

# Special Specification 4127

## Precast - Arch, Headwall & Wingwall Units



### 1. DESCRIPTION

Design, fabricate and furnish precast arches, integral arch, and headwall and wingwall units in accordance with these specifications and in conformity with the lines, grades, design and dimensions shown on the plans or as established by the Engineer. This item does not govern the design or installation of drilled shafts and abutments.

### 2. MATERIALS

2.1 **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 427, "Surface Finishes for Concrete"
- Item 440, "Reinforcement for Concrete"
- DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants"

Provide precast arches, integral arch, and headwall and wingwall units. Use Class H concrete with a minimum design strength of 5,000 psi.

2.2 **Design.** All precast elements must be designed in accordance with the AASHTO LRFD (Load and Resistance Factor Design) Bridge Design Specifications, 7<sup>th</sup> Edition (including any applicable Interims), for HL-93 loading. A minimum of two ft. cover above the crown is required in the installed condition, unless noted otherwise on the shop drawings, approved and designed accordingly.

Submit to the Engineer details and design calculations bearing the seal of a licensed professional engineer in the State of Texas for review and approval. Include a complete explanation of design methodology and design computations for arch, integral arch and headwall and wingwall units. Design the precast units for earth loading, dead loading, HL-93 live loading, and rail impact loading. Design the rail to headwall and rail to wingwall connections for rail impact loading. The drilled shaft foundations and abutments in the plans have been designed to resist the earth loading, dead loading, HL-93 live loading, and rail impact loading.

2.3 **Provision for Drainage.** Provide a suitable drainage system (underdrain pipe and weep holes as shown in the plans) along the precast arch units and wingwalls to release hydrostatic pressure build up.

### 3. CONSTRUCTION

3.1 **Fabrication.** Prepare and submit detailed shop and working drawings for the precast arches, integral arch, and headwall and wingwall units including details for casting, lifting, placing, sealing joints, attachment of wingwalls, and any other detail necessary to cast and place the precast arches, integral arch, and headwall and wingwall units. Submit the lifting and placing details to the Engineer for review. Submit all others to the Engineer of Record, or a review office as directed by the District for review and approval. Submit all drawings in accordance with the formats stipulated in the Guide to Electronic Shop Drawing Review found at [http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/bridge/e\\_submit\\_guide.pdf](http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/bridge/e_submit_guide.pdf).

Fabricate precast arches, integral arch, and headwall and wingwall units in accordance with Item 424, "Precast Concrete Structural Members (Fabrication)," and DMS-7300, "Precast Concrete Fabrication Plants" except as otherwise noted in this Specification.

3.2 **Forms.** Provide forms that are sufficiently rigid and accurate to maintain the arch unit, wingwall, and headwall dimensions within the permissible variations given in this specification. All casting surfaces should be of a smooth nonporous material.

3.3 **Handling, Storing, Hauling, and Erection.**

Handling devices or holes must be permitted in each precast element for the purpose of handling and installation. The precast elements must be stored in such a manner to prevent cracking or damage. The units should not be moved until the concrete compressive strength has reached a minimum of 3000 psi, and they must not be stored in an upright position until the concrete compressive strength has reached a minimum of 4,500 psi.

3.4 **Reinforcement.**

The cover of concrete over the outside circumferential reinforcement must be 2 in. minimum. The cover of concrete over the inside circumferential reinforcement must be 1 1/2 in. minimum. The clear distance of the end circumferential wires must not be less than 1-in. nor more than 2-in. from the ends of each section. Reinforcement will be assembled using single or multiple layers of welded wire reinforcement (not to exceed 3 layers), supplemented with a single layer of deformed steel bars, when necessary. Welded wire reinforcement will be composed of circumferential and longitudinal wires meeting the spacing requirements below, and must contain sufficient longitudinal wires extending through the bridge unit to maintain the shape and position of the reinforcement. Longitudinal distribution reinforcement may be welded wire reinforcement or deformed steel bars and must meet the spacing requirements below. The ends of the longitudinal distribution reinforcement must be not more than 3 in and not less than 1 1/2 in. from the ends of the arch unit.

The outside and inside circumferential reinforcing steel for the corners of the bridge should be bent to such an angle that is approximately equal to the configuration of the bridge's outside corner.

