Designation: B745/B745M – 15 (Reapproved 2021)

Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains[1]

This standard is issued under the fixed designation B745/B745M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers corrugated aluminum pipe intended for use for storm water drainage, underdrains, the construction of culverts, and similar uses. Pipe covered by this specification is not normally used for the conveyance of sanitary or industrial wastes.

1.2 This specification does not include requirements for bedding, backfill, or the relationship between earth-cover load and sheet thickness of the pipe. Experience has shown that the successful performance of this product depends upon the proper selection of sheet thickness, type of bedding and backfill, controlled manufacture in the plant, and care in the installation. The purchaser must correlate the above factors and also the corrosion and abrasion requirements of the field installation with the sheet thickness. The structural design of corrugated aluminum pipe and the proper installation procedures are given in Practices B790/B790M and B788/B788M, respectively. A procedure for using life-cycle cost analysis techniques to evaluate alternative drainage system designs using corrugated metal pipe is given in Practice A930.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A153/A153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A307 Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

A563 Specification for Carbon and Alloy Steel Nuts (Metric) A0563_A0563M

A563M Specification for Carbon and Alloy Steel Nuts (Metric) (Withdrawn 2021)[3]

A796/A796M Practice for Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications

A930 Practice for Life-Cycle Cost Analysis of Corrugated Metal Pipe Used for Culverts, Storm Sewers, and Other Buried Conduits

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) B0209_B0209M

B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) (Withdrawn 2021)[3]

B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

B221M Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

B316/B316M Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods

B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel

B666/B666M Practice for Identification Marking of Aluminum and Magnesium Products

B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

B744/B744M Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe

B788/B788M Practice for Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe

B790/B790M Practice for Structural Design of Corrugated

[1] This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.08 on Corrugated Aluminum Pipe and Corrugated Aluminum Structural Plate.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

Aluminum Pipe, Pipe-Arches, and Arches for Culverts, Storm Sewers, and Other Buried Conduits
C443 Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
D1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
F467 Specification for Nonferrous Nuts for General Use
F467M Specification for Nonferrous Nuts for General Use (Metric)
F468 Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
F468M Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use (Metric)
F568M Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners (Metric) (Withdrawn 2012)[3]
F593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F594 Specification for Stainless Steel Nuts
F738M Specification for Stainless Steel Metric Bolts, Screws, and Studs (Withdrawn 2014)[3]
F836M Specification for Style 1 Stainless Steel Metric Nuts (Metric)

2.2 *AASHTO Standard:*[4]
T 249 Test for Helical Lock Seam Corrugated Pipe

2.3 *AISI Standard:*
AISI S100 North American Specification for the Design of Cold-Formed Steel Structural Members

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*
3.1.1 *fabricator, n*—the producer of the pipe.

3.1.2 *manufacturer, n*—the producer of the sheet.

3.1.3 *purchaser, n*—the purchaser of the finished product.

4. Classification

4.1 The corrugated aluminum pipe covered by this specification is classified as follows:

4.1.1 *Type I*—This pipe shall have a full circular cross-section, with a single thickness of corrugated sheet, fabricated with annular (circumferential) or helical corrugations.

4.1.2 *Type IA*—This pipe shall have a full circular cross-section, with an outer shell of corrugated sheet and an inner liner of smooth (uncorrugated) sheet, fabricated with helical corrugations and lock seams.

4.1.3 *Type IR*—This pipe shall have a full circular cross-section, with a single thickness of smooth sheet, fabricated with helical ribs projecting outwardly.

4.1.4 *Type II*—This pipe shall be a Type I pipe which has been reformed into a pipe-arch, having an approximately flat bottom.

4.1.5 *Type IIA*—This pipe shall be a Type IA pipe which has been reformed into a pipe-arch, having an approximately flat bottom.

4.1.6 *Type IIR*—This pipe shall be a Type IR pipe which has been reformed into a pipe-arch, having an approximately flat bottom.

4.1.7 *Type III*—This pipe, intended for use as underdrains or for underground disposal of water, shall be a Type I pipe which has been perforated to permit the in-flow or out-flow of water.

4.1.8 *Type IIIR*—This pipe, intended for the underground disposal of water or for subsurface drainage, shall be a Type IR pipe which has been perforated to permit the outflow or inflow of water.

4.2 Perforations in Type III pipe are classified as Class 1 or Class 2 and perforations in Type IIIR pipe are classified as Class 4, as described in 8.3.2.

