

723-R-282 PRECAST REINFORCED CONCRETE THREE-SIDED DRAINAGE STRUCTURES

(Revised 05-17-07)

The Standard Specifications are revised as follows:

SECTION 723, BEGIN LINE 1 DELETE AND INSERT AS FOLLOWS:

**SECTION 723 – ~~BLANK REINFORCED CONCRETE THREE-SIDED DRAINAGE STRUCTURES~~**

**723.01 Description**

10 This work shall consist of constructing a precast reinforced concrete three-sided arch drainage structure with headwalls and wingwalls, a precast reinforced concrete three-sided flat-topped drainage structure with headwalls and wingwalls, or a precast reinforced concrete true arch shape drainage structure with spandrel walls and wingwalls in accordance with 105.03, 714, and ASTM C 1504. Wingwalls, headwalls, and spandrel walls may be precast or cast-in-place.

If the span is at least 12 ft (3600 mm) and not greater than 20 ft (6100 mm), the Contractor will be permitted to substitute a four-sided precast concrete box structure in accordance with 714. The four-sided precast concrete box structure shall be of equivalent hydraulic capacity to that of the three-sided structure shown on the plans.

**MATERIALS**

**723.02 Materials**

20 Materials shall be in accordance with the following:

Structure Backfill .....	904
Flowable Backfill .....	213
Geotextiles.....	913.18
Riprap.....	904
Sealer.....	909.09 or 909.10

30 Concrete for footings and base slabs shall be class B in accordance with 702. The coarse aggregate for precast members shall be Size No. 91 in accordance with 904.

A water-reducing admixture from the Department's list of approved Water-Reducing Admixtures may be used.

40 Reinforcing steel in structure sections and precast wingwalls shall be welded wire fabric, welded deformed steel wire fabric, or deformed billet steel bars in accordance with 910.01, except as noted herein. Reinforcing steel in cast-in-place wingwalls, pedestals, base slabs, headwalls, and footings shall be deformed billet steel bars in accordance with 910.01. Reinforcing steel in headwalls and spandrel walls shall be epoxy coated. Reinforcing steel in structure sections shall be epoxy coated where the height of cover, including the pavement section, is less than 2 ft (600 mm) as measured at the edge of travel lane.

Wingwalls, headwalls, and spandrel walls shall be connected to the outside structure sections. Wingwalls shall be connected to the spandrel walls if the structure is a true arch shape structure. Precast wingwalls shall be connected with bolted steel plates. Steel used in bolted connections of wingwalls to structure sections or spandrel walls shall be in accordance with AASHTO M 270 grade 36 (AASHTO M 270M grade 250) and galvanized after fabrication in accordance with AASHTO M 232 (AASHTO M 232M), Class A or B. Bolts shall be in accordance with ASTM A 307 and galvanized in accordance with AASHTO M 232 (AASHTO M 232M).

Weep holes shall be provided in all wingwalls.

## **CONSTRUCTION REQUIREMENTS**

### **723.03 Shop Drawings**

The Contractor shall submit, for approval, three copies of design computations and five sets of shop drawings. Each sheet shall be signed by and shall bear the seal of a professional engineer. The shop drawings shall include all details, dimensions, and quantities necessary to construct the structure, wingwalls, and headwalls or spandrel walls if applicable and shall include, but not be limited to, the following information.

- (a) Structure span and rise.
- (b) Structure section details showing all concrete dimensions and reinforcing steel requirements.
- (c) Design computations and details for pedestals, if required.
- (d) Footing design computations and details showing all concrete dimensions, elevations, and reinforcing steel with bar sizes, bar bending diagrams, lengths, and spacings indicated. Footing plan and section views shall be provided. If a pile footing is required, the pile layout shall be shown. The actual soil bearing pressure shall be noted on the footing detail sheets.
- (e) Wingwall design computations and details showing all concrete dimensions, reinforcing steel, bar bending diagrams, and anchorage details. Wingwall plan, elevation, and section views shall be provided.
- (f) Headwall or spandrel wall details showing all concrete dimensions, reinforcing steel, bar bending diagrams, and anchorage details. Headwall or spandrel wall elevation and section views shall be provided.
- (g) Structure backfill type and limits for the structure and wingwalls.
- (h) Minimum concrete strength for all precast portions of the structure.

Structure section or wingwall fabrication shall not begin until written approval of the shop drawings and design computations have been received from the Engineer.

**723.04 Design**

Except as modified herein, the structure sections shall be designed for the following:

- (a) the live load shown on the General Plan for the structure, or
- (b) HL-93 in accordance with the AASHTO LRFD Bridge Design Specifications, if no live-load design criteria are shown on the General Plan.

