Section 02624

STRUCTURAL PLATE CULVERT STRUCTURES

1.0 G E N E R A L

1.01 SECTION INCLUDES

A Structural plate culverts and special structural plate shapes.

B References to Technical Specifications:
1. Section 01200 – Measurement and Payment Procedures
2. Section 01350 – Submittals
3. Section 03300 – Cast-in-Place Concrete
4. Section 02318 – Excavation and Backfill for Utilities

C Referenced Standards:
1. American Society for Testing and Materials (ASTM)
   a. ASTM A 153, "Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   b. ASTM B 695, "Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
   c. ASTM B 221, "Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
2. American Association of State Highway and Transportation Officials (AASHTO)

1.02 MEASUREMENT AND PAYMENT

A Measurement for structural plate pipes, pipe arches, arches, underpasses or box culverts is on a linear foot basis, measured along flow lines between ends of structures. Separate measurement will be made for each different required size, gage, or minimum thickness of the required material.

B For multiple structures, the measured length will be the sum of the lengths of barrels as prescribed above.

C Payment for structural plate culvert structures includes aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, and all labor and materials required for installation as indicated on Plans.

D Refer to Section 01200 – Measurement and Payment Procedures.

1.03 SUBMITTALS

A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.

B Submit product quality, material sources, and field quality information in accordance with this Section.

1.04 ACCEPTANCE AT SITE

A Furnish an itemized statement of the number and size of plates in each shipment. From this list, a visual inspection will be made by the Engineer, including an examination of the plates for deficiency in size, radius of curvature specified, and any evidence of poor workmanship. The inspection may include taking samples for chemical analysis and determination of weight of splutter coating. The plates making up the shipment shall fully meet the requirement of these specifications. Any plates failing to do so shall be rejected.

B The Engineer may elect to have the material inspected and sampled in the rolling mill or in the fabrication shop. A chemical analysis of any plate may be required from the mill. The inspection, either in the mill or in the shop, will be under the direction of the Engineer. The Engineer will have free access to the mill or shop for inspection. Any material which has been previously rejected at the mill or shop and included in a later lot will be rejected unless the material has been satisfactorily repaired.

C Structural plate with a damaged splutter coating, or which shows defective workmanship shall be rejected. Minor damaged areas of splutter coating, as judged by the Engineer, may be repaired by painting with a zinc dust-zinc oxide paint conforming to Federal Specification TT-P-641g. The requirement applies not only to individual plates but to the entire shipment.

D The following defects are considered to be poor workmanship. The presence of any one of them in an individual structural plate will be cause for rejection:

1. Uneven laps.
2. Elliptical shaping (unless specified).
3. Variation from a straight center line.
4. Ragged edges and damaged coatings.
5. Loose, uneven lined or spaced bolts.
6. Illegible brand.
7. Bruised, scaled or broken splutter coating.
8. Dents or bends in the metal.

2.0 P R O D U C T S

2.01 METAL PIPE AND ARCH MATERIALS

A Plates and fasteners used for construction of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes shall conform to AASHTO M167 for galvanized corrugated steel structures and to AASHTO M219 for aluminum alloy structures.

B Steel fasteners shall be mechanically galvanized or hot-dip galvanized and shall conform to ASTM A 153, Class C or D, or ASTM B 695, Class 40. The weight of galvanized coating shall be determined according to Test Method Tex-728-I.

C Steel plates shall consist of structural units of corrugated galvanized steel. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet. Plates will have approximately a 2 inch lip beyond each end and crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled.

D Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of one foot. When required, aluminum alloy inverts, toe walls, footings and closure plates shall conform to the material requirements for the aluminum structural plate. Extruded aluminum transverse stiffeners shall conform to ASTM B 221, Alloy 6061-T6.

E The material for metal headwalls shall comply with requirements shown on the Plans.

2.02 STRUCTURE AND MATERIAL DESIGNATION

A The types of structures will be indicated on the Plans by one of the following descriptions:

1. Structural Plate Pipe (Galvanized. Steel)
2. Structural Plate Pipe (Alum.)
3. Structural Plate Pipe Arch (Galvanized. Steel)
4. Structural Plate Pipe Arch (Alum.)
5. Structural Plate Arch (Galvanized. Steel)
6. Structural Plate Arch (Alum.)
7. Structural Plate Underpass (Galvanized. Steel)
8. Structural Plate Underpass (Alum.)
9. Structural Plate Box Culvert (Galvanized. Steel)
10. Structural Plate Box Culvert (Alum.)