5. Ordering Information

5.1 Orders for material to this specification shall include the following information as necessary, to adequately describe the desired product:

5.1.1 Name of material (corrugated aluminum pipe),

5.1.2 ASTM designation and year of issue, as B745-_ for inch-pound units or B745M-_ for SI units,

5.1.3 Type of pipe (4.1),

5.1.4 Method of fabrication for Type I and Type II pipe (7.1),

5.1.5 Diameter of circular pipe (8.1.1), or span and rise of pipe-arch section (8.2.1),

5.1.6 Length, either total length or length of each piece and number of pieces,

5.1.7 Description of corrugations (7.2),

5.1.8 Sheet thickness (8.1.2),

5.1.9 Coupling bands, number, and type (9.1) if special type is required,

5.1.10 Gaskets for coupling bands, if required (9.3),

5.1.11 For perforated pipe, the class of perforations. If no class is specified for Type III pipe, Class 1 perforations will be furnished. Type IIIR pipe is furnished with Class 4 perforations only (8.3.2.1 and 8.3.2.3),

5.1.12 Certification, if required (13.1), and

5.1.13 Special requirements.

6. Materials

6.1 *Aluminum Sheet for Pipe*—All pipe fabricated under this specification shall be formed from aluminum-alloy sheet conforming to Specification B744/B744M.

6.2 *Aluminum Sheet for Coupling Bands*—The sheet used in fabricating coupling bands shall conform to Specification B744/B744M.

6.3 *Rivets*—The material used for rivets in riveted pipe shall conform to the requirements of Specification B316/B316M for alloy 6053-T61 and alloy 5056 H32, to meet or exceed the following mechanical properties:

Tensile Strength, min, ksi [MPa]	25 [170]
Yield Strength, min, ksi [MPa]	14 [95]
Shear Strength, min, ksi [MPa]	15 [105]
Elongation in 2 in., 50 mm, or 4x dia., min, %	14 [95]

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

If bolts and nuts are substituted for rivets (see 7.3.1), they shall meet the following requirements for either steel bolts and nuts, stainless steel bolts and nuts, or aluminum alloy bolts and nuts:

	Bolts	Nuts
For B745 pipe		
(Steel)	A307	A563, Gr. A
(Stainless Steel)	F593, Alloy Grp 1, 2, or 3	F594, Alloy Grp 1, 2, or 3
(Aluminum Alloy)	F468, Alloy 6061-T6	F467, Alloy 6061-T6
For B745M pipe		
(Steel)	F568M, Cl. 4.6	A563M, Cl. 5
(Stainless Steel)	F738M, Alloy Grp A1, A2, or A4	F836M, Alloy Grp A1, A2, or A4
(Aluminum Alloy)	F468M, Alloy 6061-T6	F467M, Alloy 6061-T6

The steel bolts and nuts shall be hot-dip galvanized in conformance with Specification A153/A153M, or be mechanically galvanized in conformance with Specification B695 Class 40.

6.4 *Hardware for Coupling Bands*—Bolts and nuts for coupling bands shall conform to the requirements shown in 6.3 except for the coating on steel bolts and nuts. Steel bolts, nuts, and other threaded steel items used with coupling bands shall be zinc coated by one the following processes: hot-dip process as provided in Specification A153/A153M, electroplating process as provided in Specification B633 Class FE/ZN 8, or mechanical process as provided in Specification B695 Class 8. Other steel hardware items used with coupling bands shall be zinc-coated by one of the following processes: hot-dip process as provided in Specification A153/A153M; electroplating process as provided in Specification B633 Class FE/ZN 25; or mechanical process as provided in Specification B695 Class 25. Aluminum angles and lugs shall conform to the requirements of Specification B221 or B221M for alloy 6063-T6.

6.5 *Gaskets*—If gaskets are used in couplings, they shall be a band of expanded rubber meeting the requirements of Specification D1056 for the "RE" closed cell grades, or O-rings meeting the requirements of Specification C443.

7. Fabrication

7.1 *General Requirements*—Pipe shall be fabricated in full circular cross-section.

7.1.1 Type I pipe shall have annular corrugations with lap joints fastened with rivets or shall have helical corrugations with a continuous lock seam extending from end to end of each length of pipe. As there are important differences in the structural characteristics of annular, riveted pipe versus helical pipe, it is important for the purchaser to stipulate, for Type I and Type II pipe, the method of fabrication desired. If the method of fabrication is not stated in the ordering information, the fabrication method shall be at the option of the fabricator.

7.1.2 Type IA pipe shall be fabricated with a smooth liner and helically corrugated shell integrally attached at helical lock seams extending from end to end of each length of pipe. The shell shall have corrugations of nominal 2⅔ (or 3 in. [68 or 75 mm] pitch.

7.1.3 Type IR pipe shall be fabricated with helical ribs projecting outward with a continuous lock seam extending from end to end of each length of pipe.

