



Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe¹

This standard is issued under the fixed designation F2435; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This specification covers requirements and test methods for materials, dimensions, workmanship, elongation, impact resistance, pipe stiffness, perforations, and markings for steel reinforced corrugated polyethylene (PE) piping systems of nominal sizes 8 in. (200 mm), through 80 in. (2000 mm). The steel reinforced polyethylene pipes governed by this standard are intended for use in underground applications where soil provides support for their flexible walls. These pipes will be used to collect or convey stormwater runoff for storm sewers and drainage pipes, or both.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 There is no similar or equivalent ISO 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

A591/A591M Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applications (Withdrawn 2005)³

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A1008/A1008M Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

D618 Practice for Conditioning Plastics for Testing

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

F449 Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F2136 Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe

2.2 AASHTO Standard⁴

Standard Specification for Highway Bridges, Division II, Section 30, "Metal Culverts."

2.3 Federal Standards:⁵

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.11 on Composite. Current edition approved May 1, 2007/July 1, 2012. Published June 2007/August 2012. Originally approved in 2005. Last previous edition approved in 2005/2007 as F2435-05-07. DOI: 10.1520/F2435-07-10.1520/F2435-12.

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.

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

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

2.4 Military Standards:⁵
MIL-STD-129 Marking for Shipment and Storage

3. Terminology

3.1 Definitions—Definitions used in this specification are in accordance with Terminology F412, unless otherwise noted.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 ~~double-wall~~, double-wall steel reinforced polyethylene corrugated pipe, $adj=n$ —polyethylene corrugated pipe with steel reinforcing helical V-shaped ~~profiles~~profile encapsulated within the corrugations and with ~~an~~ a closed channel on the inside of the pipe (See Fig. 42).

3.2.2 ~~single-wall~~, single-wall steel reinforced polyethylene corrugated pipe, $adj=n$ —polyethylene corrugated pipe with steel reinforcing helical V-shaped ~~profiles~~profile encapsulated within the corrugations and with ~~a~~ an open channel on the inside of the pipe (See Fig. 21).

3.2.3 triple-wall, adj —polyethylene corrugated pipe with steel reinforcing profiles either helical V-shaped profiles or U-shaped profiles encapsulated within the corrugations and with steel reinforcing helical flat profiles encapsulated within the exterior polyethylene layer and with a closed channel (polyethylene layer) on the inside of the pipe (See Fig. 3 and Fig. 4).

3.2.4 Steel Reinforced Polyethylene Corrugated Pipe (SRPCP), n —single wall, double wall or triple wall, helical (spiral) corrugated pipe with steel reinforcing ribs, either V-shaped or U-shaped, encapsulated within polyethylene.

4. Significance and Use

4.1 Steel reinforced corrugated PE pipes are used for underground applications where soil provides support to their flexible walls. Their major use is to collect or convey storm water run-off for sewers and drains, or both.

4.2 Exclusions from recommended use:

4.2.1 Permanent exposure to sunlight and exposure to chemicals whose compatibility with the pipe and fittings is not known.

5. Materials

5.1 Polyethylene Materials:

5.1.1 Polyethylene compounds used in the manufacture of steel reinforced corrugated PE drainage pipe shall meet or exceed the requirements of cell classification of 444430C333430C as defined and described in Specification D3350.