Tension Splices in the circumferential reinforcement should be made by lapping. For both smooth welded wire reinforcement and deformed welded wire reinforcement, the overlap must meet the requirements of AASHTO. The overlap of welded wire reinforcement must be measured between the outermost longitudinal wires of each fabric sheet. For deformed steel bars, the overlap must meet the requirements of AASHTO. For splices other than tension splices, the overlap must be a minimum of 12 in. for welded wire reinforcement or deformed steel bars. The center-to-center spacing of the circumferential wires in a welded wire reinforcement sheet must be not less than 2 in. nor more than 4 in. The center-to-center spacing of the longitudinal distribution steel for either line of reinforcing must be not more than 16 in.

3.5 **Concrete Surface Finish.** Finish surfaces of units in accordance with Section 420.4.13., "Ordinary Surface Finish," and Item 427, "Surface Finishes for Concrete." Provide an aesthetic formliner and surface furnish for surfaces of the precast wingwall and headwall units as shown in the plans.

3.6 **Permissible Variations.**

3.6.1 **Arch Units.**

The internal dimension should vary not more than 1% from the design dimensions nor more than 1 1/2 in., whichever is less. The haunch dimensions should vary not more than 3/4 in. from the design dimensions.

The slab and wall thickness must not be less than that shown in the design by more than 1/4 in. A thickness greater than that required by design shall not be cause for rejection, if proper jointing is not affected.

Variations in laying lengths of two opposite surfaces of the arch unit shall not be more than 1/2 in. in any section.

The underrun in length of a section must not be more than 1/2 in. in any arch unit.

The maximum variation in position of reinforcement must be  $+1/2$  in. In no case shall the cover over the reinforcement be less than  $1\ 1/2$  in. for the outside circumferential steel or be less than 1 in. for the inside circumferential steel as measured to the external or internal surface of the bridge. These tolerances or cover requirements do not apply to mating surfaces of the joints.

3.6.2 **Wingwall and Headwall Units.**

The wall thickness must not vary from that shown in the design by more than  $1/2$  in.

The length and height of the wall must not vary from that shown in the design by more than  $1/2$  in.

The maximum variation in position of reinforcement must be  $+1/2$  in. In no case should the cover over the reinforcement be less than  $1\ 1/2$  in.

3.7 **Joints.** The precast units should be produced with flat butt ends. The ends of the precast units must 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 above. The joint width must not exceed  $3/4$  inch.

3.8 **Workmanship.** The precast units must be substantially free of cracks and fractures. The ends of the precast units should be normal to the walls and centerline of the precast section, within the limits of variation given above. The faces of the wingwalls and headwalls must be parallel to each other, within the limits of variation given above.

Correct unit discrepancies including, but not limited to horizontal misalignment or variations in vertical camber, to achieve a satisfactory completed structure at no additional expense to the Department. Correction may require replacement of the member.

3.9 **Repairs.** Precast elements may be repaired, if necessary, because of imperfections in manufacturing or handling damage and will be acceptable if, in the opinion of the owner, the repairs are sound, properly finished and cured, and the repaired section conforms to the requirements of this Specification without compromising the design intent. Repair cracks that extend into the plane of the reinforcing steel that are not numerous and extensive. Perform all repairs, when approved by the owner, in accordance with the Department's Concrete Repair Manual.

3.10 **Rejection.** The precast elements should be subject to rejection because of noncompliance with the Specification requirements as set forth above. In addition, individual precast elements may be rejected because of any of the following:

- Fractures or cracks passing through a precast unit, except for a single end crack that does not exceed one half the element's thickness, and
- Numerous and extensive fine cracks on the surface of units that do not extend to the nearest plane of reinforcement.

3.11 **Marking.** Each precast unit shall be clearly marked by waterproof paint. The following shall be shown on the inside of the leg near the base of the precast bridge unit section:

- Size: Arch Span X Arch Rise (in feet)
- Earth Cover (in feet)
- Date of Manufacture
- Name or Trademark of Manufacturer

