

STATE

OF

TENNESSEE

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SPECIAL PROVISION

REGARDING

THREE SIDED PRECAST CULVERT AND BRIDGE STRUCTURES
OR PRECAST ARCHES

Description

This work consists of furnishing all materials, labor, tools, equipment, and other necessary items required to design, fabricate, and install three-sided precast culvert and bridge structures, or precast arches.

Design Submittal Guidelines

The three-sided precast culvert or arch culvert structure shall conform to the requirements of this Special Provision and the following design submittal guidelines:

- A. Structural:** Submit to the Division for approval a foundation report at each site, precast structure design drawings, and design calculations. A Professional Engineer licensed in the State of Tennessee shall stamp all design drawings and calculations.

The precast system shall provide an equivalent or greater hydraulic opening as the cast-in-place or precast 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 and the Aquatic Organism Passage (AOP) design should be submitted to the Hydraulic Design Section following TDOT Design Procedures for Hydraulic Structures or to the Roadway 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 Region Roadway Design Manager.

Roadway Design: The proposed precast system shall not affect the 10 controlling geometric design elements of the roadway. The proposed structure shall not require a Design Exception and/or need for any additional ROW or easement.

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

Any minor change in roadside geometry such as, roadway fill 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 Region Roadway Design Division for review and approval.

B. Currently the following precast systems that have been approved to be used on State Projects as long as **all** requirements of this Special Provision are satisfied.

- **CONSPAN Bridge System**
- **HY-SPAN Bridge System**
- **BEBO Bridge Concrete Arch System**
- **REDI-SPAN Arch Bridge System**

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 Structures Division for review and Engineering Approval. Allow a minimum of 3 weeks for review, comment, and Approval of the changes by the Engineer before the precast system can be installed on the project.
- b. Be fully aware of the constructability of the proposed precast system being proposed. Due to the geometry and availability of sizes of the precast units, some of the approved systems may be more sensitive to handling, installation, wing-wall requirements, and backfill and roadway sub grade placement. The precast 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.

If a different precast system option is being proposed, the Structures Division will have 60 days, after receipt of all pertinent information, to review and approve/disapprove any new precast system submitted.

C. The construction or fabrication of the precast units shall not begin until the precast system has been approved by the Structures Division and/or the Region Roadway Design Division. All approved precast elements must be manufactured in a commercial precasting facility that is certified by one of the following National Quality Control Programs:

- **ACPA: American Concrete Pipe Association**
- **NPCA: National Precast Concrete Association**
- **PCI: Precast/Prestressed Concrete Institute**

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 electing 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. Provide the foundation investigation, if not provided in the contract plans, at no additional cost to the Department.
- B.** A strip footing or precast 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 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 requirements in **204.10** 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 bridge 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 precast system drawings. 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 precast system structure drawings shall be revised to either show a bottom slab or an approved scour protection system.
- 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 feet 6 inches 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. Grout material shall meet requirements of 921.09 and shall be 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 installed in the holes and rotated (not driven) to their seat. 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, 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. Precast 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. Riprap sized appropriately for stream velocities underlain by geo-textile fabric to prevent migration of fines between rocks.
- D. All scour protection practices shall maintain flow on stream bed. Refer to roadway plans.

Observing Construction Permit Conditions

Proposals to construct precast alternatives to the contract plans, the precast alternatives shall be compatible and not alter conditions of the project permits.

Design Requirements

A. Specifications

Standard Specifications for Road and Bridge Construction of the Tennessee Department of Transportation (Current Edition 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 precast culvert and bridge structures, or precast arches and approved precast elements must be manufactured in a commercial precasting facility that is certified by one of the National Quality Control Programs noted in this provision.

B. Loadings

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

Earth Load: Based on Soil Weight of 120 psf and Granular Backfill Weight of 130 pcf. Earth Loads and Load Factors per Tables 3.4.1-1 and 3.4.1-2 of the AASHTO LRFD Specification (Latest Edition).