7.2 *Corrugations*—The corrugations shall be either annular or helical as provided in 7.1. The direction of the crests and valleys of helical corrugations shall not be less than 60° from the axis of the pipe for pipe diameters larger than 21 in. [525 mm], and not less than 45° from the axis for pipe diameters of 21 in. [525 mm] and smaller.

7.2.1 For Type I and IA pipe, corrugations shall form smooth continuous curves and tangents. The dimensions of the corrugations shall be in accordance with Table 1 for the size indicated in the order.

7.2.2 For Type IR pipe, the corrugations shall be essentially rectangular ribs projecting outward from the pipe wall. The dimensions and spacings of the ribs shall be in accordance with Table 2 for the size indicated in the order. See also Fig. 1. For the 11½ in. [292 mm] rib spacing, a stiffener shall be included midway between the ribs, if the sheet between the ribs does not include a lock seam. This stiffener shall have a nominal radius of 0.25 in. [6.4 mm] and a minimum height of 0.20 in. [5.1 mm] toward the outside of the pipe.

NOTE 1—The nominal dimensions and properties for smooth corrugations and for ribs are given in Practice B790/B790M.

NOTE 2—When requested by the purchaser, the pipe manufacturer shall provide independent verification that the nominal dimensions of the profile supplied meets or exceeds the sectional properties published in Practice A796/A796M. Such effective sectional properties shall be determined in accordance with AISI S100, North American Specification for the Design of Cold-Formed Steel Structural Members.

7.3 *Riveted Seams*—The longitudinal seams shall be staggered to the extent that no more than three thicknesses of sheet are fastened by any rivet. Pipe to be reformed into pipe-arch shape shall also meet the longitudinal seam requirement of 8.2.2.

NOTE 3—Fabrication of pipe without longitudinal seams in 120° of arc, so that the pipe may be installed without longitudinal seams in the invert, is subject to negotiation between the purchaser and fabricator.

TABLE 1 Corrugation Requirements for Type I, IA, II, IIA, and III Pipe

Nominal Size	Maximum Pitch[A]	Minimum Depth[B]	Inside Radius[C]	
			Nominal	Minimum
		B745 (in.)		
1½ by ¼ [D]	1⅞	0.24	9/32	0.25
2⅔ by ½	2⅞	0.48[E]	11/16	0.5
3 by 1	3¼	0.95	9/16	0.5
6 by 1	6¼	0.95	2.2	2.0
		B745M (mm)		
38 by 6.5[D]	48	6.0	7	6.5
68 by 13	73	12[E]	17	12
75 by 25	83	24	14	12
150 by 25	160	24	56	51

[A] Pitch is measured from crest to crest of corrugations, at 90° to the direction of the corrugations.
[B] Depth is measured as the vertical distance from a straightedge resting on the corrugation crests parallel to the axis of the pipe, to the bottom of the intervening valley.
[C] Minimum inside radius requirement does not apply to a corrugation containing a helical lock seam.
[D] The corrugation size of 1½ by ¼ in. [38 x 6.5 mm] is available only in helically corrugated pipe.
[E] For pipe 12 to 21 in. [300 to 525 mm] dia. inclusive, the minimum corrugation depth shall be 0.42 in. [11 mm].

TABLE 2 Rib Requirements for Type IR Pipe

Nominal Size	Rib			Bottom Outside Radius, Min	Bottom[D] Outside Radius, Max Avg.	Top Outside Radius, Min	Top[D] Outside Radius, Max Avg.
	Width, Min[A]	Depth, Min[B]	Spacing, Max[C]				
			in.				
¾ by ¾ by 7½	0.68	0.73	7¾	0.10	0.50	0.10+*t*	0.50+ *t*
¾ by 1 by 11½	0.68	0.95	11¾	0.10	0.50	0.10+ *t*	0.50+*t*
			mm				
19 by 19 by 190	17	19	197	2.5	12.0	2.5+*t*	12.0+*t*
19 by 25 by 292	17	24	298	2.5	12.0	2.5+*t*	12.0+*t*

[A] Width is a dimension of the inside of the rib but is measured on the outside of the pipe (outside of the rib). It shall meet or exceed the stated minimum width plus two wall thicknesses, that is, 2*T* + 0.68 in. [2 *t* + 17 mm]. Rib width measurements shall be taken at the top and bottom of the rib. The maximum allowable difference between the top and bottom rib width measurements is 0.1875 in. [4.8 mm].
[B] Depth is an average of the ribs within a sheet width measured from the inside by placing a straight edge across the open rib and measuring to the bottom of the rib.
[C] Spacing is an average of three adjacent rib spacings for ¾ by ¾ by 7½ in. [19 by 19 by 190 mm] pipe and two adjacent rib spacings for ¾ by 1 by 11½ in. [19 by 25 by 292 mm] pipe measured center-to-center of the ribs, at 90° to the direction of the ribs.
[D] The averages of the two top rib radii and of the two bottom radii shall be within the minimum and maximum tolerances. The term outside radius refers to the surface outside of the pipe. See Fig. 1.

