



SECTION 1023

STRUCTURAL PLATE PIPE AND PIPE ARCHES

1023.1 Scope. This specification covers corrugated galvanized steel structural plates intended for use in construction of pipe and pipe arches. The plates shall consist of corrugated galvanized metal and shall be curved such that the plates can be bolted together to form a structure of the specified shape and size.

1023.2 Basis of Acceptance. The basis of acceptance will be in accordance with [Sec 1020.2](#), [Sec 1020.5](#), and as specified herein.

1023.3 Material. Corrugated galvanized steel structural plate for structural plate pipe and pipe arches shall be in accordance with AASHTO M 167, with the following modifications.

1023.3.1 Corrugations. The radii of curvature of the corrugations shall be at least one-half the depth of the corrugations. The corrugations shall have a depth of 2 inches (50 mm) and a pitch of 6 inches (150 mm). The depth of corrugations shall not underrun the specified depth by more than 5 percent, and the pitch of the corrugations shall not deviate from the specified depth by more than 1/4 inch (6 mm).

1023.3.2 Spelter Coating. The spelter coating shall be free from injurious defects such as blisters, flux and uncoated spots. For testing the weight (mass) of spelter coating and for chemical analysis, if required, the manufacturer shall take two samples for each 100 plates of each thickness of a shipment or fraction thereof. The samples may be obtained from a piece approximately 3 inches (75 mm) square, cut from a corner of a plate or from a coupon approximately 6 inches (150 mm) square attached to the center of one edge of the plate prior to galvanizing. The coupon shall be of the same thickness and base metal as the plate to which the coupon is attached. One sample shall be retained for the engineer for QA purposes and one sample shall be tested by the manufacturer. If the result of a test for weight (mass) of coating for any sample is not in accordance with AASHTO M 167, an additional sample shall be cut for tests from each of two other plates in the lot represented by the nonconforming sample. All original samples and samples for retest shall be in accordance with AASHTO M 167, or the entire shipment will be rejected. At the option of the engineer, the material may be accepted or rejected on the basis of magnetic gauge results, except at the request of the contractor or manufacturer, plates rejected by magnetic gauge results will be sampled as specified above.

1023.3.3 Accepted Brands of Metal. No metal will be accepted under these specifications until after the manufacturer's certificate and guarantee have been approved by the engineer.

1023.3.3.1 Manufacturer's Certificate. The manufacturer of the structural plate identified by the manufacturer's mark shall file with Construction and Materials, a certificate setting forth the name of the manufacturer, the base metal manufacturer, the specified chemical composition and a typical or average analysis showing the percent of sulfur, copper and any other elements specified in Table I of AASHTO M 167. The certificate shall be sworn to for the manufacturer by a person having legal authority to bind the company. Mismatching or other misrepresentation by the manufacturer will be considered sufficient reason to discontinue acceptance under these specifications. Notice sent to the manufacturer of the

discontinuance of acceptance will be considered to be notice to all companies handling that particular manufacturer's product.

1023.3.3.2 Manufacturer's Guarantee. The manufacturer of the structural plate shall submit with the certificate a guarantee providing that all structural plate furnished is in accordance with the specifications, shall bear the manufacturer's identification mark and shall be replaced without cost when not in accordance with the specified analysis, sheet thickness or spelter coating. The guarantee shall be so worded as to remain in effect as long as the manufacturer continues to furnish the material.

1023.3.4 Bolts and Nuts for Connecting Plates.

1023.3.4.1 Bolts for connecting plates shall be 3/4 inch (19 mm) in diameter and shall be in accordance with ASTM A 449. Nuts shall be in accordance with ASTM A 563, Grade C. Bolts, nuts and washers shall be galvanized in accordance with AASHTO M 232, or the bolts, nuts and washers may be mechanically galvanized. If mechanically galvanized, the coating thickness, adherence and quality requirements shall be in accordance with AASHTO M 232, Class C. Except as specified herein, bolts and nuts shall meet the dimension requirements of ANSI B18.2.1 for heavy hex bolts and ANSI B18.2.2 for heavy hex nuts. The bearing surface of both bolts and nuts shall be symmetrically shaped to a one-inch (25 mm) radius spherical surface. The maximum height of the wrench flats on bolts and thickness of nuts shall be within the limits specified in ANSI B18.2.1 and ANSI B18.2.2, respectively. Bolt lengths shall be such as to result in at least "full nuts" when tightened in place. The bolts and nuts may be sampled and tested before erection, or the bolts, nuts and washers may be accepted on certified mill tests by the manufacturer.