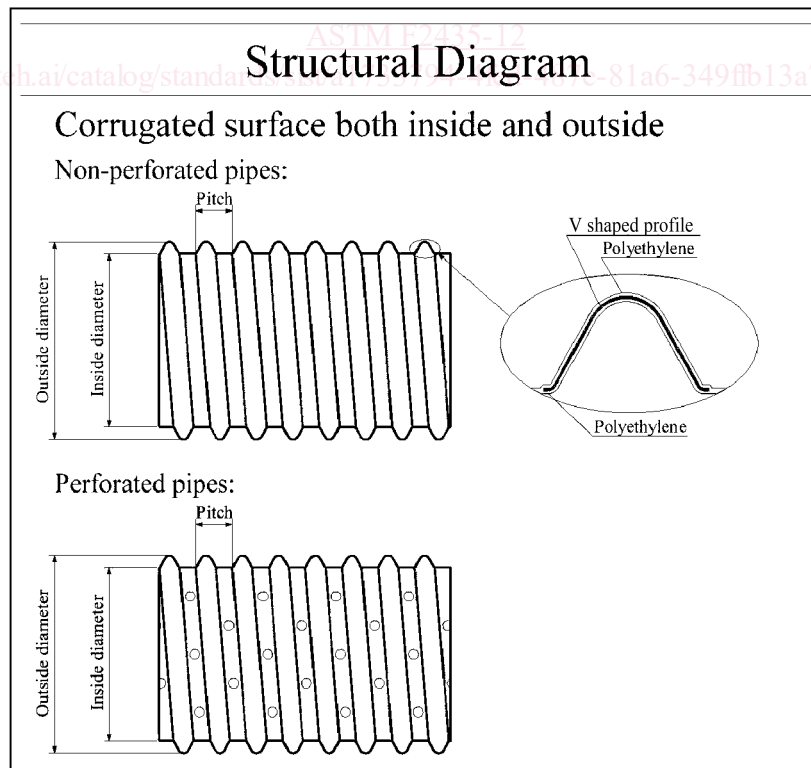


FIG. 21 Single-Wall Single-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV

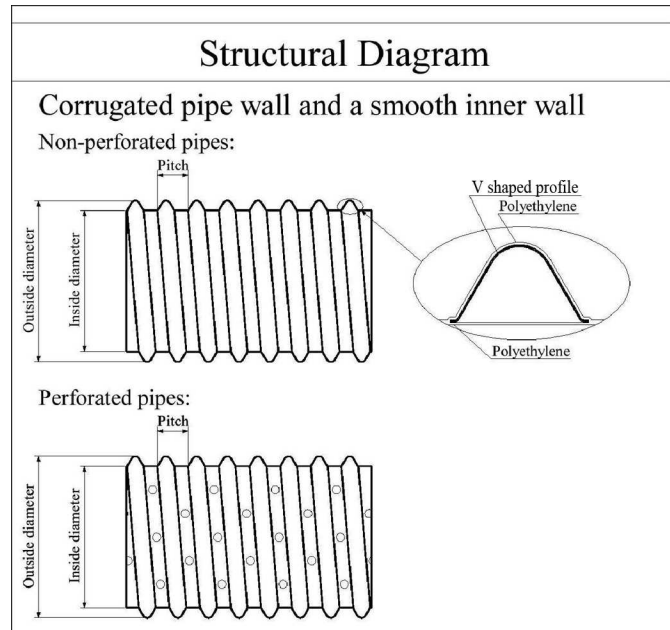


FIG. 42 ~~Double-Wall-Double-Wall~~ Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV