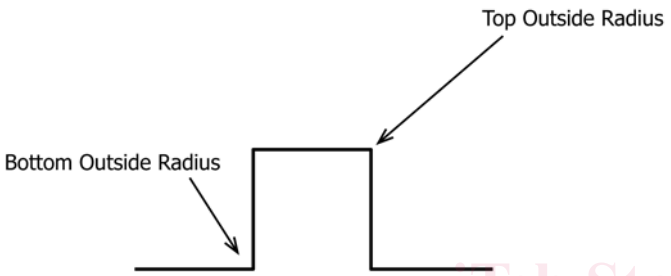

FIG. 1 Outside Radius of the Pipe (see Table 2)

7.3.1 The size of rivets, number per corrugation, and width of lap at the longitudinal seam shall be as stated in Table 3, depending on sheet thickness, corrugation size, and diameter of pipe. For pipe with 1 in. [25 mm] deep corrugations, ½-in. [Metric M12] diameter bolts and nuts may be used instead of rivets on a one-for-one replacement ratio. Circumferential seams shall be riveted using rivets of the same size as for longitudinal seams and shall have a maximum rivet spacing of 6 in. [150 mm], measured on centers, except that six rivets will be sufficient in 12-in. [300 mm] diameter pipe.

7.3.2 All rivets shall be driven cold in such a manner that the sheets shall be drawn tightly together throughout the entire lap. The center of a rivet shall be no closer than twice its diameter from the edge of the sheet. The distance between the centerlines of the two rows of rivets, where two rows are required, shall not be less than 1½ in. [38 mm]. All rivets shall have neat, workmanlike, and full hemispherical heads or heads of a form acceptable to the purchaser, shall be driven without bending, and shall completely fill the hole.

TABLE 3 Riveted Longitudinal Seams

Specified Sheet Thickness		Nominal Corrugation Size					
		2⅔ × ½ in. 68 × 13 mm[A,B]		3 × 1 in. 75 × 25 mm[C,D]		6 × 1 in. 150 × 25 mm[E,D]	
		Rivet Diameters, min.					
in.	mm	in.	mm	in.	mm	in.	mm
0.060	1.52	5⁄16	8.0	⅜	9.5	½	12.7
0.075	1.91	5⁄16	8.0	⅜	9.5	½	12.7
0.105	2.67	⅜	9.5	½	12.7	½	12.7
0.135	3.43	⅜	9.5	½	12.7	½	12.7
0.164	4.17	⅜	9.5	½	12.7	½	12.7

[A] One rivet each valley for pipe diameters 36 in. [900 mm] and smaller. Two rivets each valley for pipe diameters 42 in. [1050 mm] and larger.
[B] Minimum width of lap: 1½ in. [38 mm] for pipe diameters 36 in. [900 mm] and smaller, and 3 in. [75 mm] for pipe diameters 42 in. [1050 mm] and larger.
[C] Two rivets each valley for all pipe diameters.
[D] Minimum width of lap: 3 in. [75 mm] for pipe of all diameters.
[E] Two rivets each crest and valley for all pipe diameters.

7.4 *Helical Lock Seams*—The lock seam for Type I pipe shall be formed in the tangent element of the corrugation profile with its center near the neutral axis of the corrugation profile. The lock seam for Type IA pipe shall be in the valley of the corrugation, shall be spaced not more than 30 in. [760 mm] apart, and shall be formed from both the liner and the shell in the same general manner as Type I helical lock seam pipe. The lock seam for Type IR shall be formed in the flat zone of the pipe wall, midway between two ribs.

7.4.1 The edges of the sheets within the cross-section of the lock seam shall lap at least 5⁄32 in. [4.0 mm] for pipe 10 in. [250 mm] or less in diameter and at least 5⁄16 in. [7.9 mm] for pipe greater than 10 in. [250 mm] in diameter, with an occasional tolerance of minus 10 % of lap width allowable. The lapped surfaces shall be in tight contact. The profile of the sheet shall include a retaining offset adjacent to the 180° fold (as described in AASHTO T 249) of one sheet thickness on one side of the lock seam, or one-half sheet thickness on both sides of the lock seam, at the fabricator's option. There shall be no visual cracks in the metal, loss of metal-to-metal contact, or excessive angularity on the interior of the 180° fold of metal at the completion of forming the lock seam. The lock seam shall be mechanically staked (indented) at periodic intervals, or otherwise specially constructed to prevent slippage.

