

Item No. 558
Structural Plate Structures

558.1 Description

This item shall consist of furnishing and installing structural plate pipes, pipe arches, arches and special shapes conforming to these specifications, of the sizes, out dimensions and materials indicated at locations indicated or as directed by the Engineer, in conformity with established lines and grades. Structural plate pipes shall be furnished round or elongated, as indicated.

558.2 Materials and Manufacture

(1) Plates

The plates and fasteners used for construction of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes shall conform to AASHTO M 167 for galvanized corrugated steel structures and to AASHTO M 219 for aluminum alloy structures.

Steel fasteners may be mechanically galvanized or hot-dip galvanized.

Steel plates shall consist of structural units of corrugated galvanized metal. 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 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. Footings for arches shall be designed and constructed to accommodate this additional length.

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 1 foot.

Plates shall be formed to provide bolted lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure will be as indicated. Joints shall be staggered so that not more than 3 plates are jointed at any one point. Unless otherwise indicated, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be (a) staggered in rows 2 inches apart, with 1 row in the valley and 1 in the crest of the corrugations and not less than 4 bolts per foot for galvanized steel structures or (b) in rows 1 3/4 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. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of the plate shall be not less than 1 3/4 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch. Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified.

Burned edges shall be free from oxide and burrs, shall present a proper finish and legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

(2) Metal Headwalls

The material for metal headwalls shall comply with details indicated.

When required, aluminum alloy inverts, toe walls, footings and closure plates shall conform to the material requirements for the aluminum structural plate structure. Extruded aluminum transverse stiffeners shall conform to ASTM B 221, Alloy 6061-T6.

(3) Concrete

Concrete and reinforcing steel shall conform to Item No. 403S, "Concrete for Structures" and Item No. 406, "Reinforcing Steel". Unless otherwise indicated, concrete for footings and headwalls shall be Class A. Riprap for slope protection and for invert paving, when required, shall be Class B concrete, with reinforcement as indicated and shall conform to Item No. 591S, "Riprap for Slope Protection".

Material for membrane curing shall conform to Item No. 409, "Membrane Curing".

558.3 Visual Inspection

The Contractor shall furnish an itemized statement of the number and size of plates in each shipment. From this list a visual inspection shall include an examination of the plates for deficiency in size, radius of curvature specified and any evidence of poor quality of work as outlined herein. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating. The plates making up the shipment shall fully meet the requirements of these specifications. Any plates failing to do so will be rejected.

558.4 Mill and Factory Inspection

If the Engineer so elects, he may have the material inspected and sampled in the rolling mill or in the shop where fabricated. He may require from the mill the chemical analysis of any plate. The inspection, either in the mill or in the shop, shall be under the direction of the Engineer. The Engineer or his representative shall have free access to the mill or shop for inspection and every facility shall be extended to him for this purpose. Any material which has been previously rejected at the mill or shop and included in a later lot will be cause for rejection unless it has been satisfactorily repaired.

558.5 Quality of Work

Structural plates on which the spelter coating has been damaged or which show substandard work, shall be rejected, except that damaged areas of spelter coating deemed by the Engineer to be of a minor nature may be repaired by painting with a zinc dust-zinc oxide paint conforming to individual plates but to the shipment as a whole. The following defects indicate substandard work and their presence in any individual structure plate will be cause for rejection:

- (a) Uneven laps
- (b) Elliptical shaping (unless specified)
- (c) Variation from a straight center line
- (d) Ragged edges
- (e) Loose, uneven lined or spaced bolts
- (f) Illegible brand
- (g) Bruised, scaled or broken spelter coating
- (h) Dents or bends in the metal itself

558.6 Design

(1) Gage or Minimum Thickness and Corrugations for Structural Plate

The gage or minimum thickness and permissible corrugations of metal plates to be furnished for each structure will be as indicated.

