
Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains

AASHTO Designation: M 196M/M 196-24

Technically Revised: 2024

Editorially Revised: 2024

Technical Subcommittee: 4b, Flexible and Metallic Pipe

ASTM Designation: B745/B745M-15(2021)



**American Association of State Highway and Transportation Officials
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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 *AASHTO LRFD Bridge Design Specifications* and *AASHTO LRFD Bridge Construction Specifications*.
- 1.3. The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the inch-pound units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - M 197M/M 197, Aluminum Alloy Sheet for Corrugated Aluminum Pipe
 - M 232M/M 232, Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - T 249, Helical Lock Seam Corrugated Pipe
 - *AASHTO LRFD Bridge Design Specifications*
 - *AASHTO LRFD Bridge Construction Specifications*
- 2.2. *ASTM Standards:*
 - A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
 - A563M, Standard Specification for Carbon and Alloy Steel Nuts (Metric)
 - B221M, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)

- B316/B316M, Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods
- B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- B666/B666M, Standard Practice for Identification Marking of Aluminum and Magnesium Products
- B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- D1056, Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
- F467M, Standard Specification for Nonferrous Nuts for General Use (Metric)
- F468M, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use (Metric)
- F568M, Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners (withdrawn 2012; no replacement)
- F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- F594, Standard Specification for Stainless Steel Nuts
- F738M, Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs (withdrawn 2015; no replacement)
- F836M, Standard Specification for Style 1 Stainless Steel Metric Nuts (Metric)

2.3. *AISI Standard:*

- S100, North American Specification for the Design of Cold-Formed Steel Structural Members

3. TERMINOLOGY

3.1. *Descriptions of Terms Specific to This Standard:*

- 3.1.1. *fabricator*—the producer of the pipe.
- 3.1.2. *manufacturer*—the producer of the sheet.
- 3.1.3. *purchaser*—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 that 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 that 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 that 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 that has been perforated to permit the inflow or outflow 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 that 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 Section 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. AASHTO designation and year of issue, as M 196M-__ for SI units or M 196-__ for inch-pound units;
- 5.1.3. Type of pipe (Section 4.1);
- 5.1.4. Method of fabrication for Type I and Type II pipe (Section 7.1);
- 5.1.5. Diameter of circular pipe (Section 8.1.1), or span and rise of pipe-arch section (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 (Section 7.2);
- 5.1.8. Sheet thickness (Section 8.1.2);
- 5.1.9. Coupling bands, number, and type (Section 9.1) if special type is required;
- 5.1.10. Gaskets for coupling bands, if required (Section 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 (Section 8.3.2);
- 5.1.12. Certification, if required (Section 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 M 197M/M 197.

- 6.2. *Aluminum Sheet for Coupling Bands*—The sheet used in fabricating coupling bands shall conform to M 197M/M 197.
- 6.3. *Rivets*—The material used for rivets in riveted pipe shall conform to the requirements of ASTM B316/B316M for alloy 6053-T4, with the following mechanical properties:

Tensile strength, min, MPa [ksi]	170 [25]
Yield strength, min, MPa [ksi]	95 [14]
Shear strength, min, MPa [ksi]	105 [15]
Elongation in 50 mm [2 in.], or 4 × diameter, min, %	16

If bolts and nuts are substituted for rivets (see Section 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 M 196M 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
For M 196 pipe:		
(Steel)	A307	A563, Gr. A
(Stainless steel)	F593, Alloy Grp 1, 2, or 3	F594M, Alloy Grp 1, 2, or 3
(Aluminum alloy)	F468, Alloy 6061-T6	F467M, Alloy 6061-T6

The steel bolts and nuts shall be hot-dip galvanized in conformance with M 232M/M 232, or be mechanically galvanized in conformance with ASTM B695, Class 40.

- 6.4. *Hardware for Coupling Bands*—Bolts and nuts for coupling bands shall conform to the requirements shown in Section 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 of the following processes: hot-dip process as provided in M 232M/M 232; electroplating process as provided in ASTM B633, Class Fe/Zn 8; or mechanical process as provided in ASTM 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 M 232M/M 232; electroplating process as provided in ASTM B633 Class Fe/Zn 25; or mechanical process as provided in ASTM B695, Class 25. Aluminum angles and lugs shall conform to the requirements of ASTM 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 ASTM D1056 for the “RE” closed cell grades, or O-rings meeting the requirements of ASTM C990.

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 68- or 75-mm [$2\frac{2}{3}$ - or 3-in.] 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 Section 7.1. The direction of the crests and valleys of helical corrugations shall not be less than 60 degrees from the axis of the pipe for pipe diameters larger than 525 mm [21 in.], and not less than 45 degrees from the axis for pipe diameters of 525 mm [21 in.] 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.

Table 1—Corrugation Requirements for Types I, IA, II, and III Pipe

Nominal Size, mm	Max Pitch, ^a mm	Min Depth, ^b mm	Inside Radius ^c	
			Nominal, mm	Min, mm
M 196M				
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
M 196				
1½ by ¼ ^d	1⅞	0.24	⅝	0.25
2⅓ by ½	2⅞	0.48 ^e	1⅞	0.5
3 by 1	3¼	0.95	⅞	0.5
6 by 1	6¼	0.95	2.2	2.0

^a Pitch is measured from crest to crest of corrugations, at 90 degrees 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 38 by 6.5 mm [1½ by ¼ in.] is available only in helically corrugated pipe.

^e For pipe 300- to 525-mm [12 to 21 in.] diameter inclusive, the minimum corrugation depth shall be 11 mm [0.42 in.].

- 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. For the 292-mm [11½ in.] 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 6.4 mm [0.25 in.] and a minimum height of 5.1 mm [0.20 in.] toward the outside of the pipe.

Note 1—When requested by the purchaser, the pipe manufacturer shall provide independent verification that the nominal dimensions of the profile supplied meet or exceed the effective sectional properties published in ASTM A796/A796M. Such effective sectional properties shall be determined in accordance with AISI S100.