Designation: A978/A978M – 08 (Reapproved 2013)

Standard Specification for Composite Ribbed Steel Pipe, Precoated and Polyethylene Lined for Gravity Flow Sanitary Sewers, Storm Sewers, and Other Special Applications[1]

This standard is issued under the fixed designation A978/A978M; 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 composite ribbed steel pipe, precoated and polyethylene lined intended for use for gravity flow sanitary sewers, storm sewers, and other special applications such as water transmission pipe, rehabilitation pipe, slip line pipe, and irrigation pipe where extra corrosion and abrasion resistance are required. The steel sheet used in the fabrication of the pipe has a polymer coating over a metallic coating of zinc on both sides. In addition, as the pipe is being fabricated, the ribs are filled with polyethylene and then a polyethylene liner is extruded onto the interior surface.

1.2 The exterior polymer precoating provides extra protection of the steel against soilside corrosion, in addition to that provided by the metallic coating, and also provides a dielectric barrier for cathodic protection. The interior polymer precoating provides an adhesive layer between the galvanized steel and the polyethylene lining. The applied lining provides internal protection against corrosion, erosion, and abrasion. By filling the rib which has a deltoid shape (smaller at the opening in the pipe wall than at the bottom of the rib), the polyethylene is mechanically connected to the pipe wall and the polyethylene liner is then thermally bonded to the filled rib.

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 Practice A798/A798M.

1.4 This specification is applicable to orders in either inch-pound units as A978, or in SI units as A978M. Inch-pound units and SI units are not necessarily equivalent. SI units are shown in brackets in the text for clarity, but they are the applicable values when the material is ordered to A978M.

1.5 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

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

A563M Specification for Carbon and Alloy Steel Nuts (Metric)

A742/A742M Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe

A780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

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

A798/A798M Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

A902 Terminology Relating to Metallic Coated Steel Products

A926 Test Method for Comparing the Abrasion Resistance of Coating Materials for Corrugated Metal Pipe

A929/A929M Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

B633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel

[1] This specification is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.17 on Corrugated Steel Pipe Specifications.

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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.

TABLE 1 Rib Requirements for Steel Pipe

Nominal Size	Deltoid Shaped Rib				Bottom Outside Radius, Min	Bottom Outside Radius,[E] Max Avg	Top Outside Radius, Min	Top Outside Radius,[E] Max Avg
	Narrowest Width,[A] Min	Widest Width,[B] Min	Depth,[C] Min	Spacing,[D] Max				
			A978, in.					
¾ by ¾ by 7 ½	0.45	0.68	0.73	7 ½	0.10	0.25	0.10+t	0.25+t
¾ by 1 by 11 ½	0.45	0.68	0.90	11 ¾	0.10	0.25	0.10+t	0.25+t
			A978M, mm					
19 by 19 by 190	12	17	19	190	2.5	6.0	2.5+t	6.0+t
19 by 25 by 292	12	17	23	298	2.5	6.0	2.5+t	6.0+t

[A]Narrowest width is a dimension of the inside of the rib measured on the inside of the pipe.
[B]Widest 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 thickness (that is, 2t + 0.68 in. (2t +17mm)).
[C]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.
[D]Spacing is an average of three adjacent ribs (one sheet width) spacings for ¾ by ¾ × 7 ½ in. pipe and two adjacent rib (one sheet width) spacings for the ¾ × 1 × 11 ½ in. pipe measured center-to-center of the ribs, at 90° to the direction of the ribs.
[E]The average of the two top rib radii and of the two bottom radii shall be within the minimum and maximum tolerances. The term" outside" refers to the outside surface of the pipe.

B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
C443 Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C443M Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
D638 Test Method for Tensile Properties of Plastics
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers
D1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D2240 Test Method for Rubber Property—Durometer Hardness
D1435 Practice for Outdoor Weathering of Plastics
D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D5576 Practice for Determination of Structural Features in Polyolefins and Polyolefin Copolymers by Infrared Spectrophotometry (FT-IR)
D5630 Test Method for Ash Content in Plastics
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
F836M Specification for Style 1 Stainless Steel Metric Nuts (Metric)

2.2 *AASHTO Standard:*[4]

T 249 Test for Helical Lock Seam Corrugated Pipe
Standard Specifications for Highway Bridges, Division II, Section 26
LRFD Bridge Construction Specifications, Section 26

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology A902.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *composite, n*—the joining of steel and plastic to achieve a synergy of desirable characteristics not attainable by either material alone.

3.2.2 *deltoid shape, n*—the open triangular shape of the rib profile, which has a greater dimension at the base (away from the pipe wall) than at the peak (opening at the interior wall of the pipe).