7.4.2 Specimens cut from production pipe normal to and across the lock seam shall develop the tensile strength as provided in Table 4, when tested according to AASHTO T 249. For Type IA pipe, the lock seam strength shall be as tabulated based on the thickness of the corrugated shell.

7.4.3 When the ends of helically-corrugated lock seam pipe have been re-rolled to form annular corrugations, either with or without a flanged end finish, the lock seam in the re-rolled end shall not contain any visible cracks in the base metal and the tensile strength of the lock seam shall be not less than 60 % of that required in 7.4.2.

7.5 *End Finish:*

TABLE 4 Specified Aluminum Alloy Sheet Thicknesses and Lock Seam Tensile Strength

Specified Sheet Thickness[A,B]		Lock Seam Tensile Strength, min.	
in.	mm	lbf/in.	kN/m
0.036	0.91	100	17
0.048	1.22	145	25
0.060	1.52	170	30
0.075	1.91	245	43
0.105	2.67	425	74
0.135	3.43	550	96
0.164	4.17	700	122

[A] Thicknesses listed are those included in Specification B744/B744M.
[B] For Type IA pipe, the lock seam tensile strength requirement shall be based on the thickness of the corrugated shell.

7.5.1 To facilitate field jointing, the ends of individual pipe sections with helical corrugations or ribs may be re-rolled to form annular corrugations extending at least two corrugations from the pipe end, or to form an upturned flange meeting the requirements in 7.5.3, or both. The diameter of ends shall not exceed that of the pipe barrel by more than the depth of the corrugation. All types of pipe ends, whether re-rolled or not, shall be matched in a joint such that the maximum difference in the diameter of abutting pipe ends is ½ in. [13 mm].

7.5.2 When pipe with helical corrugations or ribs is re-rolled to form annular corrugations in the ends, the usual size of annular corrugations is 2⅔ by ½ in. [68 by 13 mm].

7.5.3 If a flanged finish is used on the ends of individual pipe sections to facilitate field jointing, the flange shall be uniform in width, be not less than ½ in. [13 mm] wide, and shall be square to the longitudinal axis of the pipe.

7.5.4 The ends of all pipe which will form the inlet and outlet of culverts, fabricated of sheets having normal thicknesses of 0.075 in. [1.91 mm] and less, shall be reinforced in a manner approved by the purchaser, when specified.

8. Pipe Requirements

8.1 *Type I, Type IA, and Type IR Pipe:*

8.1.1 *Pipe Dimensions*—The nominal diameter of the pipe shall be as stated in the order, selected from the sizes listed in Table 5. The size of corrugations, which are standard for each size of pipe, are also shown in Table 5. The average inside diameter of circular pipe and pipe to be reformed into pipe-arches shall not vary more than 1 % or ½ in. [13 mm], whichever is greater, from the nominal diameter when measured on the inside crest of the corrugations. Alternately, for pipe having annular corrugations, conformance with the inside diameter requirement may be determined by measuring the outside circumference, for which minimum values are given in Table 5.

NOTE 4—The outside circumference of helically corrugated pipe is influenced by the corrugation size and the angle of the corrugations, affecting the number of corrugations crossed, therefore no minimum circumferential measurement can be specified.

TABLE 5 Pipe Sizes

Nominal Inside Diameter		Corrugation Sizes[A]					Minimum Outside Circumference[B]	
in.	mm	1½ by ¼ in. 38 by 6.5 mm	2⅔ (by ½ in. 68 by 13 mm	3 by 1 in. 75 by 25 mm	6 by 1 in. 150 by 25 mm	Ribbed Pipe[C]	in.	mm
4	100	X					11.4	284
6	150	X					17.7	441
8	200	X					24.0	598
10	250	X					30.2	755
12	300		X				36.5	912
15	375		X			X	46.0	1148
18	450		X			X	55.4	1383
21	525		X			X	64.8	1620
24	600		X			X	74.2	1854
27	675		X			X	83.6	2091
30	750		X	X		X	93.1	2325
33	825		X	X		X	102.5	2561
36	900		X	X		X	111.9	2797
42	1050		X	X		X	130.8	3269
48	1200		X	X	X	X	149.6	3739
54	1350		X	X	X	X	168.4	4209
60	1500		X	X	X	X	187.0	4675
66	1650		X	X	X	X	205.7	5142
72	1800		X	X	X	X	224.3	5609
78	1950			X	X	X	243.0	6075
84	2100			X	X	X	261.7	6542
90	2250			X	X		280.3	7008
96	2400			X	X		299.0	7475
102	2550			X	X		317.6	7941
108	2700			X	X		336.3	8408
114	2850			X	X		355.0	8874
120	3000			X			373.6	9341

[A] An "X" indicates standard corrugation sizes for each nominal diameter of pipe.
[B] Measured in valley of annular corrugations. Not applicable to helically corrugated pipe.
[C] Rib sizes ¾ by ¾ by 7½ in. [19 by 19 by 190 mm] and ¾ by 1 by 11½ in. [19 by 25 by 292 mm].