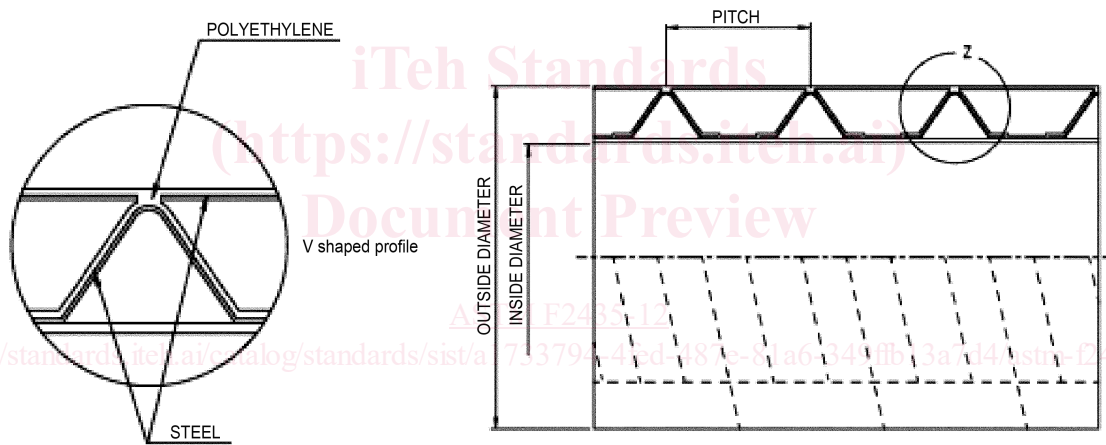


FIG. 3 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe-Type A Pipe – Type IIA

5.1.2 Slow crack growth resistance of the polyethylene ~~natural resin compound~~ shall be determined by testing in accordance with Test Method F2136. The applied stress shall be 600 psi (4100 kPa). The test specimens must exceed 2441 h with no failures. Testing shall be done on polyethylene material taken from the finished pipe.

5.1.3 *Carbon Black Content*—Minimum 2.0 wt. % to a maximum 3.0 wt. % of the total of the polyethylene compound.

5.2 *Steel Materials:*

5.2.1 The minimum thickness of the steel ~~profile sheet~~ shall be 0.0078 inches (0.20 mm) as listed in Tables 1-4 and the minimum yield strength shall not be ~~The steel substrate shall conform to Specification A1008/A1008M lessor A653/A653M than 20 ksi (140 MPa). The steel substrate shall conform either to Specification, and the minimum yield strength of the steel sheet shall not be A1008/A1008M and have a less than 24.66 ksi (170 MPa). The zinc-galvanized coating shall have a minimum zinc coating designation of 20Z (intermediate coating) as defined in Specification A591/A591M or to Specification A653/A653M and have a zinc coating design of G40 as defined in Specification A653/A653M.~~

5.2.2 *Steel Material Content*—Maximum 46% ~~75%~~ ($\pm 2\%$) of the total weight of the pipe. The steel material is fully encapsulated by the polyethylene material with a minimum thickness of the polyethylene of 0.055 in. (1.4 mm) for single-wall and double-wall pipe and 0.020 in. (0.5 mm) for triple-wall pipe, at its thinnest point of 0.012 in. (0.3 mm).

5.3 *Rework Material*—Rework material is not to be used in the manufacture of this product.

5.4 *Gaskets*—Elastomeric gaskets shall comply with the requirements specified in Specification F477.

5.5 *Lubricant*—The lubricant used for assembly of gasketed joints shall have no detrimental effect on the gasket or on the pipe.

