



*Standard Specification
for*



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

AASHTO DESIGNATION: M 36M-98¹
(ASTM DESIGNATION: A 760/A 760M-95b)

1. SCOPE

1.1 This specification covers corrugated steel 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. 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.

1.1.1 Steel sheet with zinc and aramid fiber composite coating may be specified for fabrication of pipe. Pipe made from sheet with this composite coating is always furnished with an asphalt coating. Therefore, the requirements in this specification should be considered as applying to a semi-finished pipe; the finished pipe must include provisions of M 190M.

NOTE 1—Pipe fabricated with zinc and aramid fiber composite coated sheet and asphalt post-coating may be used for sanitary sewers and industrial applications. Petroleum products or similar materials in the sewer effluent may affect the performance of the asphalt coating.

1.2 The several different metallic coatings may not provide equal protection of the base metal against corrosion and/or abrasion 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 corrugated steel pipe can be provided by use of coatings applied after fabrication of the pipe as described in

M 190M, or by use of polymer precoated corrugated steel pipe as described in M 245M.

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 upon 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 *Standard Specifications for Highway Bridges*, Division II, Section 26.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- 2.1.1 M 190M Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
- M 198 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
- M 218M Steel Sheet, Zinc-Coated (Galvanized) for Corrugated Steel Pipe
- M 232M/M 232 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- M 245M Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains

M 274M Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe

M 289M Aluminum-Zinc Alloy Coated Sheet Steel for Corrugated Steel Pipe

M 291M Carbon and Alloy Steel Nuts (Metric)

M 298 Coatings of Zinc Mechanically Deposited on Iron and Steel

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 241M Helical Continuously Welded Seam Corrugated Steel Pipe

T 249M Helical Lock Seam Corrugated Pipe

2.1.2 *Standard Specifications for Highway Bridges*

2.2 ASTM Standards:

- A 780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- A 796/A 796 M Structural Design of Corrugated Steel Pipe, Pipe-Arches, and Arches for Storm and Sanitary Sewers and Other Buried Applications
- A 885 Steel Sheet, Zinc and Aramid Fiber Composite Coated for Corrugated Steel Sewer, Culvert, and Under-drain Pipe

¹ This specification is technically identical to ASTM A 760/A 760M-95b.

- A 929/A 929M Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
- B 633 Electrodeposited Coatings of Zinc on Iron and Steel
- D 1056 Flexible Cellular Materials—Sponge or Expanded Rubber
- F 568M Carbon and Alloy Steel Externally Threaded Metric Fasteners

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 AIT2 — aluminum-coated Type 2, and

3.2.5 AIT1 — aluminum-coated Type 1.

4. PIPE CLASSIFICATION

4.1 The corrugated steel 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 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, Zn-5 Al-MM alloy, or zinc and aramid fiber composite coating) (Section 6.1);

5.1.2.1 For Zn-5 Al-MM alloy, class

of coating structure (class A, minimized, etc.);

5.1.3 AASHTO designation and date of issue (M 36M-98);

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, or 10);

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 2);

NOTE 2—Pipe manufactured with annular corrugations may have an element of weakness in the longitudinal seams as compared to pipe with helical corrugations. Therefore, consideration of the method of fabrication is important when pipe is installed under certain conditions of loading.

5.1.10 When zinc and aramid fiber composite coated sheet is used for fabrication of pipe, the type of asphalt coating (Sections 1.1.1 and 8.5);

NOTE 3—See M 190M for additional information appropriate to bituminous post-coatings on pipe.

5.1.11 Coupling bands, number, and type (Section 9.1) if special type is required;

5.1.12 Gaskets for coupling bands, if required (Section 9.3);

5.1.13 For Type III pipe, class of perforations, if other than Class I (Section 8.3.2);

5.1.14 Certification, if required (Section 14.1); and

5.1.15 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 218M, or aluminum-coated Type 2 sheet conforming to M 274M, 55 percent aluminum-zinc alloy-coated sheet conforming to M 289M or zinc-5 percent aluminum-mischmetal alloy-

coated sheet conforming to ASTM A 929/A 929M or aluminum-coated Type 1 conforming to ASTM A 929/A 929M. If the type of metallic coating is not stated in the order, zinc-coated sheet conforming to M 218M 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
F 568, Cl. 8.8	M 291M, Cl. 12

The bolts and nuts shall be hot-dip galvanized in conformance with M 232M/ M 232, or be mechanically galvanized in conformance with M 298, Class 40.