8.1.2 *Sheet Thickness*—Sheet thickness shall be as specified by the purchaser from the specified sheet thicknesses listed in Table 4 (Note 5 and Note 6). For Type IA pipe, the thickness of both the shell and the liner shall be given; the thickness of the corrugated shell shall be at least 60 % of the thickness of the equivalent Type I pipe; the liner shall have a nominal thickness of at least 0.036 in. [0.91 mm]; and the sum of the specified thicknesses of shell and liner shall equal or exceed the specified thickness of an equivalent pipe of identical corrugations as the shell according to the design criteria in the Practice B790/B790M.

NOTE 5—The sheet thicknesses indicated in Table 4 are the thicknesses listed as available in Specification B744/B744M.

NOTE 6—The purchaser should determine the required thickness for Type I, IA, or IR pipe, or Type I, IA or IR pipe to be reformed into Type II, IIA or IIR pipe according to the design criteria in Practice B790/B790M, or other appropriate guidelines. Specified thickness of 0.036 in. [0.91 mm] is generally used only for Type IA pipe.

8.1.3 When specified by the purchaser, the finished pipe shall be factory elongated to the extent specified. The elongation shall be accomplished by the use of a mechanical apparatus which will produce a uniform deformation throughout the length of the section.

NOTE 7—When corrugated aluminum pipe is designed according to Practice B790/B790M and installed according to Practice B788/B788M, vertical elongation (factory or field) is not required for structural purposes.

8.2 *Type II, Type IIA, and Type IIR Pipe:*

8.2.1 *Pipe-Arch Dimensions*—Pipe furnished as Type II, IIA, or IIR shall be made from Type I, IA, or IR pipe respectively, and shall be reformed to provide a pipe-arch shape. All applicable requirements for Types I, IA, or IR pipe shall be met by finished Types II, IIA, and IIR respectively. Pipe-arches shall conform to the dimensional requirements of Table 6, Table 7, or Table 8 [Table 9, Table 10, or Table 11]. All dimensions shall be measured from the inside crest of corrugations for Type II pipe or from the inside liner or surface for Types IIA or IIR pipe, respectively.

8.2.2 *Longitudinal Seams*—Longitudinal seams of riveted pipe-arches shall not be placed in the corner radius.

TABLE 6 Pipe-Arch Requirements—2⅔ by ½ in. Corrugations

Pipe Arch Size, in.	Equiv. Dia, in.	Span[A], in.	Rise[A], in.	Min. Corner Radius, in.	Max B[B], in.
17 × 13	15	17	13	3	5¼
21 × 15	18	21	15	3	6
24 × 18	21	24	18	3	7¼
28 × 20	24	28	20	3	8
35 × 24	30	35	24	3	9½
42 × 29	36	42	29	3½	10½
49 × 33	42	49	33	4	11½
57 × 38	48	57	38	5	13½
64 × 43	54	64	43	6	15
71 × 47	60	71	47	7	16½
77 × 52	66	77	52	8	18
83 × 57	72	83	57	9	20

[A] A tolerance of ±1 in. or 2 % of equivalent diameter, whichever is greater, is permissible in span and rise.
[B] B is defined as the vertical dimension from a horizontal line across the widest portion of the arch to the lowest portion of the base.

TABLE 7 Pipe-Arch Requirements—3 by 1 in. Corrugations

Pipe Arch Size, in.	Equiv. Dia., in.	Span[A], in.	Rise[A], in.	Min. Corner Radius, in.
53 × 41	48	53–2.4	41 + 2.4	7
60 × 46	54	60–2.7	46 + 2.7	8
66 × 51	60	66–3.0	51 + 3.0	9
73 × 55	66	73–3.3	55 + 3.3	12
81 × 59	72	81–3.6	59 + 3.6	14
87 × 63	78	87–4.4	63 + 4.4	14
95 × 67	84	95–4.8	67 + 4.8	16
103 × 71	90	103–5.2	71 + 5.2	16
112 × 75	96	112–5.6	75 + 5.6	18
117 × 79	102	117–5.9	79 + 5.9	18
128 × 83	108	128–6.4	83 + 6.4	18
137 × 87	114	137–6.9	87 + 6.9	18
142 × 91	120	142–7.1	91 + 7.1	18

[A] Negative and positive numbers listed with span and rise dimensions are negative and positive tolerances, zero tolerance in opposite direction.