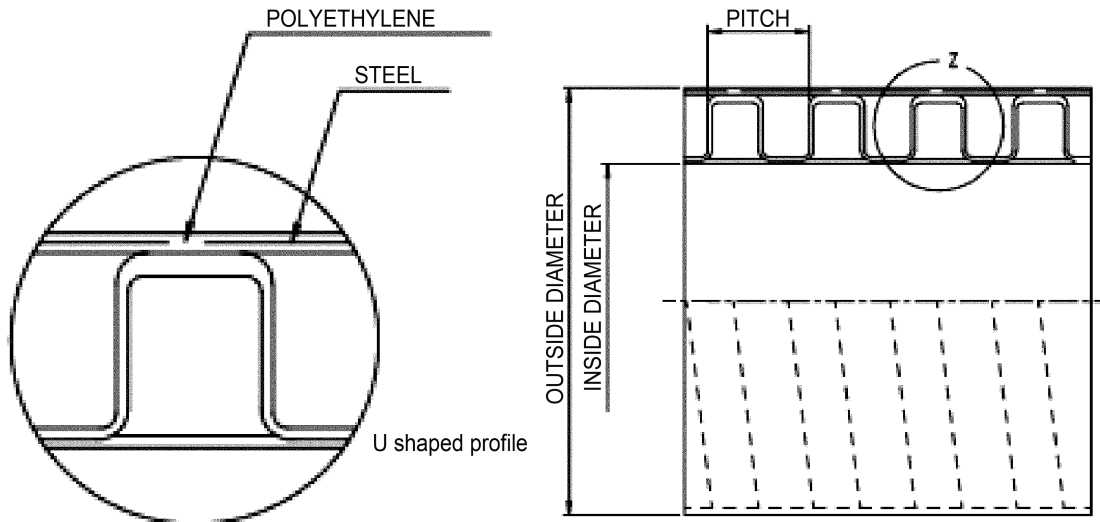


FIG. 4 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe - Type B Pipe - Type IIB

NOTE 1—The purpose of the HDPE encapsulation of the steel is to attain bonding between the steel and PE to form a composite structure. The PE encapsulation is not for protecting the steel from corrosion damage. The minimum PE thickness of 0.012 in. at the thinnest point still maintains the bond between the steel and PE. The pipe is designed to combine pipe stiffness and buckling performance. The thickness of the HDPE encapsulation does not affect product performance.

6. Requirements

6.1 *Workmanship*—The inside and outside surfaces of the pipe shall be semi-matte or glossy in appearance and free of chalking, sticky, or tacky materials. The pipe wall shall not have cracks, holes, blisters, voids, foreign inclusions or other defects that are visible to the naked eye and that can affect the wall integrity or the bonding to the steel reinforcement. Holes deliberately placed in perforated pipe are permitted. The surface shall be free of bloom.

6.2 Pipe Dimensions and Tolerances:

6.2.1 Pipe Dimensions (for both perforated and non-perforated pipe) shall comply with Table 1, Table 3, and Table 4 for single-wall and double-wall pipe and Table 2 for triple-wall pipe, when measured in accordance with Test Method D2122.

6.2.2 *Inside Diameter*—The tolerance on the nominal inside diameter shall be $\pm 2.0\%$, when measured in accordance with section 8.3.

6.2.3 *Outside Diameter*—The tolerance on the nominal outside diameter shall be $\pm 2.0\%$, when measured in accordance with section 8.4.

6.2.4 *Wall Thickness*—The tolerance of the minimum wall thickness of the waterway of the pipe (see Tables 1 and 1-24) shall be $+35\%$ when measured in accordance with 8.5.

6.2.5 *Length*—The pipe shall be sold in any length agreeable to the user. Length shall not be less than 99 % of the specified length when measured in accordance with section 8.6.

6.3 Perforations:

6.3.1 *Drainage Pipe*—When perforations are necessary they shall be cleanly cut and uniformly spaced along the length and circumference of the pipe in a size, shape, and pattern suited to the needs of the user. Perforations shall be in the valley portion of the pipe. The reinforcing steel material shall not be exposed by these perforations.

6.3.2 The inlet area of the perforations shall be a minimum of 1 in.²/ft (21 cm²/m) of pipe.

6.4 *Pipe Stiffness*—The pipe shall have a minimum pipe stiffness as shown in Table 1 and Tables 1-4 and Table 2 at 5 % deflection, when tested in accordance with section 8.7.

NOTE 2—The 5 % deflection criteria was selected for testing convenience and should not be considered as a limitation with respect to in-use deflection.

NOTE 3—Figs. 1-4 are meant to be representative of the reinforced PE composite pipes described in this standard.

NOTE 4—Tables 1-4 describe four different types of pipes identified as Types I, II, III and IV which are different as to structure (single and double wall and triple wall structure), profile shape (U-shaped or V-shaped), waterway wall thicknesses and steel thicknesses. These differences are detailed in the Tables.

6.5 *Bonding of the Steel to the Polyethylene*—The mechanical bond between the steel reinforcement and the polyethylene shall be greater than the tensile strength of the polyethylene resin required for this standard. It shall not be possible to separate any two layers with a probe or with the point of a knife blade so that the layers separate cleanly, or the probe or knife moves freely between the layers. There shall be no separation of the polyethylene from the steel reinforcing plate, when the pipe is deflected 40 %, in accordance with Test Method D2412.

