) systems that have been approved to be used on State Projects as long as **all** requirements of this Special Provision are satisfied. The five (5) systems are as follows:

CONSPAN Bridge System supplied by Contech Construction Products, Nashville TN

HYSpan Bridge System supplied by Permatile Concrete Products, Bristol TN/VA.

BEBO Bridge System supplied by Contech Construction Products, Nashville TN

AQUA-ARCH System supplied by Sherman Dixie, Nashville TN

REDI-SPAN System supplied by Tricon Pre-Cast, Houston TX

FOLEY ARCH System supplied by Foley Products Company, Newnan, GA 30263

Footnotes:

- a. Modifications made to the above Bridge Systems beyond the requirements of this Special Provision shall be approved before use on State Projects. These revised details shall be submitted to the Division Structures for review and Engineering Approval. Contractor shall allow a minimum of 3 weeks for review, comment and Approval of the changes by the Engineer before the system can be installed on the project.
- b. The Contractor shall be fully aware of the constructability of the proposed system he proposes. Due to the geometry and availability of sizes of the pre-cast units, some of the approved systems may be more sensitive to handling, installation, wing-wall requirements, and backfill and roadway sub grade placement. The systems are paid for in-place and the repair of any damage to the units that occurs during any phase of the installation shall be the sole responsibility of the Contractor.

The Contractor has the option to propose another pre-cast system. The Division Structures will have 60 days, after receipt of all pertinent information, to review and approve/disapprove any new system submitted by the Contractor.

- C. The construction or fabrication of the pre-cast units shall not begin until the pre-cast system has been approved by Division of Structures and/or Roadway Design Division. All approved pre-cast elements must be manufactured in a commercial pre-casting facility and fabricated under the purview of the Division of Materials and Tests inspectors.

FOUNDATION PROTECTION DESIGN PARAMETERS

The following are the requirements for foundation investigation, footing design, footing placement and scour protection:

- A) Adequate sub-surface investigation shall be provided at each site to determine the location of the rock line in the area of the proposed footings. The results of this investigation will determine the type of footing needed and the required scour protection (if required). If the Contractor elects to use one of the approved scour protection systems and place a strip footing on in-place material, a more detailed foundation investigation shall be performed at the site to determine the allowable bearing pressure and the predicted settlement of the underlying material. The Contractor at his own expense shall provide the foundation investigation, if not provided in the contract plans.
- B) A strip footing or pre-cast footing can be used if the footing is bearing on rock or adequate scour protection and bearing is provided for the footing. A strip footing not bearing on rock without an approved scour protection can only be used if the footing is placed below the 500-year scour elevation except as provided in (c), below. A scour investigation of the underlying material at the site of the culvert shall be undertaken by the Contractor to determine this probable scour depth if acceptable scour protection system will not be provided for the strip footing.
- C) The structure footings and wing-wall footings shall be founded on suitable material. A bottom slab is required when rock is not available or the footing cannot be reasonably placed below the 500-year scour elevation or an approved scour protection system is not provided. When a bottom slab is required, all unsatisfactory material shall be removed and replaced with satisfactory bearing material according to section 204.10 of the TDOT Road and Bridge Specifications before placement of slab. A cut-off wall will be provided at the inlet and outlet end of the structure and poured monolithically with the bottom slab.
- D) If a concrete box culvert with a bottom slab is specified on the contract plans, the bottom slab or the approved scour protection system shall be shown on the proposed pre-cast system drawings. All cost associated with the bottom slab or the approved scour protection system shall be included in the linear foot cost of the pre-cast system. If a concrete slab bridge is specified on the contract plans and the initial rod soundings at the site shows a change in conditions, the pre-cast system structure drawings shall be revised to either show a bottom slab or an approved scour protection system. The bottom slab will be paid according to Section 109.04 "Method of Payment for Extra Work" of the Standard Specifications. The extra work prices includes the cost of all forms, placement, reinforcing steel, concrete and all material and labor required for complete placement of the bottom slab. If an approved scour protection is used in lieu of a concrete slab, the Contractor will be paid for according Section 109.04. The cost of the scour protection shall be similar in the cost to the placement of a concrete slab.

- E) Strip footings on rock: The bottom of footing shall follow the rock surface along the wall line. Holes 1.5 inch in diameter and 2'6" in depth shall be drilled on 12-inch centers into competent rock. The holes shall be air blown to remove all debris and filled with non-shrink grout. All grouting material shall be approved by the Division Materials and Test and placed in the drilled holes as recommended by the grout manufacturer. If the hole cannot be de-watered then the grout must be placed through a tremie tube or pressured pumped with the initial pump nozzle at bottom of hole. Number 8 reinforcing bars shall be rotated full depth of holes. Slight tapping will be allowed during the bar rotation process but tapping without rotation will not be allowed.