1023.3.4.2 Other fasteners may be used if the fasteners:

- (a) Meet the chemical and mechanical requirements in [Sec 1023.3.4.1](#).
- (b) Have body diameter and bearing areas no less than those specified in [Sec 1023.3.4.1](#).
- (c) Provide a comparable fit with the corrugations.

1023.4 Manufacture. Plates shall be connected by bolts at longitudinal and circumferential seams. Joints shall be staggered such that no more than three plates come together at any one point. Plates shall be furnished in standard sizes to permit structure length increments of 2 feet (600 mm). The size and shape of the plates shall be such that the finished structure will have the dimensions shown on the plans or as specified herein and the circumferential or peripheral transverse seams will be staggered at least one foot (300 mm), except that the engineer may permit the seams in adjacent plates used for construction of beveled or skewed ends to be continuous. At least four bolts shall be used per foot (300 mm) of longitudinal seam, unless a greater number is specified on the plans, staggered in two rows 2 inches (50 mm) apart, with one row in the valleys and one row on the crests of the corrugations. Bolts along circumferential seams shall be spaced no more than 10 inches (250 mm) apart. The distance from the center of bolt hole to the edge of the plate shall be no less than 1.75 times the diameter of the bolt. The diameter of the bolt holes for the longitudinal seams, except holes at corners of plates, shall not exceed the diameter of the bolts by more than 1/4 inch (6 mm). The major axis of the holes for transverse seams, including the holes at the corners of the plates, shall not exceed the diameter of the bolt by more than 1/2 inch (13 mm) and the average of the major and minor axis shall not exceed the diameter of the bolt by more than 1/4 inch (6 mm).

1023.4.1 Circular Pipe. A manufacturing tolerance of 3 inches (75 mm) will be permitted in the diameter of the pipe. The thickness of metal to be used for each structure will be specified in the contract. The plates shall be prominently marked to show the position in which the plates are to be placed in the structure.

1023.4.2 Pipe-Arch. Plates for a pipe-arch shall form a cross-section made up of four circular arcs tangent to each other at the arcs' junctions and symmetrical about the vertical axis. The top shall be an arc of no more than 180 degrees or no less than 155 degrees. The bottom shall be an arc of no more than 50 degrees or no less than 10 degrees. The top shall be joined at each end to the bottom by an arc of no more than 87.5 degrees or no less than 75 degrees. The radius of corner arcs shall be between 16 and 21 inches (400 and 525 mm) for Type C-29 and smaller sizes, and between 29 and 33 inches (725 and 825 mm) for Type C-30 and larger sizes. The dimensions of structural plate pipe-arch shall be as specified below, subject to a manufacturing tolerance of two percent plus one inch (25 mm). The thickness of metal to be used for each structure will be specified in the contract.

Structural Plate Pipe-Arch							
English							
Type	Area, Sq Ft	Span, Ft-In.	Height, Ft-In.	Type	Area, Sq Ft	Span, Ft-In.	Height, Ft-In.
C-1	22	6-1	4-7	C-28	105	14-10	9-1
C-2	24	6-4	4-9	C-29	109	15-4	9-3
C-3	26	6-9	4-11	C-30	98	13-3	9-4
C-4	28	7-0	5-1	C-31	102	13-6	9-6
C-5	31	7-3	5-3	C-32	106	14-0	9-8
C-6	33	7-8	5-5	C-33	110	14-2	9-10
C-7	35	7-11	5-7	C-34	115	14-5	10-0
C-8	38	8-2	5-9	C-35	119	14-11	10-2
C-9	40	8-7	5-11	C-36	124	15-4	10-4
C-10	43	8-10	6-1	C-37	129	15-7	10-6
C-11	46	9-4	6-3	C-38	133	15-10	10-8
C-12	49	9-6	6-5	C-39	138	16-3	10-10
C-13	52	9-9	6-7	C-40	143	16-6	11-0
C-14	55	10-3	6-9	C-41	148	17-0	11-2
C-15	58	10-8	6-11	C-42	153	17-2	11-4
C-16	61	10-11	7-1	C-43	158	17-5	11-6
C-17	64	11-5	7-3	C-44	163	17-11	11-8
C-18	67	11-7	7-5	C-45	168	18-1	11-10
C-19	71	11-10	7-7	C-46	174	18-7	12-0
C-20	74	12-4	7-9	C-47	179	18-9	12-2
C-21	78	12-6	7-11	C-48	185	19-3	12-4
C-22	81	12-8	8-1	C-49	190	19-6	12-6
C-23	85	12-10	8-4	C-50	196	19-8	12-8
C-24	89	13-5	8-5	C-51	202	19-11	12-10
C-25	93	13-11	8-7	C-52	208	20-5	13-0
C-26	97	14-1	8-9	C-53	214	20-7	13-2
C-27	101	14-3	8-11