TABLE 4 Nominal Pipe Sizes, Dimensions, and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe

Nominal Pipe Size		Inside Diameter		Outside Diameter		Pitch	Minimum Waterway Wall	Pipe Stiffness
in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	psi (MPa)			
8 (200)	8.0 (203)	9.10 (231.1)	2.16 (54.9)	0.13 (3.3)	58 (0.40)			
10 (250)	10.0 (254)	10.95 (278.1)	2.16 (54.9)	0.13 (3.3)	58 (0.40)			
12 (300)	12.0 (305)	13.12 (333.2)	2.16 (54.9)	0.13 (3.3)	58 (0.40)			
18 (450)	18.0 (457)	19.58 (497.3)	2.63 (66.8)	0.165 (4.2)	58 (0.40)			
24 (600)	24.0 (610)	26.56 (674.6)	3.42 (86.7)	0.165 (4.2)	58 (0.40)			
28 (700)	28.0 (711)	30.85 (783.6)	3.85 (97.8)	0.204 (5.2)	58 (0.40)			
32 (800)	32.0 (813)	35.11 (891.8)	4.25 (108.0)	0.212 (5.4)	58 (0.40)			
36 (900)	36.0 (914)	39.4 (1000.8)	4.88 (123.9)	0.272 (6.9)	58 (0.40)			
40 (1000)	40.0 (1016)	47.20 (1198.9)	6.69 (170.0)	0.382 (9.7)	58 (0.40)			
45 (1125)	44.0 (1118)	51.73 (1313.9)	7.48 (190.0)	0.402 (10.2)	58 (0.40)			
48 (1200)	48.0 (1219)	56.42 (1432.1)	8.07 (205.0)	0.425 (10.8)	58 (0.40)			
54 (1375)	54.0 (1372)	63.12 (1602.2)	8.85 (224.8)	0.449 (11.4)	58 (0.40)			
64 (1525)	61.0 (1524)	70.41 (1787.4)	9.25 (235.0)	0.469 (11.9)	58 (0.40)			
67 (1675)	67.0 (1676)	76.40 (1939.1)	9.25 (235.0)	0.492 (12.5)	58 (0.40)			
73 (1825)	73.0 (1829)	82.98 (2106.7)	9.25 (235.0)	0.512 (13.0)	58 (0.40)			
80 (2000)	80.0 (2032)	91.25 (2316.8)	9.25 (235.0)	0.512 (13.0)	58 (0.40)			

TABLE 2 Nominal Pipe Sizes, Dimensions, and Pipe Stiffness for Triple-Wall Pipe - Type IIA and IIB