APPROVED SCOUR PROTECTION MATERIALS:

In lieu of a bottom concrete slab the Contractor can provide adequate scour protection with the following systems:

- A) 12 inch thick Reno mattress. The top of the baskets of the Reno mattress shall coincide with the existing streambed elevation.
- B) Pre-cast articulating concrete block mat system connected by interwoven stainless steel cable. The system shall provide the required geo-textile fabric placed underneath the system to prevent the migration of fines through the blocks. The block mat system shall be anchored to the underlying material. The block mat shall be sized to the stream velocities at the particular site and the top of the blocks will coincide with the existing streambed elevation.
- C) Rip-Rap sized appropriately for stream velocities underlain by geo-textile fabric to prevent migration of fines between rocks.

OBSERVING CONSTRUCTION PERMIT CONDITIONS:

Proposals to construct pre-cast alternatives to the contract plans, the pre-cast alternatives shall be compatible with the project permits. Otherwise, the Contractor must apply for and obtain any new or revised permits based on approved alternate plans. No time for obtaining such permits will be eligible for contact extensions request.

DESIGN REQUIREMENTS**SPECIFICATIONS:**

Standard Specifications for Road and Bridge Construction of the Tennessee Department of Transportation (March 1, 1996 Editions and Supplemental Specifications)

Tennessee Department of Transportation Earth Retaining Structures Manual

AASHTO Load Resistance Factor Design Standard Specifications for the Design of Highway Bridges, Current Edition with Addenda.

Three sided pre-cast culvert and bridge structures, or pre-cast arches shall be cast in a certified precast plant under plant controlled conditions, and in accordance with the TDOT procedure for the Manufacture and Acceptance of pre-cast concrete drainage structures, noise wall panels, and retaining wall panels”.

LOADINGS:

Live Load: HL93 Live Load with tandem load as appropriate.

Earth Load: Based on Soil Weight of 120 psf and 1.15 Soil-Structure interaction factor.

Lateral Earth Pressure: maximum of 0.50 times soil weight; minimum of 0.25 times soil weight. And as specified in Art. 17.8 of the AASHTO Standard Specifications for the Design of Highway Bridges, 1996 Edition with Addenda.

NON-UNIFORM LOADS:

The pre-cast system designs in standard fills assume uniform loading on each exterior wall. Non-uniform loads that significantly affect the loading on the culvert shall be accounted for in the design of the system. (for example, if bridge culvert runs along the toe of an embankment or next to a retaining wall)

WINGWALLS: Wing walls shall be designed as free standing units and in accordance with AASHTO Bridge Design Specifications, current edition and the requirements of the TDOT Earth Retaining Structures Manual. Pre-approved wall systems under the procedures outlined in the Manual need not to be re-approved as wing-walls, if acceptable to the site conditions. MSE wing-walls is subject to approval on a site by site basis. If approved for the site, the backfill material for the MSE walls shall be a free-draining material with the appropriate sacrificial coating on the metal straps. Any non-approved pre-cast retaining wall system used for wing-walls is subject to approval by the Engineer on a project by project basis.

HEADWALLS AND CURBS: Pre-cast or cast-in-place headwalls and/or curbs shall be positively attached to the pre-cast system sections.

RAILING REQUIREMENTS: If the contract plans shows that the culvert/bridge requires a traffic railing attached to the structure, the traffic railing and attachment shall be detailed on the proposed design drawings and shall meet the crash test requirements of NCHRP 350. The type of proposed bridge rail shall be consistent with the rail on the contract drawings.

DEBRIS DEFLECTION WALL: See Standard Drawings STD-15-17 & 18. A debris deflection wall shall be constructed on the inlet end of the pre-cast structure when specified on the plans unless the Engineer deems such deflectors inappropriate for the proposed alternative pre-cast system. The Engineer will be the final arbiter in such cases. Details of the wall and method of attachment to the pre-cast unit shall be specified on the pre-cast system design drawings.

PAVED OUTLET DETAILS: See Standard Drawings STD-15-16. Paved outlets shall be used when specified on the plans. If required, details shall be shown on the alternate design drawings.

LOW FLOW CHANNEL CONSTRUCTION: See Standard Drawing STD-15-16A. Low flow channel Standard drawing shall be used as shown on the alternate design drawings.

STAGE CONSTRUCTION REQUIRMENTS: If the structure is specified to be stage constructed on the plans, the pre-cast system design drawings shall be detailed and designed to accommodate the phasing requirements. The number of traffic lanes and lane widths shall not be reduced in order to accommodate the use of culvert system. Any temporary shoring that may be required to stage construct the culvert shall be included in the cost of the culvert system.

WALL DRAINAGE: Four (4) inch diameter weep holes at six (6) foot center to center spacing to be placed in the wing-walls and exterior walls. See Standard Drawing STD-15-14 for further notes and details for placement of weep hole and aggregate drains.

MATERIAL SPECIFICATIONS:

Concrete: Shall be Class "A" (Cast-in-place) with minimum concrete strength, $f'c = 3000$ psi or greater as required by design. Pre-cast shall be Class "P" with a minimum concrete strength, $f'c = 4000$ psi or greater as required by design.

Reinforcing Steel: Shall be ASTM A615 Grade 60, See Section 604 and 907 of the Standard Specifications and Supplemental Specifications 600, when fill on the structure is less than one (1) foot, epoxy coated reinforcing steel shall be used in the top mat of the top slab and curbs including the tie stirrup bars in the curb.