Metric							
Type	Area, m ²	Span, mm	Height, mm	Type	Area, m ²	Span, mm	Height, mm
C-1	2.0	1850	1400	C-28	9.8	4500	2750
C-2	2.2	1950	1450	C-29	10.1	4700	2800
C-3	2.4	2050	1500	C-30	9.1	4050	2850
C-4	2.6	2150	1550	C-31	9.5	4100	2900
C-5	2.9	2200	1600	C-32	9.8	4250	2950
C-6	3.1	2350	1650	C-33	10.2	4300	3000
C-7	3.3	2400	1700	C-34	10.7	4400	3050
C-8	3.5	2500	1750	C-35	11.1	4550	3100
C-9	3.7	2600	1800	C-36	11.5	4650	3150
C-10	4.0	2700	1850	C-37	12.0	4750	3200
C-11	4.3	2850	1900	C-38	12.4	4800	3250
C-12	4.6	2900	1950	C-39	12.8	4950	3300
C-13	4.8	3000	2000	C-40	13.3	5050	3350
C-14	5.1	3100	2050	C-41	13.7	5200	3400
C-15	5.4	3250	2100	C-42	14.2	5250	3450
C-16	5.7	3350	2150	C-43	14.7	5300	3500
C-17	5.9	3500	2200	C-44	15.1	5450	3550
C-18	6.2	3550	2250	C-45	15.6	5500	3600
C-19	6.6	3600	2300	C-46	16.2	5650	3650
C-20	6.9	3750	2350	C-47	16.6	5700	3700
C-21	7.2	3800	2400	C-48	17.2	5850	3750
C-22	7.5	3850	2450	C-49	17.7	5950	3800
C-23	7.9	3900	2550	C-50	18.2	6000	3850
C-24	8.3	4050	2550	C-51	18.7	6050	3900
C-25	8.6	4250	2600	C-52	19.3	6200	3950
C-26	9.0	4300	2650	C-53	19.9	6300	4000
C-27	9.4	4350	2700

1023.4.3 Beveled Ends When specified on the plans, end plates for forming beveled ends shall be shaped to produce the specified slope in the finished structure. Burnt edges shall be free from oxide and burrs, and shall present a workmanlike finish. Any edges cut after galvanizing shall be completely covered with two coats of single component inorganic zinc or organic zinc-rich paint, meeting the approval of the engineer. Legible identification marks shall be placed on each part plate to designate the plate's proper position in the structure.

1023.5 Workmanship. All plates shall show careful and finished workmanship. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of these defects in an individual plate or in general in any shipment, will be considered sufficient cause for rejection:

- (a) Improper shape.
- (b) Ragged edges.
- (c) Unevenly aligned or spaced bolt holes.
- (d) Illegible brands.
- (e) Bruised, scaled or broken spelter coating.

(f) Dents in the metal.

(g) Bends in the metal not specified.

1023.6 Assembly Instructions and Drawings. The contractor shall provide the engineer with detailed assembly instructions and drawings for each structural plate pipe or pipe-arch prior to the installation of these structures.

1023.7 Repair of Galvanizing. Spelter coating damaged in the field shall be repaired by hot-dip galvanizing, the metallizing process as specified in [Sec 1020](#) or by the zinc alloy stick method in accordance with [Sec 1081](#), except that in instances of minor damage, the engineer may permit repair by painting with two coats of single component inorganic zinc or organic zinc-rich paint. The paint and application shall meet the approval of the engineer.