6.4 Hardware for Coupling Bands—Bolts and nuts for coupling bands shall conform to the following requirements:

Bolts	Nuts
F 568, Cl. 4.6	M 291M, Cl. 5

Bolts, nuts, and other threaded 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 B 633, Class Fe/Zn 8; or mechanical process as provided in M 298, 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 B 633, Class Fe/Zn 25; or mechanical process as provided in M 298M, Class 25.

6.5 Gaskets—If gaskets are used in couplings, they shall be a band of ex-

panded rubber meeting the requirements of ASTM D 1056 for the "RE" closed cell grades, or O-rings meeting the requirements of M 198.

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, except that the pipe fabricated from zinc and aramid fiber composite coated sheet shall be fabricated by riveted or lock seam fabrication only.

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. Zinc and aramid fiber composite coated sheet shall not be used for fabrication of Type IA pipe.

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.

NOTE 4—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 where 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 5—The nominal dimensions and properties for smooth corrugations and for ribs are given in AASHTO *Standard Specifications for Highway Bridges*, Division I, Section 12, and in ASTM A 796.

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 6.)

NOTE 6—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.

7.3.1 The size of rivets, number per corrugation, and width of lap at the longitudinal seam shall be as stated in Table 4, depending on sheet thickness, corrugation size, and diameter of pipe. For pipe with 25-mm deep corrugations, M 12 diameter bolts and nuts may be used in lieu 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 150 mm, measured on centers, except that six riv-

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
<i>M 36M—All values in millimeters</i>				
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 corrugations, at 90 degrees to the direction of the 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	Diameter	Minimum Average Depth	Minimum Corrugation Depth
<i>All values in millimeters</i>			
38 by 6.5	all	6.1	5
68 by 13	300 thru 525	12.1	10
68 by 13	over 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.

TABLE 3 Rib Requirements for Types IR and IIR 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, ^A Min.	Depth, ^B Min.	Spacing ^C Max.				
Millimeters							
19 by 19 by 190	17	19	197	2.5	6.0	2.5 + t	6.0 + t
19 by 25 by 292	17	24	298	2.5	6.0	2.5 + t	6.0 + 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) and shall meet or exceed the stated minimum width plus two times the wall thicknesses, that is, $2t + 17$ mm.

^B Depth is an average of three ribs (one sheet width) measured from the inside by placing a straightedge across the open rib and measuring to the bottom of the rib.

^C Spacing is an average of three ribs (one sheet width) measured center-to-center of the ribs at 90° to the direction of the ribs.

^D The average of the four rib radii (Top and Bottom) shall be within the minimum and maximum tolerances. The outside radius refers to the surface outside of the pipe.

ets will be sufficient 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. 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.

7.4 Resistance Spot Welded

Seams—The longitudinal seams shall be staggered to the extent that no more than three thicknesses of sheet are fastened by any spot weld. Pipe to be reformed into pipe-arch shape shall also meet the longitudinal seam requirement of Section 8.2.2 (Note 6).

7.4.1 The size of spot welds, number per corrugation, and width of lap at the longitudinal seam shall be as stated in Table 4, depending on sheet thickness, corrugation size, and diameter of pipe. Circumferential seams shall be welded using spot welds of the same size as

for longitudinal seams and shall have a maximum weld spacing of 150 mm, except that six welds will be sufficient in 300-mm diameter pipe.

7.4.2 All spot welds shall be made in such a manner that the sheets will be drawn tightly together throughout the lap. The outside edge of each spot weld shall be at least 6.5 mm from the edge of the sheet. The welding shall be performed in such a manner that the exterior surfaces of 90 percent or more of the spot welds on a length of pipe shall show no evidence of melting or burning of the base metal, and the base metal shall not be exposed when the area adjacent to the electrode contact surface area is wire brushed. Discoloration of the spot weld surfaces will not be cause for rejection.

7.4.3 Welding equipment shall be qualified before use, and the qualification shall be verified before each work shift and when changing sheet thickness, all as described in Annex A1. If use of the equipment at the approved machine settings fails to produce satisfactory welds, fabrication shall be stopped until adjustments are made and the equipment is requalified.

7.5 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 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 pipe shall be formed in the flat zone of the pipe wall, midway between two ribs.

7.5.1 The edges of the sheets within the cross section of the lock seam shall lap at least 4.0 mm for pipe 250 mm or less in diameter and at least 7.9 mm for pipe greater than 250 mm in diameter, with an occasional tolerance of minus 10 percent 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-degree fold (as described in T 249M) 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 visible cracks in the metal, loss of metal-