Reinforcing Bar Support Details: See Standard Drawing STD-9-1.

Curing Concrete : All cast-in-place concrete shall be cured in accordance with Article 604.24 of the Standard Specifications. All pre-cast concrete shall be cured in accordance with Article 615.11 and for handling, placing and consolidating the concrete for pre-cast members shall be in accordance with Article 615.10.

Concrete Finish: See Standard Specifications Article 604.22. In general, curbs, edges of slabs, exposed faces and ends of wing-walls, debris deflection walls, ends of interior walls, and exposed face of end-walls shall receive a class II finish.

HANDLING AND PLACEMENT OF PRE-CAST UNITS

The pre-cast units shall be stored, erected, and supported according to manufacture recommendations. A representative from the manufacture shall be present during off loading of the units if stored on site, during erection of the members and during the placement of the structural backfill. The location of the lifting points shall be supported by design calculations. The location of the lifting points and any special instructions shall be clearly shown on the culvert drawings. It is the Contractor responsibility to insure that the units get installed properly. Any damage that occurs to the units due to fabrication, storage, or installation and in addition to

problems that may occur due to the use of the pre-cast system will be corrected at no added cost to the project.

BACKFILL REQUIREMENTS

The order of placement of structural backfill around the culvert shall be specifically detailed on the design drawings and a manufacture representative shall be present during the placement of the backfill. At a minimum, back filling of the pre-cast system shall be in accordance with Section 204.11 of the Standard Specifications. The requirements for stepping of boundary slopes to prevent wedge action, for proper layering and compacting of backfill, and for maintaining (at all times) equal heights of backfill against the exterior walls of the culvert shall be strictly enforced. See Standard Drawings STD-15-14 & 15 for other details and notes.

METHOD OF PAYMENT

The “Three Sided Precast Culvert Structure – Barrel (Size)” units will be paid for as follows:

Pre-cast Culvert units: The pre-cast culvert system units will be paid by the linear foot of barrel.

- 607-50.60 LF THREE SIDED PRECAST CULVERT STRUCTURE – BARREL (SIZE)
- 607-50.61 LF THREE SIDED PRECAST CULVERT STRUCTURE – BARREL (SIZE)
- 607-50.62 LF THREE SIDED PRECAST CULVERT STRUCTURE – BARREL (SIZE)
- 607-50.63 LF THREE SIDED PRECAST CULVERT STRUCTURE – BARREL (SIZE)
- 607-50.64 LF THREE SIDED PRECAST CULVERT STRUCTURE – BARREL (SIZE)

Wing wall, cut off walls, and all concrete other than the structure barrel and runners except bottom if required to be included in the linear foot cost of the pre-cast system.

Bottom slab: If slab-bridge was set-up on contract plans and due to poor foundation material a bottom slab was required, the bottom slab shall be constructed by the Section 109.04. Otherwise the bottom slab and/or scour protection to be included in the linear foot cost of the pre-cast system.

The cost of the following will be included in the above items for the pre-cast structure complete in place:

Any additional foundation information that will be required to determine the location of competent rock and the scour potential of the underlying material. All engineering costs for the design and preparation of design drawings for the culvert system and wing-walls. All material and labor cost for the complete fabrication and installation of the pre-cast units. All material and labor cost for the complete installation of all wing-walls either cast-in-place or pre-cast. All material and labor cost for the design, placement, concrete, reinforcing steel, and any other incidentals required for the complete installation of the bottom slab when the contract plans structure with a bottom slab is specified. If phase construction of the structure is required by the plans, the cost of any temporary shoring or

adjustments in the culvert system that is required to maintain the number of traffic lanes and lane widths as noted on the plans will be included in these items. If required, the cost of the bridge rail along with the required attachments to the structure and any modification that will be required in order to meet NCHRP 350 requirements. The additional cost of having representative from the manufacture at the site during various phases of installation of the pre-cast system shall be included in items bid on for the pre-cast system.

The excavation for the pre-cast system will be paid for under Roadway Road and drainage excavation. See Standard Drawings STD-15-2, 14, & 15 for pay limits of excavation. The structural backfill Class "A" Grading "D" will be paid for under item 303-01.02 "Granular Backfill (Bridges). See Standard Drawings STD-15-2, 14, & 15 for limits of placement. Any additional foundation fill material required for culverts with a bottom slab will be paid for under Roadway item 204-08 "Foundation Fill Material" per cubic yard. If a concrete slab bridge is specified on the contract plans and a bottom slab is required due to the location of suitable bearing material or scour requirements, the bottom slab will be paid according to Section 109.04 "Method of Payment for Extra Work" of the Standard Specifications. The extra work prices includes the cost of all forms, placement, reinforcing steel, concrete and all material and labor required for complete placement of the bottom slab. If an approved scour protection is used in lieu of a concrete slab, the Contractor will be paid for according Section 109.04 but the cost of the scour protection shall be similar in the cost to the placement of a concrete bottom slab.