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The minimum design concrete compressive strength for structure sections shall be 5000 psi (35 000 kPa). For wingwalls, headwalls, and spandrel walls it shall be 4,000 psi (27 600 kPa). Wingwalls, headwalls, and spandrel walls shall be designed based on a minimum equivalent fluid pressure of 40 lb/ft<sup>3</sup> (6.3 kN/m<sup>3</sup>). If flowable backfill is to be used, the Contractor shall consider the effects of hydrostatic pressure on the structure. Horizontal pressures shall be increased for sloping backfill surfaces and live load surcharge. Footings shall be designed for the allowable soil bearing shown on the plans. Wingwalls and wingwall footings shall be designed in accordance with the soil parameters shown on the plans. Wingwall footings, headwall connections, and spandrel walls shall be checked for sliding and for overturning. Headwalls with bridge railing mounted on top, and the anchorage of the headwall or spandrel wall to the structure section, shall be designed for the bridge railing test level shown on the plans.

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Continuity shall be established between the structure footing and the wingwall footing.

**(a) Placement of Reinforcement**

For three-sided arch or true arch shape structure sections, the concrete cover over the outside circumferential reinforcement shall be a minimum of 2 in. (50 mm). The cover over the inside circumferential reinforcement shall be a minimum of 1 1/2 in. (40 mm). The clear distance of the end circumferential reinforcement shall not be less than 1 in. (25 mm) nor more than 2 in. (50 mm) from the ends of the structure section. The ends of the longitudinal distribution reinforcement shall be not more than 3 in. (75 mm) from the ends of the structure section.

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For flat-topped structure sections, the cover dimension over the top mat of reinforcement shall be a minimum of 2 in. (50 mm). The cover over the lower mat of reinforcement in the structure top shall be a minimum of 1 1/2 in. (40 mm). The cover in the legs shall be a minimum of 2 in. (50 mm). The clear distance of the end circumferential reinforcement shall not be less than 1 in. (25 mm) nor more than 2 in. (50 mm) from the ends of the structure section. The ends of the longitudinal distribution reinforcement shall not be more than 2 in. (50 mm) from the ends of the structure section.

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Cover for wingwall, pedestal, headwall, and spandrel wall reinforcement shall be a minimum of 2 in. (50 mm). Cover for footing and base slab reinforcement shall be 3 in. (75 mm) for the top and sides and 4 in. (100 mm) for the bottom.

**(b) Splicing and Spacing of Reinforcing Steel**

140 *Except as noted herein, reinforcing steel splicing and spacing requirements shall be in accordance with the AASHTO document referenced on the General Plan for the structure or the AASHTO LRFD Bridge Design Specifications if no AASHTO document is referenced. Tension splices in circumferential reinforcement shall be made by lapping. Deformed billet steel bars used for longitudinal distribution reinforcement shall have a center to center spacing not to exceed 12 in. (300 mm) in flat-topped structure sections or 16 in. (400 mm) in arch structure sections.*

*The maximum spacing for wingwall reinforcing steel shall be 18 in. (450 mm) for horizontal bars and 12 in. (300 mm) for vertical bars.*

150 *Exterior corner reinforcement for flat-topped structure sections shall be fully developed beyond the point where it is no longer required to resist flexure.*

#### **723.05 Manufacture**

*Handling devices or holes will be permitted in each structure or wingwall section. However, not more than six holes shall be cast or drilled in each section. Cast holes shall be tapered.*

160 *The section ends shall be of such design and shall be so formed that when the structure sections are erected, they shall make a continuous line of structure with a smooth interior free of irregularities.*

*The structure sections, wingwalls, headwalls, and spandrel walls shall be free of fractures. The ends of the structure sections shall be normal to the walls and centerline, except where beveled ends are specified. The surface of the structure sections shall be a smooth steel form or troweled surface. Trapped air pockets causing surface defects shall be considered as part of a smooth steel form finish.*

170 *Wingwalls, headwalls, and spandrel walls shall be given a finish in accordance with 702.21.*

*The structure units shall not be stored in an upright position until the designated handling and storage compressive strength, as shown on the shop drawings, has been achieved.*

#### **723.06 Marking**

*Each structure section and wingwall shall be clearly marked with waterproof paint. The following information shall be shown on the inside face of each wingwall and on a vertical leg of each structure section.*

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- (a) structure span and rise (structure sections only)*
  - (b) date of manufacture*
  - (c) name or trademark of the manufacturer*
  - (d) design earth cover*

