
Standard Specification for Corrugated Steel Pipe, Metallic- Coated, for Sewers and Drains

AASHTO Designation: M 36-16 (2020)¹

Technical Subcommittee: 4b, Flexible and Metallic Pipe

Release: Group 2 (June)

ASTM Designation: A760/A760M-01a



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This specification covers corrugated steel pipe (CSP) 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. The steel sheet used in fabrication of the pipe has a protective metallic coating of zinc (galvanizing), aluminum Type 2, 55 percent aluminum-zinc alloy, zinc-5 percent aluminum-mischmetal alloy, or aluminum Type 1.
- 1.2. The several different metallic coatings may not provide equal protection of the base metal against corrosion or abrasion, or both, in all environments. Some environments may be so severe that none of the metallic coatings included in this specification will provide adequate protection. Additional protection for CSP can be provided by use of coatings applied after fabrication of the pipe as described in M 190, or by use of polymer-precoated CSP as described in M 245.
- 1.3. 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 on the proper selection of sheet thickness, type of bedding and backfill, controlled manufacture in the plant, and care in the installation. The installation procedure is described in *AASHTO LRFD Bridge Construction Specifications*, Section 26.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 190, Asphalt-Coated Corrugated Metal Culvert Pipe and Pipe-Arches
 - M 218, Steel Sheet, Zinc-Coated (Galvanized), for Corrugated Steel Pipe
 - M 232M/M 232, Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - M 245, Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Drains
 - M 274, Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
 - M 289, Aluminum-Zinc Alloy Coated Sheet Steel for Corrugated Steel Pipe
 - T 65M/T 65, Mass [Weight] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
 - T 213M/T 213, Mass [Weight] of Coating on Aluminum-Coated Iron or Steel Articles
 - T 241, Helical Continuously Welded Seam Corrugated Steel Pipe

- T 249, Helical Lock Seam Corrugated Pipe
- *AASHTO LRFD Bridge Construction Specifications*
- *AASHTO LRFD Bridge Design Specifications*

2.2. *ASTM Standards:*

- A563M, Standard Specification for Carbon and Alloy Steel Nuts (Metric)
- A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- A796/A796M, Standard Practice for Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications
- A929/A929M, Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
- B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- C443M, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
- D1056, Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
- F568M, Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners (withdrawn 2012; no replacement)

2.3. *AISI Standard:*

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

3. **TERMINOLOGY**

3.1. *Description 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. *minimized coating structure*—a coating characterized by a finer metallurgical coating structure obtained by a treatment designed to restrict the formation of the normal coarse-grain structure formed during solidification of the Zn-5 Al-MM alloy coating.
- 3.1.4. *purchaser*—the purchaser of the finished product.
- 3.1.5. *regular coating structure*—the normal coating structure resulting from unrestricted grain growth during normal solidification of the Zn-5 Al-MM alloy coating.

3.2. *Abbreviations:*

- 3.2.1. *55 Al-Zn*—55 percent aluminum-zinc,
- 3.2.2. *MM*—mischmetal,
- 3.2.3. *Zn-5 Al-MM*—zinc-5 percent aluminum-mischmetal,
- 3.2.4. *ALT2*—aluminum-coated Type 2, and
- 3.2.5. *ALT1*—aluminum-coated Type 1.

4. PIPE CLASSIFICATION

- 4.1. *The CSP 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 IIIA*—This pipe, intended for use as underdrains, shall consist of a semicircular cross section having a smooth (uncorrugated) bottom with a corrugated top shield.
- 4.2. Perforations in Type III pipe are included in three classes as described in Section 8.3.2.
- 4.3. *Zn-5 Al-MM alloy-coated material is available in two coating classes, or structures, as follows:*
- 4.3.1. *Class A*—Minimized coating structure.
- 4.3.2. *Class B*—Regular coating structure.

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 steel pipe);
- 5.1.2. Type of metallic coating (zinc, aluminum-coated Type 2, aluminum-coated Type 1, 55 Al-Zn alloy or Zn-5 Al-MM alloy) (Section 6.1);
- 5.1.2.1. For Zn-5 Al-MM alloy, class of coating structure (Class A, minimized, etc.) (Section 4.3);
- 5.1.3. AASHTO designation and date of issue (M 36- ____);
- 5.1.4. Type of pipe (Section 4.1);
- 5.1.5. Diameter of circular pipe (Table 6), or span and rise of pipe-arch section (Tables 8, 9, 10, or 11);

- 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. For Type I and Type II pipe, the pipe fabrication method, whether with annular corrugations or helical corrugations (Section 7.1.1) (Note 1);
- Note 1**—Pipe with annular corrugations with spot welded or riveted seams is designed by different criteria than pipe with helical corrugations. Pipe with annular corrugations must consider seam strength. Therefore, consideration of the method of fabrication is important when pipe is installed under certain conditions of loading.
- 5.1.10. Joining systems, including the type of joint from Section 9.1 and gasket, if required (If no joining system is specified, the fabricator shall select the system.);
- 5.1.11. For Type III pipe, class of perforations, if other than Class 1 (Section 8.3.2);
- 5.1.12. Certification, if required (Section 14.1); and
- 5.1.13. Special requirements.