B When designated as one of the above types without the material being designated, the Contractor may furnish the structure in either galvanized steel or aluminum.

2.03 PLATE JOINTS

A Form plates to provide bolted lap joints. Punch bolt holes so that plates having like dimensions, curvature, and the same number of bolts per foot of seam are interchangeable.

B Curve each plate to proper radius so that cross-sectional dimensions of finished structure will be as indicated on Plans.

C Stagger joints so that not more than three plates are jointed at any one point. Unless otherwise specified, place bolt holes along those edges of plates that will form longitudinal seams in the finished structure as follows:

1. Stagger in rows 2 inches apart, with one row in the valley and one in the crest of corrugations with not less than 4 bolts per foot for galvanized steel structures.

2. Stagger in rows 1 ¾ inches apart with 2 bolts in each valley and on each crest and not less than 16 bolts per 3 feet for aluminum alloy structures.

D Provide for a bolt spacing of not more than 12 inches for bolt holes along edges of plates that will form circumferential seams in finished structure.

E Keep minimum distance from center of hole to edge of plate to not less than 1 ¾ times diameter of bolt.

F For the diameter of bolt holes in longitudinal seams do not exceed diameter of the bolt. Diameter of bolt holes in longitudinal seams shall not exceed diameter of bolt by more than 1/8 inch.

G Cut plates for forming skewed or sloped ends to give the angle of skew or slope specified.

H Repair burned edges to eliminate oxide and burrs. Maintain legible identification numerals on each plate to designate its proper position in the finished structure.

2.04 CONCRETE

A Concrete shall conform to Section 03300 – Cast-in-Place Concrete. Unless otherwise shown on the Plans, use Class A concrete for footings and headwalls. Use Class B concrete for slope protection and for invert paving, when required. Place reinforcement as shown on the Plans.

2.05 REINFORCING STEEL

A Reinforcing steel shall conform to requirements of Section 03300 – Cast-in-Place Concrete.

3.0 E X E C U T I O N

3.01 PROTECTIVE COATINGS, LININGS AND PAVINGS

A When required, protect structural plate structures with bituminous coating, bituminous lining or have invert paved with bituminous material. Remove moisture, dirt, oil, unbonded or incompatible paint, grease, alkalies, or other foreign matter from the surface to be coated before applying the coating material.

B When specified or called in the Plans apply bituminous coatings to inside and outside of structures to a minimum thickness of 0.05 inch as provided in AASHTO M190, Type A.

C Apply a protective coating to coupling bands for coated structures. Use coatings in accordance with AASHTO M190. Coupling bands may be single-dipped with the coating thickness requirement waived.

D Apply bituminous linings, if required, over bituminous coatings, to inside bottom portion of structure as provided in AASHTO M190, Type C.

E When linings and pavings are not required, an asphalt mastic coating may be substituted for bituminous coating on corrugated steel or aluminum structures on outside surface of the structure. The inside surface need not be coated.

F When specified or called in the Plans, use an asphalt mastic coating conforming to requirements of AASHTO M243, except that asbestos fibers will not be used. Perform this process at the fabrication plant. Apply asphalt mastic material uniformly to the outside surface with a minimum thickness of 0.05 inch. Pinholes, blisters, cracks or lack of bond are cause for rejection.

G When protective coatings are applied to structures, be sure that the thickness of metal is clearly identified on the inner surface of each section with paint or other approved means. Repair damaged protective coatings, linings and invert paving. Use bituminous material conforming to provisions of AASHTO M190 or other approved materials to repair damaged asphalt mastic coatings.

H Coat that portion of nuts and bolts projecting outside the pipe after installation. The portion of nuts and bolts projecting inside the structure need not be coated.

I When asphalt mastic is used for protective coating, the surface at joints of the structure need not be coated prior to assembly. Thoroughly seal joints after assembly with asphalt mastic on outside of the structure.

3.02 CONSTRUCTION METHODS

A Excavate in accordance with Section 02318 – Excavation and Backfill for Utilities. Make trenches for pipes, pipe arches, underpasses or box culverts of sufficient width to provide free working space for erection and thorough tamping of backfill and bedding material under and around the structure. If the quality of the native soil is less than that of the proposed backfill material, extended the excavation to each side of the barrel, a minimum horizontal distance of half the span or two-thirds of the total rise, whichever is greater.

