Section 2420. Structural Plate Pipes, Pipe Arches, and Arches

2420.01 DESCRIPTION.

Furnish and construct structural plate pipes, pipe arches, or arches meeting requirements of these specifications and of the sizes and dimensions shown in the contract documents.

2420.02 MATERIALS.

A. Use materials for structural plate pipe, pipe arches, and arches that meet the requirements of Section 4144.

B. Unless specified otherwise, furnish a galvanized corrugated steel structure.

2420.03 CONSTRUCTION.

A. Quality of Work.

1. In addition to compliance with the details of construction, the completed structure must demonstrate high quality work. Plates on which the galvanizing has been damaged or broken, either in the shop or in shipping, or which show defective work will be rejected. The requirement applies not only to the individual plates but to the shipment for any contract as a whole.

2. Among others, the following defects are specified as constituting poor quality work. The presence of any or all of them in any individual culvert plate, in any shipment, or, in general, in the completed culvert, will constitute sufficient cause for rejection:

- **a.** Uneven laps.
- **b.** Elliptical shaping (unless specified), or otherwise excessive distortion.
- **c.** Variations from a straight center line.
- **d.** Ragged edges.
- **e.** Loose, unevenly lined or spaced bolts.
- **f.** Illegible brand.
- **g.** Damaged, scaled, or broken galvanizing.
- **h.** Dents or bends in the metal itself.

B. Bedding.

1. When a pipe structure is to be erected in a trench, construct the trench to be wide enough to permit thorough tamping of the earth backfill material against every plate except the bottom one.

2. Bed the pipe in an earth foundation of uniform density. Carefully shape the foundation with a template, or use other means and check with a template. Support the pipe at the desired grade. Ensure pipe has the required camber to fit the lower plate of the pipe.

3. When rock in either ledge or boulder formation is encountered, remove it below grade. Replace the rock with suitable materials in a manner to

provide a minimum 8 inch (200 mm) thick compacted earth cushion having a thickness under the pipe no less than 1/2 inch per foot (40 mm/m) of fill over the pipe.

4. When firm foundation is not encountered at the grade established, due to soft, spongy, or other unsuitable soil, remove all unsuitable soil for a maximum distance of one diameter under and on each side of the pipe. Replace with suitable earth or granular material properly compacted to provide adequate support of the pipe. Use other special construction methods if specified. Excavate unsuitable soil below grade and place backfill material only at the at the Engineer's direction. This will be paid for as extra work unless provided otherwise in the contract documents.

5. Prepare the base according to Article 2416.03, D, 2. Ensure the bedding provides camber to allow for settlement after placing the fill. Vary the amount of camber to suit the height of fill and nature of supporting soil. Provide a minimum camber of 1% of the length of the pipe.

C. Multiple Structures.

When multiple structures of pipe or pipe arches are used, space them so that the adjacent sides of pipe are from 50% of the diameter to a maximum of 4 feet (1 m) apart to permit tamping of backfill material. Ensure the distance between plates at skewback of multiple arch spans is no less than 10% of the longer adjoining span.

D. Field Erection, Structural Plate Pipe, and Pipe Arches.

1. Beginning at the downstream end, place full sized bottom plates along the center line of the structure, lapping each plate one corrugation with the previous plate. Use fasteners to connect plates at longitudinal and circumferential seams. Stagger joints so that no more than three plates come together at one point.

2. After all plates have been placed, tighten all bolts to a minimum torque value of 100 foot pounds (135 N·m) and a maximum of 300 foot pounds (400 N·m).

3. When end treatment requires a rigid headwall, anchor the plates to the headwall with anchor bolts no smaller than 3/4 inch (19 mm) and spaced at no more than 19 inch (480 mm) on center.

4. Assemble pipe arch plates so they form cross sections made up of four circular arcs that are tangent to each other at their junctions and are symmetrical about the vertical axis.

E. Skewed Arch Spans.

Ensure the end skew of arches does not exceed 45 degrees. When the skew is more than 15 degrees, adjust the length of the structure so that no portion of the live load will be carried by the cut portion of the end. Where right-of-way or other conditions do not permit the required length, support the cut end with rigid headwalls designed to meet the conditions. Anchor the

plates to the headwall with 3/4 inch (19 mm) bolts spaced at no more than 19 inch (480 mm) on center.

F. Arch Anchorage.
Anchor each side of the arch to the foundation by means of a formed channel or a structural angle bolted to the bottom row of plates. Ensure the arch plates bear directly on the channel or angle. Use channels or angles made of the same material as the plates. Anchor them to the foundation at intervals of no more than 24 inches (0.6 m).

G. Field Erection, Arches.

1. Begin erection of arch plates at the downstream end by bolting the side plates, at intervals no greater than 24 inches (0.6 m), to the angle or channel attached to the foundation.

2. Set plates inside the vertical leg of the angle or the longer leg of the channel. Ensure they bear directly on the horizontal leg of the angle or the web of the channel.

3. Assemble succeeding plates so that joints at right angles to the center line of the arch are staggered and not continuous for more than the width of one plate.

4. Support the upper edge of each plate of the first ring in its proper place until the full number of plates for the ring is in position.

5. Tighten bolts in each section as required in Article 2420.03, D.

H. Shop Forming.

1. When specified, shop form structural plate pipes to increase the vertical diameter approximately 5% out of round before placement of the fill.

2. A tolerance of ± 2.5% of the nominal pipe diameter or 5 inches (125 mm), whichever is less, will be permitted.

I. Placing Backfill Material.

1. After the structure has been assembled, place backfill material according to Articles 2402.03, G; 2402.03, H; and 2402.03, I. Thoroughly tamp each layer between the structure and the sides of the trench or for a distance on each side of the structure equal to the diameter of the structure.

2. After the fill over the structure has been completed to the full height, release and remove the struts, if any.

3. Exercise care when placing backfill material to prevent excessive distortion of the shape of the structure, either in peaking action or rolling action. Deflection in any direction greater than 2.5% from the original

specified shape will not be allowed during the backfill material placement operation.

4. In addition to placing backfill material as required above, when the Engineer orders, build approach fills that will provide a roadway 10 feet (3 m) wide over the culvert, with grades no steeper than 10%.

2420.04 METHOD OF MEASUREMENT.

Measurement will be as follows:

A. Structural pipe culvert: feet (meters) to the nearest foot (0.1 m) shown in the contract documents for each culvert. The quantity of pipe will be determined as follows:

1. Pipes and arches with either square or skewed vertical ends: end to end of metal on center line of structure.

2. Pipes or pipe arches with square ends, beveled: average end to end at top and bottom of pipe.

3. Pipes or pipe arches with skewed ends, beveled: average end to end at top and bottom of pipe parallel to center line.

4. Arches with ends other than vertical: as noted in the contract documents.

B. Excavation for structural plate pipe: as specified for culverts in Article 2402.04. When the pipe is installed without change in location, dimensions, or elevation, the quantities of Class 20 or Class 23 and Class 24 excavation, as shown in the contract documents, will be the quantities for which payment is made.

C. Excavation for structural plate arches: as specified for structures in Article 2402.04 for the respective classes of excavation performed.

D. Structural concrete: Article 2403.04 applies.

E. Steel reinforcement: Article 2404.04 applies.

2420.05 BASIS OF PAYMENT.

A. Payment for structural pipe culvert of type and size specified will be the contract unit price for per linear foot (meter).

B. Payment is full compensation for furnishing all materials, labor, and equipment necessary to complete the work.

C. Excavation for structures, structural concrete, and reinforcement will be paid for separately.