(2) Skewed Structures

The end skew shall not exceed 45 degrees. When the skew of arches is more than 15 degrees, the length of the structure shall be such that no portion of the live load will be carried by the cut portion of the arch end. Where right of way or other conditions do not permit the required length, the cut end shall be supported by a rigid headwall designed to meet the conditions. When the skew angle of pipes exceeds 20 degrees and the structure has the ends cut to fit a slope, the ends shall be reinforced with concrete riprap or other suitable end treatment as indicated on the plans or as directed by the Engineer. If headwalls are required, the plates shall be anchored to the headwall with not less than 3/4 inch diameter by 6 inch mini-length bolts, at not over 19 inch centers. If structures are to have skewed ends, bevels, step-bevels or other special end treatment, this information will be indicated.

(3) Multiple Structures Installed in Parallel Lines

Where multiple lines of pipes, pipe arches or box culverts greater than 48 inches in diameter or span are used, they shall be spaced so that adjacent sides of the pipe shall be at least 1/2 diameter or 3 feet apart, whichever is less, to permit adequate compaction of backfill material. For diameters up to and including 48 inches, the minimum spacing shall be not less than 24 inches.

(4) Substructure for Arches

The substructure for structural plate arches shall be as indicated.

558.7 Designation of Type

The type(s) of structure will be indicated by one of the following descriptions:

- Structural Plate Pipe (Galv. Steel)
- Structural Plate Pipe (Alum.)
- Structural Plate Pipe Arch (Galv. Steel)
- Structural Plate Pipe Arch (Alum.)
- Structural Plate Arch (Galv. Steel)
- Structural Plate Underpass (Galv. Steel)
- Structural Plate Underpass (Alum.)
- Structural Plate Long Span Structures (Galv. Steel)
- Structural Plate Long Span Structures (Alum.)

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

558.8 Construction Methods

(1) Excavation

All excavation shall conform to Item No. 401, "Structural Excavation". Trenches for pipes, pipe arches, underpasses or box culverts shall be of sufficient width to provide free working space for erection and thorough tamping of the 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, the excavation shall extend, to each side of the barrel, a minimum horizontal distance of half the span or 2/3 of the total rise, whichever is

greater. The Contractor shall make such temporary provisions as may be necessary to insure adequate drainage of the trench and bedding during the construction operation.

(2) Foundations, Structural Plate Structures with Metal Inverts

These structures shall be bedded in a foundation of sandy earth material carefully and accurately shaped to fit the lower part of the pipe for at least 10 percent of its overall height, except that the length of bedding arc need not exceed the width of the bottom plate. The sandy material shall be at least 3 inches in thickness so as to obtain uniform seating of the corrugations on the pipe bed. For culverts the bedding specified herein shall be the full width of the invert.

Where rock, in either ledge or boulder formation, is encountered, it shall be removed below grade and replaced with a compacted earth cushion having a thickness of not less than 1/2 inch per foot height of fill over the top of the pipe, with the minimum allowable thickness of 12 inches and a maximum of 24 inches under the pipe. Where the soil encountered at the established grade is a quicksand, muck or similar unstable material, it shall be removed and replaced in conformance with Item No. 401, "Structural Excavation". Special bedding, when required, shall be as indicated.

(3) Foundations, Structural Plate Structures with Reinforced Concrete Footings

Footings for these structures shall be formed and finished to true lines and grades as established by the Engineer. Anchors or slots (for box culverts) shall be set to true line and grade when placing concrete for each substructure unit. The work of placing substructure units shall conform to Item No. 403S, "Concrete for Structures", Item No. 406, "Reinforcing Steel" and Item No. 410, "Concrete Structures".

Footing shall be placed entirely on (a) rock, shale or similarly hard material or (b) firm soil or compacted soil cushion. When part of the founding area is rock, it shall be undercut and replaced 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, the soil may removed and the footings place directly on rock as indicated.

(4) Erection

Structural plate structures shall be installed as indicated and in accordance with this item.

Any steel in joints which is not protected by galvanizing shall be coated with suitable asphaltum paint.

Pipes and/or plates shall be handled carefully to avoid damage to any protective coating. Damaged coatings shall be repaired.