### **723.07 Testing**

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#### **(a) Type of Test Specimen**

*Concrete compressive strength shall be determined from compression tests made on cylinders or cores. For cylinder testing, a minimum of four cylinders shall be taken during each production run of structure sections or wingwalls. For core testing, one core shall be cut from a structure section selected at random from each group of 15 structure sections or less of a particular size and production run. One core shall be cut from each group of four or fewer wingwalls. For each continuous production run, each group of 15 structure sections of a single size or fraction thereof or four wingwalls shall be considered separately for the purpose of testing and acceptance. A production run shall be considered continuous if not interrupted for more than three consecutive days.*

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#### **(b) Compression Testing**

*Cylinders shall be made and tested in accordance with ASTM C 39. Cores shall be obtained and tested for compressive strength in accordance with ASTM C 497 (ASTM C 497M).*

#### **(c) Acceptability of Core Tests**

*The compressive strength of the concrete in each group of sections as defined above will be acceptable when the core test strength is equal to or greater than the design concrete strength.*

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*If the compressive strength of the core tested is less than the design concrete strength, the structure section or wingwall from which that core was taken may be recored. If the compressive strength of the recore is equal to or greater than the design concrete strength, the compressive strength of the concrete in that group of sections will be acceptable.*

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*If the compressive strength of a recore is less than the design concrete strength, the structure section or wingwall from which that core was taken will be rejected. Two structure sections or wingwalls from the remainder of the group shall be selected at random. One core shall be taken from each. If the compressive strength of both cores is equal to or greater than the design concrete strength, the remainder of the structure sections or wingwalls in that group will be acceptable. If the compressive strength of either of the two cores tested is less than the design concrete strength, the remainder of the structure sections or wingwalls in the group will be rejected. However, at the option of the manufacturer, each remaining structure section or wingwall in the remainder of the group may be cored and accepted individually. The sections which have cores with less than the design concrete strength will be rejected.*

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#### **(d) Plugging Core Holes**

*The core holes shall be plugged and cured by the manufacturer such that the structure is in accordance with all test requirements of these specifications. Structure sections or wingwalls repaired accordingly will be considered satisfactory for use.*

#### **(e) Test Equipment**

*The manufacturer shall furnish all facilities, equipment, and personnel necessary to conduct the required testing.*

**723.08 Rejection**

240 *Structure sections, wingwalls, or spandrel walls will be rejected due to the following conditions.*

(a) *fractures or cracks pass through the wall, except for a single end crack which does not exceed one-half the thickness of the wall;*

(b) *defects which indicate proportioning, mixing, or molding which are not in accordance with this specification;*

(c) *honeycombed or open texture; or*

250 (d) *damaged section ends, where such damage prevents making a satisfactory joint.*

**723.09 Repairs**

*Structure sections, wingwalls, or spandrel walls may be repaired, if necessary, due to imperfections in manufacture, handling damage, or construction. Repairs will be acceptable if it is determined that the repairs are sound, properly finished and cured, and if the repaired structure section or wingwall is in accordance with the requirements herein.*

260 **723.10 Trench Compaction**

*The soils in the bottom of the excavation shall be compacted to 95% of the maximum dry density. If 95% of the maximum dry density cannot be obtained in the bottom of the excavation or in other areas, the Office of Geotechnical Engineering shall be contacted for additional recommendations. If during construction, soft soils are encountered at depths that make removal impractical, the Office of Geotechnical Engineering shall be contacted for additional recommendations.*

**723.11 Footings**

270 *Footings may be cast-in-place or precast. Where a precast footing is utilized, a 4 in. (100 mm) layer of coarse aggregate No. 53 in accordance with 301 shall be placed under the full width of the footing. All footings shall be given a smooth float finish. The footing concrete shall reach a compressive strength of 2,000 psi (13 800 kPa) before placement of the structure sections or wingwalls. The surface shall not vary more than 1/4 in. in 10 ft (6 mm in 3 m) when tested with 10 ft (3 m) straightedge.*

**723.12 Pedestals**

280 *Where a reinforced concrete pedestal is required between the base of the structure leg and the top of the footing, the Contractor shall have the option of providing a structure with extended legs or constructing the pedestals.*

**723.13 Placement of Structure Sections and Wingwalls**

*For three-sided arch structures and three-sided flat-topped structures, the structure sections and wingwalls shall be set on masonite or steel shims. A minimum gap of 0.5 in. (13 mm) shall be provided between the footing and the bottom of each section or wingwall. The gap shall be filled with a mortar in accordance with 707.09.*