Nominal Size		Inside Diameter		Outside Diameter		Pitch	Minimum Waterway Wall		Minimum Steel Thickness		Minimum Pipe Stiffness Type IIA		Minimum Pipe Stiffness Type IIB	
inch	mm	inch	mm	inch	mm		inch	mm	inch	mm	psi	MPa	psi	MPa
12	300	11.89	302	13.46	342	1.18	30	0.039	1.0	0.0118	0.30	50.75	0.35	
14	350	13.66	347	15.55	395	1.38	35	0.047	1.2	0.0118	0.30	50.75	0.35	
15	375	14.76	375	16.73	425	1.50	38	0.055	1.4	0.0118	0.30	43.50	0.30	
16	400	15.75	400	17.72	450	1.50	38	0.055	1.4	0.0118	0.30	40.60	0.28	
18	450	18.07	459	20.31	518	1.57	40	0.055	1.4	0.0118	0.30	40.60	0.28	
20	500	19.69	500	22.24	565	1.77	45	0.059	1.5	0.0118	0.30	40.60	0.28	
21	525	20.67	525	23.23	590	1.77	45	0.059	1.5	0.0118	0.30	40.60	0.28	
24	600	24.02	610	26.85	682	2.17	55	0.059	1.5	0.0118	0.30	39.15	0.27	
27	675	26.57	675	30.51	775	2.60	66	0.067	1.7	0.0118	0.30	39.15	0.27	
28	700	27.72	704	31.50	800	2.60	66	0.083	2.1	0.0118	0.30	39.15	0.27	
30	750	29.53	750	33.31	846	2.60	66	0.083	2.1	0.0118	0.30	39.15	0.27	
32	800	31.50	800	35.83	910	2.91	74	0.083	2.1	0.0118	0.30	39.15	0.27	
36	900	35.43	900	40.39	1026	3.15	80	0.118	3.0	0.0118	0.30	39.15	0.27	
40	1000	39.37	1000	45.28	1150	3.39	86	0.122	3.1	0.0118	0.30	39.15	0.27	
42	1050	41.34	1050	47.24	1200	3.39	86	0.122	3.1	0.0118	0.30	39.15	0.27	
44	1100	43.31	1100	50.98	1295	7.48	190	0.157	4.0	0.0118	0.30	58	0.40	
48	1200	47.24	1200	54.92	1395	7.48	190	0.157	4.0	0.0118	0.30	58	0.40	
54	1375	53.15	1350	60.83	1545	7.48	190	0.177	4.5	0.0118	0.30	58	0.40	
60	1524	59.06	1500	67.44	1713	8.07	205	0.177	4.5	0.0118	0.30	58	0.40	
66	1650	64.96	1650	73.35	1863	8.07	205	0.177	4.5	0.0118	0.30	58	0.40	
71	1800	70.87	1800	79.25	2013	8.07	205	0.177	4.5	0.0118	0.30	58	0.40	
80	2000	78.74	2000	87.13	2213	8.07	205	0.177	4.5	0.0118	0.30	58	0.40	

TABLE 3 Pipe Dimensions for Pipe Stiffness Testing

Pipe Size in., (mm)	Length of specimen in., (mm)		Length of pitch in., (mm)
	Pitches		
8 (200)	9	19.5 (495)	2.5 (55)
10 (250)	9	19.5 (495)	2.5 (55)
12 (300)	9	19.5 (495)	2.5 (55)
18 (450)	7	18.5 (469)	3.0 (67)
24 (600)	6	20.5 (522)	3.5 (87)
28 (700)	5	19.5 (490)	4 (98)

Pipe Size- in., (mm)	Pitches	Length of specimen in., (mm)	Length of pitch- in., (mm)
32 (800)	5	22.0 (540)	4.5 (108)
36 (900)	4	19.5 (496)	5.0 (124)
40 (1000)	3	20.0 (510)	7.0 (170)
44 (1100)	3	22.5 (570)	7.5 (190)
48 (1200)	3	24.0 (615)	8.0 (205)
54 (1350)	3	27.0 (675)	9.0 (225)
60 (1500)	3	29.0 (735)	10 (245)
66 (1650)	3	28.0 (705)	9.5 (235)
72 (1800)	3	28.0 (705)	9.5 (235)
80 (2000)	3	28.0 (705)	9.5 (235)

TABLE 4 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type IV (V-shaped profile)

Nominal Size		Inside Diameter		Outside Diameter		Pitch		Waterway Wall Thickness (min)		Minimum Steel Thickness		Minimum Pipe Stiffness	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	MPa	psi
8	200	8.0	203	9.1	231.1	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
10	250	10.0	254	10.95	278.1	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
12	300	12.0	305	13.3	338.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
15	375	15.0	381	16.3	413.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
18	450	18.0	457	19.3	489.0	2.44	62.0	0.059	1.5	0.0118	0.30	0.275	40
24	600	24.0	610	25.7	653.0	2.76	70.0	0.059	1.5	0.0118	0.30	0.235	34
30	750	30.0	762	32.2	817.0	3.54	90.0	0.079	2.0	0.0118	0.30	0.200	29
36	900	36.0	915	38.2	970.0	3.94	100.0	0.079	2.0	0.0118	0.30	0.155	22.5
42	1050	42.0	1067	44.4	1128.0	3.94	100.0	0.079	2.0	0.0118	0.30	0.145	21
48	1200	48.0	1220	52.0	1320.0	6.30	160.0	0.157	4.0	0.0118	0.30	0.135	20
60	1500	60.0	1524	65.2	1656.0	7.68	195.0	0.157	4.0	0.0118	0.30	0.105	15