- C. Non-Uniform Loads.** The precast 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 precast system. (For example, if bridge culvert runs along the toe of an embankment or next to a retaining wall)
- D. Wingwalls.** Wingwalls shall be designed as free standing units and in accordance with AASHTO LRFD Bridge Design Specifications, current edition, and the requirements of the Department's Earth Retaining Structures Manual. Pre-approved wall systems under the procedures outlined in the Manual need not to be re-approved as wingwalls, if acceptable to the site conditions. MSE wingwalls are subject to approval on a site by site basis and shall be shown on the Departments Qualified Products List. 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 precast retaining wall system used for wingwalls is subject to approval by the Engineer on a project basis.
- E. Headwalls And Curbs.** Precast or cast-in-place headwalls and/or curbs shall be positively attached to the precast system sections.
- F. 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 MASH. The type of proposed bridge rail shall be consistent with the rail on the contract drawings.
- G. Debris Deflection Wall.** See Standard Drawings STD-17-21 and STD-17-22. If A debris deflection wall is proposed, the wall shall be constructed on the inlet end of the precast structure when specified on the plans unless the Engineer deems such deflectors inappropriate for the proposed alternative precast system. The Engineer will be the final arbiter in such cases. Details of the wall and method of attachment to the precast unit shall be specified on the precast system design drawings.
- H. Low Flow Channel Construction:** See Standard Drawing STD-17-20 or the D-AOP- Series. Low flow channel Standard drawing shall be used as shown on the alternate design drawings.
- I. Stage Construction Requirements.** If the structure is specified to be stage constructed on the plans, the precast 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 precast system. Any temporary shoring that may be required to stage construct the culvert shall be included in the cost of the culvert system. For more details, refer to EC-STR-Series Standard Drawings for in stream diversion and Temporary Diversion standards.
- J. Wall Drainage.** Four (4) inch diameter weep holes at 6-foot center to center spacing to be placed in the wing-walls and exterior walls. See Standard Drawing STD-17-17 for further notes and details for placement of weep hole and aggregate drains.

Material Specifications

The manufacturer shall retain copies of all mill test reports and material certifications.

Concrete. Cast-in-place concrete shall be Class A (Cast-in-place) with minimum concrete strength, $f'c = 3000$ psi or a Class X as required by design. Precast shall be Class P with a minimum concrete strength, $f'c = 5000$ psi or as required by design.

Reinforcing Steel. Shall be ASTM A615 Grade 60, See requirements in **604** and **907**, when fill on the structure is less than 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.

Water. All water shall be in accordance with Table 921.01-02.

Curing Concrete. All cast-in-place concrete shall be cured in accordance with **604.23**. All precast concrete shall be cured in accordance with **615.11** and handling, placing, and consolidating the concrete for precast members shall be in accordance with **615.10**.

Concrete Finish. See **604.22** requirements for finishing slab surfaces. 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 rubbed finish meeting 604.21.

Joints. The sealing of external joints between precast units shall meet manufacturers requirements and include either a bituminous, rubber, or mastic joint sealer and an approved joint wrap at least 12 inches wide.

Handling And Placement Of Precast Units

The precast units shall be stored, erected, and supported according to manufacture recommendations. Each shipment shall be accompanied with a manufacture's certification. A representative from the manufacture shall be present during offloading 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. Ensure that the units get installed properly. Any damage that occurs to the units due to fabrication, storage, installation or as a consequence of problems attributable to the use of the precast 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. Backfilling of the precast system shall be in accordance with **204.11**. 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-17-17 and STD-17-18 for other details and notes.

Method Of Measurement

The Department will measure three sided pre-cast culvert and bridge structures, or precast arches of the different shapes and sizes specified by the linear foot installed and accepted complete in place.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
607-50.6_	THREE SIDED PRECAST CULVERT STRUCTURE – BARREL (SIZE)	LF

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 precast 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 and embedded as required and the method of payment by 109.04. Otherwise, the bottom slab and/or scour protection to be included in the linear foot cost of the precast system.

Such payment is full compensation for the precast structure complete in place and will include the following:

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 precast units. All material and labor cost for the complete installation of all wing-walls either cast-in-place or precast. 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 MASH requirements. The additional cost of having representative from the manufacture at the site during various phases of installation of the precast system shall be included in items bid on for the precast system.

The excavation for the precast system will be paid for under Roadway Road and drainage excavation. See Standard Drawings STD-17-3, STD 17-17, and STD-17-18 for pay limits of excavation. The structural backfill Type "A" Grading "D" will be paid for under item 303-01.02 "Granular Backfill (Bridges). See Standard Drawings STD-17-3, STD 17-17, and STD-17-18 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 109.04 "Method of Payment for Additional and Altered Work". The extra work prices includes the cost of all forms, placement, reinforcing steel, concrete and all material and labor required for complete placement and embedment of the bottom slab.

If an approved scour protection is used in lieu of a concrete slab, payment will be according to requirements in 109.04 but the cost of the scour protection shall be similar in the cost to the placement of a concrete bottom slab.