B Foundations, Structural Plate Structures with Metal Inverts: Have these structures bedded in a foundation of sandy earth material carefully and accurately shaped to fit the lower part of the pipe for at least ten percent of its overall height. However, the length of bedding arch need not exceed the width of the bottom plate. Obtain uniform seating of corrugations on pipe bed by placing the sandy material at least 3 inches thick. For culverts, place bedding to full width of the invert.

1. Excavation in Rock: Where rock, in either ledge or boulder formation, is encountered, remove it below grade and replace with a compacted earth cushion having a thickness of not less than 1/2 inch per foot height of fill over top of the pipe, with the minimum allowable thickness of 12 inches and a maximum of 24 inches under the pipe.
2. Where the soil encountered at the established grade is a quicksand, muck or similar unstable material, remove and replace it in accordance with Section 02318– Excavation and Backfill for Utilities. When required, use special bedding as shown on Plans.

C Foundations, Structural Plate Structures with Reinforced Concrete Footings: Form footings for these structures and finish them to true lines and grades as established by Engineer.

1. Set anchors or slots for box culverts to true line and grade when placing concrete for each substructure unit. Conform to Section 03300– Cast-in-Place Concrete for placing substructure units.
2. Place footings entirely in rock, shale or similarly hard material, or on firm soil or compacted soil cushion. When part of the founding area is rock, undercut it and replace it with a minimum 12 inch thick compacted soil cushion. When a thin layer of soil is partially covering rock within the bearing area and when practical to do so, soil may be removed and footings placed directly on rock in accordance with details shown on Plans.

D Erection: Install structural plate structures in accordance with Plans and manufacturer's recommendations.

1. Coat any steel in joints which is not protected by galvanizing with suitable bituminous coating.
2. Handle pipes and plates carefully to avoid damage to any protective coating. Repair damaged coatings.
3. For anchoring plates to headwalls or other concrete end treatment, use anchor bolts with ¾ inch diameter by 6 inch minimum length on not more than 19-inch centers.
4. Do not place plates for arch structures until the concrete cement substructure has cured for a minimum of 3 days.
5. When all plates are in position, tighten nuts and bolts progressively and uniformly, beginning at one end of the structure. Tighten nuts a second time to a torque of not less than 150 ft-lbs nor more than 300 ft-lbs for steel bolts and not less than 100 ft-lbs nor more than 150 ft-lbs for aluminum bolts. If an impact wrench is used, check with a long-handled, structural or socket wrench or a torque wrench to ensure that they are properly tightened. Replace service bolts used in drawing the plates together with standard high strength bolts.

E Shape Control: Furnish acceptable shape control devices for monitoring horizontal and vertical shape of structures. Maintain the shape within two percent of design measurements span or rise, whichever is greater or 5 inches, whichever is less, during erection and backfilling.

F Backfilling: Perform backfilling and embankment construction around the pipe in accordance with Section 02318– Excavation and Backfill for Utilities, except as modified below.

1. Within vertical planes 2 feet beyond the horizontal limits of the structure and until a minimum of 2 feet of cover has been compacted over the structure, only hand operated, mechanical tamping equipment shall be permitted.
2. Unless otherwise shown, no heavy earth moving equipment shall be permitted to haul over the structure until a minimum of 2 feet of permanent or temporary compacted fill has been placed. Remove and replace plates or structures damaged by equipment or backfilling operation.

3. During backfilling, to avoid unequal pressures and produce uniformly compacted backfill material of uniform density throughout the length of the structure and ensure proper backfill under the structure.
4. Prior to adding each new layer of loose backfill material, until a minimum 2 feet of cover is obtained, an inspection will be made of the inside periphery of the structure to determine any local or unequal deformation caused by improper construction methods.
5. Backfill the structure so that when backfill is complete the inside dimensions are within tolerances set forth in shape control. In the case of arches other than pipe arches when backfilling is completed before headwalls are placed, place the first material midway between ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. Construct the ramp evenly from both sides. Thoroughly the backfilling material as it is placed. After two ramps have been constructed to the top of the arch, deposit the remainder of backfill from the top of the arch both ways from the center, to the ends and as evenly as possible on both sides of the arch. If headwalls are built before the arch is backfilled, place fill material first adjacent to one headwall until the top of the arch has been reached, after which fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit material evenly on both sides of the arch.
6. For multiple structures, perform same backfill process for all structures more or less simultaneously. Backfilling between barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Do not drop backfill material from a height or concentrated in such an amount prior to distribution over the top arc that damage to the flexible structure will result. Compact this backfill with hand operated tampers or other equipment acceptable to Engineer.

END OF SECTION