TABLE 8 Pipe-Arch Requirements—¾ by ¾ by 7½ in. and ¾ by 1 by 11½ in. Rib Corrugations

Pipe Arch Size, in.	Equiv. Dia., in.	Span[A], in.	Rise[A], in.	Min Corner Radius, in.
20 × 16	18	20–1.0	16 + 1.0	5
23 × 19	21	23–1.0	19 + 1.0	5
27 × 21	24	27–1.5	21 + 1.5	5
33 × 26	30	33–1.5	26 + 1.5	5
40 × 31	36	40–1.8	31 + 1.8	5
46 × 36	42	46–2.1	36 + 2.1	6
53 × 41	48	53–2.4	41 + 2.4	7
60 × 46	54	60–2.7	46 + 2.7	8
66 × 51	60	66–3.0	51 + 3.0	9
73 × 55	66	73–3.3	55 + 3.3	12
81 × 59	72	81–3.6	59 + 3.6	14

[A] Negative and positive numbers listed with span and rise dimensions are negative and positive tolerances, zero tolerance in opposite direction.

TABLE 9 Pipe-Arch Requirements—[68 by 13 mm Corrugations]

Pipe Arch Size, mm	Equiv. Dia, mm	Span[A], mm	Rise[A], mm	Min. Corner Radius, mm	Max B[B], mm
430 × 330	375	430	330	75	135
530 × 380	450	530	380	75	155
610 × 460	525	610	460	75	185
710 × 510	600	710	510	75	205
780 × 560	675	780	560	75	225
885 × 610	750	870	630	75	240
970 × 690	825	970	690	75	255
1060 × 740	900	1060	740	90	265
1240 × 840	1050	1240	840	100	290
1440 × 970	1200	1440	970	130	345
1620 × 1100	1350	1620	1100	155	380
1800 × 1200	1500	1800	1200	180	420
1950 × 1320	1650	1950	1320	205	460
2100 × 1450	1800	2100	1450	230	510

[A] A tolerance of ±25 mm or 2 % of equivalent diameter, whichever is greater, is permissible in span and rise.
[B] B is defined as the vertical dimension from a horizontal line across the widest portion of the arch to the lowest portion of the base.

8.2.3 Reforming Type IR pipe into Type IIR pipe-arch shall be done in such a manner as to avoid damage to the external ribs.

8.3 *Type III and IIIR Pipe:*

TABLE 10 Pipe Arch Requirements—
[75 by 25 mm Corrugations]

Pipe Arch Size, mm	Equiv. Dia, mm	Span[A], mm	Rise[A], mm	Min. Corner Radius, mm
1340 × 1050	1200	1340–60	1050 + 60	180
1520 × 1170	1350	1520–70	1170 + 70	205
1670 × 1300	1500	1670–75	1300 + 75	230
1850 × 1400	1650	1850–85	1400 + 85	305
2050 × 1500	1800	2050–95	1500 + 95	355
2200 × 1620	1950	2200–110	1620 + 110	355
2400 × 1720	2100	2400–120	1720 + 120	410
2600 × 1820	2250	2800–130	1820 + 130	410
2840 × 1920	2400	2840–145	1920 + 145	460
2970 × 2020	2550	2970–150	2020 + 150	460
3240 × 2120	2700	3240–165	2120 + 165	460
3470 × 2220	2850	3470–175	2220 + 175	460
3800 × 2320	3000	3600–180	2320 + 180	460

[A] Negative and positive numbers listed with span and rise dimensions are negative and positive tolerances, zero tolerance in opposite direction.

TABLE 11 Pipe Arch Requirements—
[19 by 19 by 190 mm and 19 by 25 by 292 mm Rib Corrugations]

Pipe Arch Size, mm	Equiv. Dia, mm	Span[A], mm	Rise[A], mm	Min Corner Radius, mm
500 × 410	450	500–25	410 + 25	130
580 × 490	525	580–25	490 + 25	130
680 × 540	600	680–40	540 + 40	130
830 × 670	750	830–40	670 + 40	130
1010 × 790	900	1010–45	790 + 45	130
1160 × 920	1050	1160–55	920 + 55	155
1340 × 1050	1200	1340–60	1050 + 60	180
1520 × 1170	1350	1520–70	1170 + 70	205
1670 × 1300	1500	1670–75	1300 + 75	230
1850 × 1400	1650	1850–85	1400 + 85	305
2050 × 1500	1800	2050–95	1500 + 95	355

[A] Negative and positive numbers listed with span and rise dimensions are negative and positive tolerances, zero tolerance in opposite direction.

8.3.1 Type III and IIIR pipe shall have a full circular cross-section and shall conform to the requirements for Type I or Type IR pipe, and in addition shall contain perforations conforming to one of the classes described in 8.3.2.