3.2.3 *extruded liner, n*—a liner produced by a process that applies melted polyethylene into the ribs and sequentially extrudes a liner over the top of the rib openings and across the adjacent flats while the pipe is being fabricated.

4. Ordering Information

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

4.1.1 Name of material (composite ribbed steel pipe, precoated and polyethylene lined),

4.1.2 Type of metallic coating (zinc) (see 5.1),

4.1.3 ASTM designation and year of issue, as A978 for inch-pound units or as A978M for SI units,

4.1.4 Rib size and spacing (see Table 1). If not stated, the size and spacing combination furnished shall be at the fabricator's option,

4.1.5 Diameter of pipe (see 7.1),

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

4.1.7 Sheet thickness (see 7.2),

4.1.8 Joint connectors, number, and type (soil tight, water-resistant, or watertight),

4.1.9 Certification, if required (see 13.1), and

4.1.10 Special requirements.

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

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

NOTE 1—Typical ordering descriptions are as follows: (*1*) Composite ribbed steel pipe, precoated and polyethylene lined, zinc-coated, in accordance with Specification A978, ¾ by ¾ by 7 ½ in., 72 in. diameter, 600 ft. in length, 0.109 in. sheet thickness, 30-soil tight joint connectors; (*2*) Composite ribbed steel pipe, precoated and polyethylene lined, zinc-coated, in accordance with Specification A978M, 19 by 19 by 190 mm, 1800 mm diameter, 182.9 m in length, 2.77 mm sheet thickness, 30-soil tight joint connectors.

5. Material

5.1 *Steel Sheets for Pipe*—All pipe fabricated under this specification shall be formed from polymer precoated sheet conforming to Specification A742/A742M, except that one side of the sheet (interior side of pipe) shall have additives that will enhance the bond with the extruded polyethylene liner.

5.1.1 The polymer shall have a minimum thickness of 10 mils [250 µm] on each side.

5.1.2 The polymer coating is applied to steel having a metallic coating of zinc as described in Specification A929/A929M.

5.2 *Polyethylene for Rib Filling and the Internal Liner*—The polyethylene for rib filling and the internal liner shall be a virgin resin which is predominantly an ethylene octene copolymer. The polymer shall be stabilized for processing at 500°F [260°C] and to endure a 180-day exposure to sunlight. The polymer can contain pigments and stabilizer but shall be 99 % minimum polyethylene resin.

5.2.1 The resin properties shall be:

Melt index: I_2 = 7.5 g/10 min (± 1.5)	Test Method D1238
Flow Rate Ratio: I_{10}/I_2 = 7-8	Test Method D1238
Density: 0.902 g/cc (± .002)	Test Methods D792
Hardness: Shore D = 45 (± 5)	Test Method D2240
Ash Content: <1.0 %	Test Method D5630

5.2.2 Analyze the precoated film and the polymer by FTIR spectrophotometry in accordance with Practice D5576 and liquid chromatography methods and compare to standards to verify the polymer is suitable for the application. A lot identification system shall be used to allow traceability of resin.

5.3 *Steel Sheet for Joint Connectors*—The sheet used in fabricating joint connectors shall conform to the same specification listed in 5.1 as that used for fabricating of the pipe furnished under the order.

5.4 *Polyethylene for Joint Connectors*—The polyethylene used in fabricating joint connectors shall be compatible with the polymer precoated sheet conforming to the specification listed in 5.1 or with the polyethylene used to fill the ribs and fabricate the liner as listed in 5.2, or both.

5.5 *Hardware for Storm Sewer Joint Connectors*—External bolts and nuts for storm sewer joint connectors shall conform to the following requirements:

	Bolts	Nuts
For A978 pipe	Specification A307	Specification A563, Grade A
[For A978M pipe]	[Specification F568M, Class 4.6]	[Specification A563M, Class 5]

5.5.1 Bolts, nuts, and other threaded items used with joint connectors 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 8. Other hardware items used with joint connectors 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.

5.6 *Hardware for Sanitary Sewer Joint Connectors*—External bolts and nuts for sanitary sewer joint connectors shall conform to the following requirements:

	Bolts	Nuts
For A978 pipe	Specification F593 Martensitic Alloy 410	Specification F594 Martensitic Alloy 410
[For A978M pipe]	Specification F738M Martensitic Alloy 410	Specification F836M Martensitic Alloy 410

5.7 *Gaskets*—If gaskets are used in connecting, 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 or Specification C443M, butyl rubber base joint sealant, or other approved resilient materials.