TABLE 1 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type I (V-shaped profile)

Nominal Size		Inside Diameter		Outside Diameter		Pitch		Waterway Wall Thickness (min)		Minimum Steel Thickness		Minimum Pipe Stiffness	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	psi	MPa
8	200	8.0	203	9.1	231.1	2.16	54.9	0.13	3.3	0.0118	0.30	58	0.40
10	250	10.0	254	10.95	278.1	2.16	54.9	0.13	3.3	0.0118	0.30	58	0.40
12	300	12.0	305	13.12	333.2	2.16	54.9	0.13	3.3	0.0118	0.30	58	0.40
18	450	18.0	457	19.58	497.3	2.63	66.8	0.165	4.2	0.0157	0.40	58	0.40
24	600	24.0	610	26.56	674.6	3.42	86.9	0.165	4.2	0.0157	0.40	58	0.40
28	700	28.0	711	30.85	783.6	3.85	97.8	0.204	5.2	0.0157	0.40	58	0.40
32	800	32.0	813	35.11	891.8	4.25	108.0	0.212	5.4	0.0157	0.40	58	0.40
36	900	36.0	914	39.4	1000.8	4.88	124.0	0.272	6.9	0.0157	0.40	58	0.40
40	1000	40.0	1016	47.2	1198.9	6.69	169.9	0.382	9.7	0.0157	0.40	58	0.40
45	1125	44.0	1118	51.73	1313.9	7.48	190.0	0.402	10.2	0.0157	0.40	58	0.40
48	1200	48.0	1219	56.42	1432.1	8.07	205.0	0.425	10.8	0.0157	0.40	58	0.40
54	1375	54.0	1372	63.12	1603.2	8.85	224.8	0.449	11.4	0.0157	0.40	58	0.40
61	1525	61.0	1524	70.41	1788.4	9.25	235.0	0.469	11.9	0.0157	0.40	58	0.40
67	1675	67.0	1676	76.4	1940.6	9.25	235.0	0.492	12.5	0.0157	0.40	58	0.40
73	1825	73.0	1829	82.98	2107.7	9.25	235.0	0.512	13.0	0.0157	0.40	58	0.40
80	2000	80.0	2032	91.25	2317.8	9.25	235.0	0.512	13.0	0.0157	0.40	58	0.40

6.6 Fitting Requirements:

6.6.1 The fittings shall not reduce or impair the overall integrity or function of the pipeline.

6.6.2 Fittings shall be supplied with joints compatible with the overall system. All joints for watertight gravity flow sewer systems shall meet the requirements of 6.6.3.1. All other joints shall meet the requirements of a soil tight joint unless otherwise specified by the manufacturer.

6.6.3 Joint Tightness:

6.6.3.1 *Watertight Joints*—Gasketed watertight joints, when utilized, shall meet the requirements of Specification D3212 using a pressure of a 10.8 psi (74 kPa) and a vacuum of 10.8 psi (74 kPa).

6.6.3.2 *Soil-tight Joints*—Soil tight joints are specified as a function of opening size, channel length and backfill particle size. If the size of the opening exceeds 3 mm, the length of the channel shall be at least four times the size of the opening. A backfill material containing a high percentage of fine-graded soils requires investigation for the specific type of joint to be used to guard against soil infiltration. Information regarding joint soil tightness criteria can be found in AASHTO’s Standard Specification for Highway Bridges, Division II, Section 30, “Metal Culverts”.