8.3.2 *Perforations*—The perforations in Type III pipe shall conform to the requirements for Class 1 or Class 2 as specified in the order and described in 8.3.2.1 and 8.3.2.2 respectively. The perforations in Type IIIR pipe shall conform to the requirements for Class 4 as described in 8.3.2.3. Class 1 perforations are for pipe intended to be used for subsurface drainage. Class 2 and Class 4 perforations are for pipe intended to be used for subsurface disposal of water, but pipe containing these classes of perforations may also be used for subsurface drainage.

8.3.2.1 *Class 1 Perforations*—The perforations shall be approximately circular and cleanly cut; shall have nominal diameters of not less than 3⁄16 in. [4.8 mm] nor greater than 3⁄8 in. [9.5 mm]; and shall be arranged in rows parallel to the axis of the pipe. The perforations shall be located on the inside crests or along the neutral axis of the corrugations, with one perforation in each row for each corrugation. Pipe connected by couplings or bands may be unperforated within 4 in. [100 mm] of each end of each length of pipe. The rows of perforations shall be arranged in two equal groups placed symmetrically on either side of a lower unperforated segment corresponding to the flow line of the pipe. The spacing of the rows shall be uniform. The distance between the center lines of rows shall be not less than 1 in. [25 mm]. The minimum number of longitudinal rows of perforations, the maximum heights of the centerlines of the uppermost rows above the bottom of the invert, and the inside chord lengths of the unperforated segments illustrated in Fig. 2 shall be as specified in Table 12.

NOTE 8—Pipe with Class 1 perforations is generally available in diameters from 4 to 21 in. [100 to 525 mm] inclusive, although perforated pipe in larger sizes may be obtained.

8.3.2.2 *Class 2 Perforations*—The perforations shall be circular holes with nominal diameters of 5⁄16 to 3⁄8 in. [8.0 to 9.5 mm], or slots with nominal width of 3⁄16 to 5⁄16 in. [4.8 to 8.0 mm] and maximum length of ½ in. [12.7 mm]. The perforations shall be uniformly spaced around the full periphery of the pipe. The perforations shall provide an opening area of not less than 3.3 sq in./sq ft [230 sq cm/sq m] of pipe surface based on nominal diameter and length of pipe.

NOTE 9—Thirty perforations, 3⁄8 in. diameter, per square foot [323 perforations, 9.5 mm diameter, per square metre] satisfies the inlet area requirement for Class 2 perforations.

8.3.2.3 *Class 4 Perforations*—The perforations shall be circular holes with nominal diameters of 5⁄16 to 3⁄8 in. [8.0 to 9.5 mm], or slots with a nominal width of 3⁄16 to 5⁄16 in. [4.8 to 8.0 mm] and a maximum length of ½ in. [12.7 mm]. All perforations shall occur in the flat sheet between spiral ribs or lockseam with the center of any hole no closer than ¾ in. [19.0 mm] from the outside edge of a rib. The perforations shall be uniformly spaced around the full periphery of the pipe. The perforations shall provide an opening area of not less than

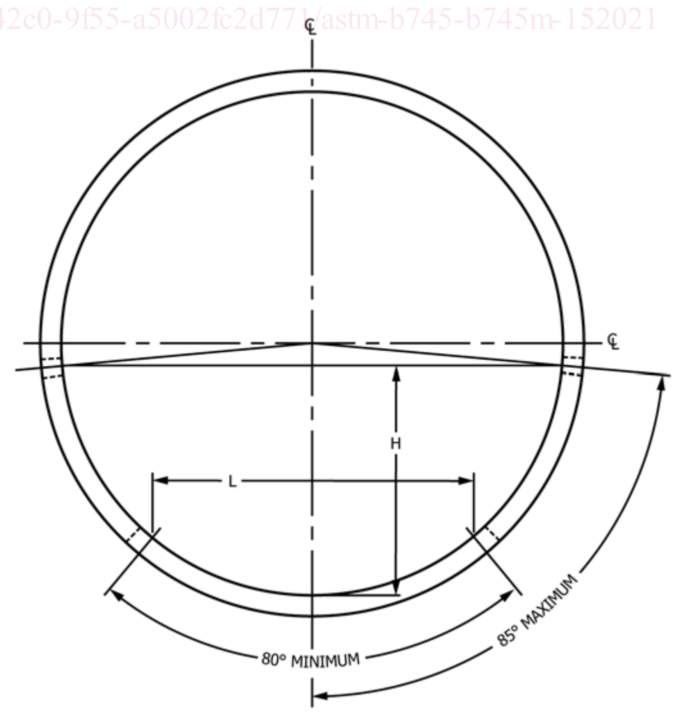

FIG. 2 Circumferential Location of Class 1 Perforations