Anchor bolts used for anchoring plates to headwalls or other concrete end treatment shall be 3/4 inch diameter by 6 inch minimum length on not more than 19 inch centers.

No plates for arch structures shall be placed until the substructure has cured for a minimum of 3 days.

When all plates are in position, all bolts not already in place shall be inserted and all nuts tightened progressively and uniformly, beginning at one end of the structure. All nuts shall be tightened 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 if using aluminum bolts. It is essential that bolts be well If an impact wrench is used, a sufficient number of bolts should be checked with a long-handled, structural or socket wrench or a torque wrench to insure that they are properly tightened. All service bolts used in drawing the plates together shall be replaced with standard high strength bolts.

(5) Shape Control

The Contractor shall furnish acceptable shape control devices for monitoring the horizontal and vertical shape of the structure(s). The shape shall be kept within 2 percent of design measurements (span or rise, whichever is greater) or 5 inches whichever is less during erection and backfilling.

(6) Backfilling

Backfilling and/or construction of the embankment around and over the pipe is a critical phase of the construction and strict adherence to these construction methods is required. Backfilling and/or embankment construction around the pipe shall conform to Item No. 401, "Structural Excavation", except as modified herein.

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 will be permitted.

Unless otherwise indicated or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 4

feet of permanent or temporary, compacted fill has been placed thereon. Plates or structures damaged by the Contractor's equipment during backfilling operation shall be removed and replaced by the Contractor at his expense.

During the backfilling operations, extreme care shall be taken to avoid unequal pressures and to obtain uniformly compacted backfill material of uniform density throughout the length of the structure and to insure proper backfill under the structure.

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.

The structure shall be backfilled so that when backfill is complete the inside dimensions shall be within tolerances set forth in shape control above. In the case of arches (does not apply to pipe arches) when backfilling is completed before headwalls are placed, the first material shall be placed midway between the ends of the arch, forming as narrow a ramp as possible until the top of the arch is reached. The ramp shall be constructed evenly from both sides and the backfilling material shall be thoroughly compacted as it is placed. After the 2 ramps have been constructed to the top of the arch, the remainder of the backfill shall be deposited 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 the headwalls are built before the arch is backfilled, the fill material shall be placed first adjacent to one headwall until the top of the arch has been reached, after which the fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit the material evenly on both sides of the arch.

For multiple structures the same backfill phases will be performed for all structures more or less simultaneously. Backfilling between the barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Backfill material shall not be dropped over the top arc so that damage to the flexible structure will result. Compaction of this backfill shall be with hand operated tampers or other acceptable equipment.

558.9 Measurement

Structural plate pipes, pipe arches, arches or special shapes of the gage or minimum thickness and corrugation indicated will be measured by the linear foot of each structure along its flow line between the ends of the structure.

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

Aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, when required, will be considered a part of the requirements of the structure and will not be measured for payment.

558.10 Payment

Payment for "Structural Plate Pipes, Pipe Arches, Arches or Special Shapes", measured as prescribed above, will be made at the unit price bid for the various sizes, gage or minimum thickness and of the required material, if specified, of the various items required by the plans, complete in place.

This payment shall be full compensation for furnishing, transporting and erecting; for handling and placing of select fill material; for all bolts, nuts, washers, anchor bolts and anchor channels or angles; for furnishing all aluminum alloy inverts, toe walls, footings, closure plates and stiffeners, when required; and for all other items of material, labor, equipment, tools and incidentals necessary to complete the various installations in accordance with these specifications.

Payment will be made under one of the following:

Pay Item No. 558 A: Structural Plate Pipe, _____, _____ Per Linear Foot.

Pay Item No. 558 B: Structural Plate Pipe Arch, _____, _____ Per Linear Foot.

Pay Item No. 558 C: Structural Plate Arch, _____, _____ Per Linear Foot

Pay Item No. 558 D: Structural Plate Underpass, _____,
_____ Per Linear Foot.

Pay Item No. 558 E: Structural Plate Box Culvert, _____,
_____ Per Linear Foot.

End