3.12 **Construction.**

- 3.12.1 Footings – The precast units must be installed on cast-in-place concrete footings founded on drilled shafts. The design, size and elevation of the footings must be as specified on the plans and confirmed by the Engineer. A 3-in. deep keyway must be formed in the top surface of the footing 3 in. clear of the outside faces of the precast units, unless specified otherwise on the plans. The footings shall be given a smooth float finish and shall reach a compressive strength of 3,000 psi before placement of the precast units. The 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 1/4 in. in 10 ft. A precast footing is not permitted.
- 3.12.2 Placement of the Precast Units – The precast units should be placed as shown on the plans. Special care shall be taken in setting the units to the true line and grade specified on the plans. The precast units shall be set on 6-in. x 6-in. masonite or steel shims. A minimum of 1/2 in. gap shall be provided between the top of footing and the bottom of the precast units. The gap shall be filled with cement grout (Portland cement and water, or cement mortar composed of one-part Portland cement and three-parts sand, by volume, and water). Cement grout shall have a minimum 28-day concrete strength of 4,000 psi.
- 3.12.3 External Protection of Joints – The butt joint made by two adjoining precast units shall be covered 7/8" x 1-3/8" preformed bituminous joint sealant and a minimum of a 9-in. wide joint wrap. The surface shall be clean and 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 9 in. on each side of the joint. The external wrap shall be either EX-WRAP RUBBER by PRESS-SEAL GASKET CORPORATION, or SEAL WRAP by MAR MAC MANUFACTURING CO., INC., or Approved Equal. The joint shall be covered continuously from the bottom of one precast section leg across the top of the arch and to the opposite precast section leg. Any laps that result in the joint wrap should be a minimum of 6 in. long with the overlap running downhill.

In addition to the joints between precast arch units, the joint between the end integral arch/headwall unit and the wingwall must be sealed with a 2'-0" strip of filter fabric. In addition, if lift holes are formed in the arch units, they should be primed and covered with a 9" x 9" square of joint wrap.

During backfilling operation, care should be taken to keep the joint wrap in its proper location over the joint.

- 3.12.4 Backfill – Backfill should be considered as all replaced excavation and new embankment adjacent to the precast units. The project construction and material specifications which include the specifications for structure excavation and roadway excavation and embankment construction, should apply except as modified in this section.

No backfill should be placed against any structural elements until approved by the Engineer.

Backfill against a waterproofed surface shall be placed with care to avoid damage to the waterproofing material.

Mechanical tampers or approved compacting equipment must be used to compact all backfill and embankment immediately adjacent to each side and over the top of each precast arch unit until it is covered to a minimum depth of one ft, unless the design fill height is less than 1 ft. Critical backfill zones (as determined by the Engineer) must be placed in lifts of eight in. or less (loose depth). Heavy compaction equipment shall not be operated in this area or over bridge until it is covered to a depth of one ft., unless the design fill height is less than one ft.

Lightweight dozers and graders may be operated over precast arch units having one ft. 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) should require two ft. of cover unless the design cover is less than two ft. In

no case should equipment operating in excess of the design load (HL 93) be permitted over the bridge units unless approved in writing by the Engineer.

Backfill (and any riprap protection specified) in front of wingwalls must be carried to Finished Grade shown in the plans.

Any additional fill and subsequent excavation required to provide the minimum cover specified should be made at no additional cost to the owner.

As a precaution against introducing unbalanced stresses in the arch units, when backfilling, at no time should the difference between the heights of fill on opposite sides of an element exceed 2 ft.

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#### 4. MEASUREMENT

The work as provided for by this Specification will be measured by the lump sum.

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#### 5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as specified under "Measurement" will be paid for as a lump sum for "Precast – Arch, Headwall & Wingwall Units."

Precast - Arch, Headwall & Wingwall Units will be paid in partial payments as follows:

- Arch – Partial payment percentage of this item will be agreed to with the Engineer prior to beginning of work under this item.
- Headwall – Partial payment percentage of this item will be agreed to with the Engineer prior to beginning of work under this item.
- Wingwall – Partial payment percentage of this item will be agreed to with the Engineer prior to beginning of work under this item.
- The sum of all partial payment percentages for this bid item should add up to 100%.

This price is full compensation for furnishing, transporting, and placing precast units; reinforcing steel, mortar, and castings for shaping of beds; manufacture of the precast units and transporting to the project; jointing of sections; jointing material; connections to new or existing structures; breaking back, and labor, materials, tools, and equipment except as otherwise noted on the plans.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 403, "Temporary Special Shoring." Excavation, bedding and backfill will be paid for in accordance with Item 400, "Excavation and Backfill for Structures." Drilled shafts will be paid for under Item 416, "Drilled Shaft Foundations". Abutment caps will be paid for under Item 420, "Concrete Substructures".