6. Fabrication

6.1 *General Requirements*—Pipe shall be fabricated in full circular cross-section with helical lock seams and helical ribs projecting outwardly.

6.2 *Profile*—The profile shall be essentially deltoid shaped ribs projecting outward from the pipe wall. The dimensions of the ribs shall be in accordance with Table 1 for the size indicated on the order. For the 11.5-in. [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 0.25 in. [6.4 mm] and a minimum height of 0.20 in. [5.1 mm] toward the outside of the pipe.

6.3 *Helical Lock Seams*—The lock seam shall be formed in the flat zone of the pipe wall, between two ribs.

6.3.1 The edges of the sheets within the cross section of the lock seam shall lap at least 5⁄16 in. [7.9 mm] with an occasional tolerance of –10 % of the 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 T249) of one sheet thickness on one side of the lock seam. There shall be no visible cracks in the metal, loss of sheet-to-sheet contact, or excessive angularity on the interior of the 180° fold of metal at the completion of forming the lock seam.

6.3.2 Specimens cut from production pipe normal to and across the lock seam shall develop the tensile strength as provided in Table 2, when tested in accordance with AASHTO T249.

7. Pipe Requirements

7.1 *Pipe Dimensions*—The nominal diameter of the pipe shall be as stated in the order, selected from the sizes listed in Table 3. The average inside diameter of pipe shall not vary

TABLE 2 Lock Seam Tensile Strength

Specified Sheet Thickness		Lock Seam Tensile Strength per Unit Width, min	
in.	mm	lbf/in.	kN/M
0.064	1.63	340	60
0.079	2.01	520	91
0.109	2.77	700	122
0.138	3.50	880	154

TABLE 3 Pipe Sizes

Nominal Inside Diameter	
in.	mm
24	600
27	675
30	750
33	825
36	900
42	1050
48	1200
54	1350
60	1500
66	1650
72	1800
78	2000
84	2100
90	2250
96	2400
102	2550
108	2700
114	2850
120	3000
126	3150
132	3300
138	3450
144	3600

more than 1 % or ½ in. [13 mm], whichever is greater, from the nominal diameter, measured from the inside of the steel pipe wall.

7.2 *Sheet Thickness*—Sheet thickness shall be specified by the purchaser from the specified sheet thickness listed in Table 4 (see Notes 2 and 3).

7.3 *Polyethylene Liner*—The polyethylene liner shall have a minimum thickness of at least 0.065 in. [1.65 mm]. The polyethylene in the ribs shall be filled with the same polyethylene material simultaneous to liner extrusion. The ribs shall fill at least 90 % of the deltoid shape.

7.3.1 *Adhesion*—There shall be no spalling, cracking, or disbonding of the applied polyethylene liner in accordance with Specification A742/A742M.

7.3.2 *Abrasion*—There shall be no disbonding or noticeable loss of thickness of the applied polyethylene liner when tested in accordance with Test Method A926, except that all test specimen panels shall be 5 ¾ in. [146 mm] wide.

7.3.3 *Weatherability*—The applied polyethylene liner shall retain at least 90 % of the original tensile strength and elongation in accordance with Test Method D638 after a 180-day sunlight exposure in accordance with Practice D1435. There shall be no liner delamination.

7.3.4 *Long-term Sunlight Exposure*—The pipe liner shall not be exposed to long-term sunlight. Inlet and outlet design shall provide protection by the use of metal end sections, pipe materials not affected by sunlight at ends of pipe line exposed,

TABLE 4 Thickness of Metallic Coated Steel Sheet[A]

Specified Thickness	
in.	mm
0.064	1.63
0.079	2.01
0.109	2.77
0.138	3.51

[A]Sheet thicknesses are referenced in Specification A742/A742M. The specified thickness is the thickness of the metallic-coated steel sheet and does not include the thickness of the polymer coating.

headwalls, inlet/outlet structures, set-backs or other methods that minimize sunlight exposure.

NOTE 2—The sheet thicknesses indicated in Table 4 are the thicknesses listed as available in Specification A742/A742M which are suitable for use with ribbed steel pipe.

NOTE 3—The purchaser should determine the required thickness of steel sheet for the pipe in accordance with the design criteria in Practice A796/A796M or other appropriate guidelines.

8. Joint Connectors

8.1 *General Requirements*—Joint connectors for composite ribbed steel pipe precoated and polyethylene lined shall be specified as soil tight, water-resistant, or watertight.

8.1.1 *Soil Tight Joint Connectors* —Joint connectors requiring soil tightness shall meet the requirements of AASHTO Standard Specifications for Highway Bridges, Division II, Section 26, or AASHTO LRFD Specifications, Section 26.