6. MATERIALS

- 6.1. *Steel Sheet for Pipe*—All pipe fabricated under this specification shall be formed from zinc-coated sheet conforming to M 218, or aluminum-coated Type 2 sheet conforming to M 274, 55 percent aluminum-zinc alloy-coated sheet conforming to M 289, or zinc-5 percent aluminum-mischmetal alloy-coated sheet conforming to ASTM A929/A929M, or aluminum-coated Type 1 conforming to ASTM A929/A929M. If the type of metallic coating is not stated in the order, zinc-coated sheet conforming to M 218 shall be used. All pipe furnished on the order shall have the same metallic coating, unless otherwise specified.
- 6.2. *Steel Sheet for Coupling Bands*—The sheet used in fabricating coupling bands shall have the same coating and shall conform to the same specification listed in Section 6.1 as that used for fabrication of the pipe furnished under the order.
- 6.3. *Rivets*—The rivets used in riveted pipe shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized. If bolts and nuts are substituted for rivets (Section 7.3.1), they shall meet the following requirements:

Bolts	Nuts
F568M	A563M
Class 8.8	Class 12

- 6.4. The bolts and nuts shall be hot-dip galvanized in conformance with M 232M/M 232 mechanically galvanized in conformance with ASTM B695, Class 40.
- 6.5. *Hardware for Joining Systems*—Bolts and nuts for coupling bands shall conform to the following requirements:

Bolts	Nuts
F568M	A563M
Class 4.6	Class 5

- 6.6. Bolts, nuts, and other threaded items used with joining systems 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 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.
- 6.7. *Gaskets*—If gaskets are used in joining systems, 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 C443M.

7. FABRICATION

- 7.1. *General Requirements*—Pipe shall be fabricated in full circular cross section except for Type IIIA, which is described in Section 8.4.
- 7.1.1. Type I pipe shall have annular corrugations with lap joints fastened with rivets or resistance spot welds, or shall have helical corrugations with a continuous lock seam or welded seam extending from end to end of each length of pipe. The type of fabrication used shall be the option of the fabricator unless otherwise specified.
- 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 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, and not less than 45 degrees from the axis for pipe diameters of 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, except if the depth measurement of one or more corrugations is less than the minimum depth in Table 1, the depth of all corrugations between adjacent seams shall be measured and the values of Table 2 for minimum average depth and minimum corrugation depth shall apply.

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

Nominal Size, mm	Maximum Pitch, ^a mm	Minimum Depth, ^b mm	Inside Radius ^c	
			Nominal, mm	Minimum, mm
38 by 6.5 ^d	48	6.0	7	6.5
68 by 13	73	12	17	12
75 by 25	83	24	14	12
125 by 25	135	24	40	36

^a Pitch is measured from crest to crest of corrugation, at 90 degrees to the direction of corrugation.

^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. If the depth measurement of one or more corrugations is less than the value indicated herein, the depth of all corrugations between seams shall be measured, and the requirements of Table 2 shall be applied. (See Section 7.2.1.)

^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 is available only in helically corrugated pipe.

Table 2—Referee Requirements for Corrugation Depth^a

Nominal Size, mm	Diameter, mm	Minimum Average Depth, mm	Minimum Corrugation Depth, mm
38 by 6.5	All	6.1	5
68 by 13	300 through 525	12.1	10
68 by 13	Greater than 525	12.4	11
75 by 25	All	24.9	23
125 by 25	All	24.9	23

^a See Section 7.2.1 for application of Table 2.

Note 2—Inspection frequently consists of measurement of the depth of one or a few corrugations. If such measurement indicates insufficient depth, application of the requirements in Table 2 provides for acceptance in cases in which greater depth of some corrugations compensates for lack of depth of others. These measurements would normally be made at one location between seams on a length of pipe.

7.2.2. For Type IR pipe, the corrugations shall be essentially rectangular ribs projecting outward from the pipe wall. The dimensions and spacing of the ribs shall be in accordance with Table 3 for the size indicated on the order. For the 292-mm rib spacing, if the sheet between the ribs does not include a lock seam, a stiffener shall be included midway between the ribs. This stiffener shall have a nominal radius of 6.4 mm and a minimum height of 5.1 mm toward the outside of the pipe.

Note 3—When requested by the purchaser, the pipe manufacturer shall provide independent verification that the nominal dimensions of the profile supplied meets or exceed the effective sectional properties published in ASTM A796/A796M. Such effective sectional properties shall be determined in accordance with AISI S100.

Table 3—Rib Requirements for Types IR and IIR Pipe

Nominal Size, mm	Rib			Bottom Outside Radius, Min, mm	Bottom Outside Radius, ^d Max Avg, mm	Top Outside Radius, Min, mm	Top Outside Radius, ^d Max Avg, mm
	Width, ^a Min, mm	Depth, ^b Min, mm	Spacing, ^c Min, mm				
19 by 19 by 190	17	19	197	2.5	12.0	2.5 + <i>t</i>	12.0 + <i>t</i>
19 by 25 by 216	17	24	222	2.5	12.0	2.5 + <i>t</i>	12.0 + <i>t</i>
19 by 25 by 292	17	24	298	2.5	12.0	2.5 + <i>t</i>	12.0 + <i>t</i>

^a Width is a dimension of the inside of the rib, but is measured on the outside of the pipe (outside of the rib) and shall meet or exceed the stated minimum width plus two times the wall thicknesses, that is, $2t + 17$ 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 three ribs within one sheet width.

^c Spacing is an average of three adjacent rib spacings for 19 by 19 by 190 pipe and two adjacent rib spacings for 19 by 25 by 292 pipe measured center-to-center of the ribs, at 90 degrees to the direction of the ribs.

^d The average of the two top rib radii and of the two bottom rib radii shall be within the minimum and maximum tolerances. The term “outside” refers to the outside surface of the pipe.

Note 4—The nominal dimensions and properties for smooth corrugations and for ribs are given in *AASHTO LRFD Bridge Design Specifications*, Section 12, and in ASTM A796.

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 have seams meeting the longitudinal seam requirement of Section 8.2.2. (See also Note 7.)

Note 5—Fabrication of pipe without longitudinal seams in 120 degrees of arc, so that the pipe may be installed without longitudinal seams in the invert, is subject to negotiation between the purchaser and fabricator.