290 *True arch shape structures may have mortar leveling pads poured in the footing keyways to ensure the correct seating of the arch sections. Leveling pads shall be approximately 2 in. (50 mm) thick and 16 in. (400 mm) long to ensure that each arch section is resting on approximately 8 in. (200 mm) of pad at each joint. The leveling pads shall be poured within 1/8 in. (3 mm) of the required elevation. No loads shall be placed on the mortar leveling pads within 72 hr of their placement. Masonite shims may also be used as leveling pads. Concrete blocks of 1 1/2 in. (40 mm) thickness, hardwood wedges, and steel or plastic shims shall be placed to retain the arch sections in their proper positions until grout can be placed in the keyway. Grout shall be compacted in the keyway to ensure that the entire area around the arch section is completely filled. The mortar used to construct the leveling pads and to grout the keyways shall be in accordance with 707.09. Grouting shall not be performed if the air temperature is expected to be below 35°F (2°C) for a period of 72 hr following grout placement.*

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#### **723.14 Sealing**

*Sealer shall be applied in accordance with 709 on the top surface of the structure section. Such sealer shall extend 5 ft (1.5 m) vertically down each vertical leg. Sealer material shall not be placed in keyway joints, if present. The sealer shall be provided for the full length of the structure. Surface preparation and application procedures shall be as recommended by the sealer manufacturer.*

#### **723.15 Joints**

310 *Joints between structure sections for three-sided arch structures and true arch shape structures, and for flat-topped structures with cover of 3 ft (0.9 m) or more, may be either butt joints or keyway joints.*

*The sections for flat-topped structures with less than 3 ft (0.9 m) of cover shall be produced with a minimum 4 in. (100 mm) deep by 1.5 in. (40 mm) wide keyway joint. Mortar in accordance with 707.09 shall be placed in the keyway joint.*

320 *All butt joints between structure sections shall be covered with a joint wrap in accordance with ASTM C 877 (ASTM C 877M), type II. The surface shall be free of dirt before the joint material is applied. The entire joint shall be continuously covered. Joints between structure sections and wingwalls, between spandrel walls and wingwalls, and between structure sections and headwalls or spandrel walls shall be covered with either the same wrap used between structure sections or with geotextile in accordance with 918.03.*

*The joint wrap shall be kept in its proper location over the joint. It shall not be damaged during the backfilling operation.*

*Joints in true arch shape structures shall be sealed with 1/2 in. (40 mm) diameter preformed mastic before placement of the joint wrap.*

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**723.16 Backfilling**

*Tapered or drilled holes for handling shall be filled in accordance with 907.05. Prior to backfilling the structure, all holes shall be covered with joint wrap material with a minimum width of 9 in. (225 mm).*

*Structure backfill shall be placed and compacted in accordance with 211.*

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*Once the level of structure backfill reaches the top of the structure, two lifts shall be spread and hand compacted over the structure without traversing the structure with heavy equipment. Compaction with heavy equipment will not be allowed until a minimum of two lifts have been placed, hand compacted, and tested.*

*The structure backfill shall be placed and compacted to the same elevation on both sides of the structure before proceeding to the next lift.*

*For three-sided arch or three-sided flat-topped structures where the height of cover as shown on the plans is 12 in. (300 mm) or less, the portion of the structure under the paved portion of the roadway and shoulders shall be backfilled with flowable backfill to the top of the vertical leg of the structure.*

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*For true arch shape structures, the backfill shall be structure backfill with a minimum height of cover of 18 in. (450 mm) including the pavement section.*

*The operation of equipment over the structure shall be in accordance with the structure manufacturer's recommendations.*

**723.17 Scour Protection**

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*When riprap is specified, geotextile shall first be placed on the in-situ soil in accordance with 616.11. Riprap shall then be placed in accordance with 616. For concrete base slabs, concrete shall be placed in accordance with 702.*

**723.18 Method of Measurement**

*Structures and wingwalls will not be measured for payment. The accepted quantities for payment will be the quantities shown on the plans.*

*Structure backfill will be measured in accordance with 211.09. Flowable backfill will be measured in accordance with 213.08. Geotextile and riprap will be measured in accordance with 616.12.*

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**723.19 Basis of Payment**

*The accepted quantities of structure will be paid for at the contract unit price per linear foot (meter) for structure, precast three-sided, of the span and rise specified. The accepted quantities of wingwalls will be paid for at the contract unit price per square foot (square meter) for wingwalls. Structure backfill will be paid for in accordance with 211.10. Flowable backfill will be paid for in accordance with 213.09. Geotextiles and riprap will be paid for in accordance with 616.13.*