8.1.2 *Water-Resistant Joint Connectors*—Joint connectors requiring water resistance for storm sewers shall meet the hydrostatic pressure test requirements of Specification D3212 except that the test shall be conducted at 2 ± 0.05 psi [14 ± 0.4 kPa], during which the joint leakage shall not exceed 200 gallons per inch of diameter per mile per day [19 L/mm/km/day].

8.1.3 *Watertight Joint Connectors* —Joint connectors requiring watertightness for sanitary sewers and watertight storm sewers shall meet the hydrostatic pressure test requirements of Specification D3212.

9. Workmanship, Finish, and Appearance

9.1 The completed pipe shall show careful, finished workmanship in all particulars. Pipe that has been damaged, either during fabrication or in shipping, shall be subject to rejection unless repairs are made that are satisfactory to the purchaser.

10. Repair of Damaged Coatings

10.1 Pipe on which either the polyethylene liner or the polymer coating or the underlying metallic coating has been damaged in fabricating or handling shall be repaired. Damage to the metallic coating shall be repaired as described in 10.2 through 10.3. Damage to the polymer coating shall be repaired as described in 10.4. Damage to the polyethylene liner shall be repaired as described in 10.5. The repair shall be done so that the completed pipe shall show careful finished workmanship in all particulars. Pipe which, in the opinion of the purchaser, has not been cleaned or coated satisfactorily shall be rejected. If the purchaser so elects, the repair shall be done in the purchaser's presence.

10.2 Damage to the metallic coating shall be repaired as provided in Practice A780, except as described herein. The damaged area shall be cleaned to bright metal by blast cleaning, power disk sanding, or wire brushing. The cleaned area shall extend at least ½ in. [13 mm] into the undamaged section of the coating. The cleaned area shall be coated within 24 h and before any rusting or soiling.

10.3 *Paints Containing Zinc Dust*—Paints containing zinc dust in accordance with Practice A780 shall be applied to a dry film thickness of at least 0.005 in. [0.13 mm] over the damaged area.

10.4 Areas of damaged polymer coating shall be repaired with a polymer coating similar and compatible with respect to durability, adhesion, and appearance of the original polymer coating.

10.4.1 The damaged area shall be repaired by first cleaning and removing all rust, dirt, oils, and other contaminates. Acceptable coating materials include ethylene acrylic acid, ethylene methacrylic acid, and other modified poly olefin based materials which display compatibility with ethylene acrylic acid polymers. Application of these coatings shall be performed by using commercial grade flame coating systems or by brush applying manufacturer-approved plural component coatings.

10.5 Areas of damaged polyethylene lining shall be repaired with a polyethylene similar and compatible with respect to durability, adhesion, and appearance of the original polyethylene liner.

10.5.1 The damaged area shall be cleaned and all loose material removed. The pipe manufacturer shall furnish compatible polyethylene in pellet, powder, cord, or sheet form with written repair instructions. The repair procedure shall use thermal bonding as obtained from a hot air blower, hot iron, hand-held extruder, or plastic flame spraying depending on the nature of the repair process.

11. Inspection

11.1 The purchaser or the purchaser's representative shall have free access to the fabricating plant for inspection, and every facility shall be extended for this purpose.

11.2 On a random basis, take samples for chemical analysis and metallic coating measurements for check purposes. These samples shall be secured from fabricated pipe or from sheets or coils of the material used in fabrication of the pipe. Determine the weight [mass] of metallic coating in accordance with Test Method A90/A90M. Measure the thickness of the polymer coating in accordance with Test Method D1005.

12. Rejection

12.1 Pipe failing to conform to the specification, or that shows poor workmanship, shall be subject to rejection. This requirement applies not only to the individual pipe, but to any shipment as a whole where a substantial number of pipes are defective. If the average deficiency in length of any shipment of pipe is greater than 1 %, the shipment shall be subject to rejection.

13. Certification

13.1 When specified in the purchase order or contract, a manufacturer's or fabricator's certification, or both, shall be furnished to the purchaser stating that samples representing each lot have been tested and inspected in accordance with this specification and have been found to meet the requirements for the material described in the order. When specified in the order, a report of the test results shall be furnished.

14. Keywords

14.1 composite ribbed steel pipe; irrigation pipe; liner pipe; polyethylene filled ribs and extruded liner; polyethylene lined steel pipe; polymer coated steel pipe; rehabilitation pipe; sanitary sewer pipe; slip line pipe; storm drain pipe; water transmission pipe