



Designation: F2435 – 22

# Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe<sup>1</sup>

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 reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 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. The steel reinforced polyethylene corrugated pipes governed by this standard are intended for use in non-pressure applications for sanitary sewers, storm sewers and drainage pipes.

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

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**A591/A591M** Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applica-

tions (Withdrawn 2005)<sup>3</sup>

**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, Required Hardness, Solution Hardened, and Bake Hardenable

**D638** Test Method for Tensile Properties of Plastics

**D1238** Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

**D1505** Test Method for Density of Plastics by the Density-Gradient Technique

**D2122** Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

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

**D2240** Test Method for Rubber Property—Durometer Hardness

**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

**D6869** Test Method for Coulometric and Volumetric Determination of Moisture in Plastics Using the Karl Fischer Reaction (the Reaction of Iodine with Water)

**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

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.62 on Sewer. Current edition approved Feb. 1, 2022. Published April 2022. Originally approved in 2005. Last previous edition approved in 2015 as F2435–15. DOI: 10.1520/F2435-22.

<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

\*A Summary of Changes section appears at the end of this standard

- 2.2 AASHTO Standard<sup>4</sup>  
Standard Specification for Highway Bridges, Division II, Section 30, “Metal Culverts.”
- 2.3 Federal Standards:<sup>5</sup>  
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
- 2.4 Military Standards:<sup>5</sup>  
MIL-STD-129 Marking for Shipment and Storage

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 PE 80 or having a cell classification of 333474C as defined and described in Specification D3350.  
5.1.2 Slow crack growth resistance of the polyethylene 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 41 h with no failures. Testing shall be done on polyethylene material taken from the finished pipe.

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 steel reinforced polyethylene corrugated pipe, *n*—polyethylene corrugated pipe with steel reinforcing helical V-shaped profile encapsulated within the corrugations and with a closed channel on the inside of the pipe (See Fig. 2).

3.2.2 single-wall steel reinforced polyethylene corrugated pipe, *n*—polyethylene corrugated pipe with steel reinforcing helical V-shaped profile encapsulated within the corrugations and with an open channel on the inside of the pipe (See Fig. 1).

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

<sup>4</sup> 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>  
<sup>5</sup> DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 <http://quicksearch.dla.mil/>

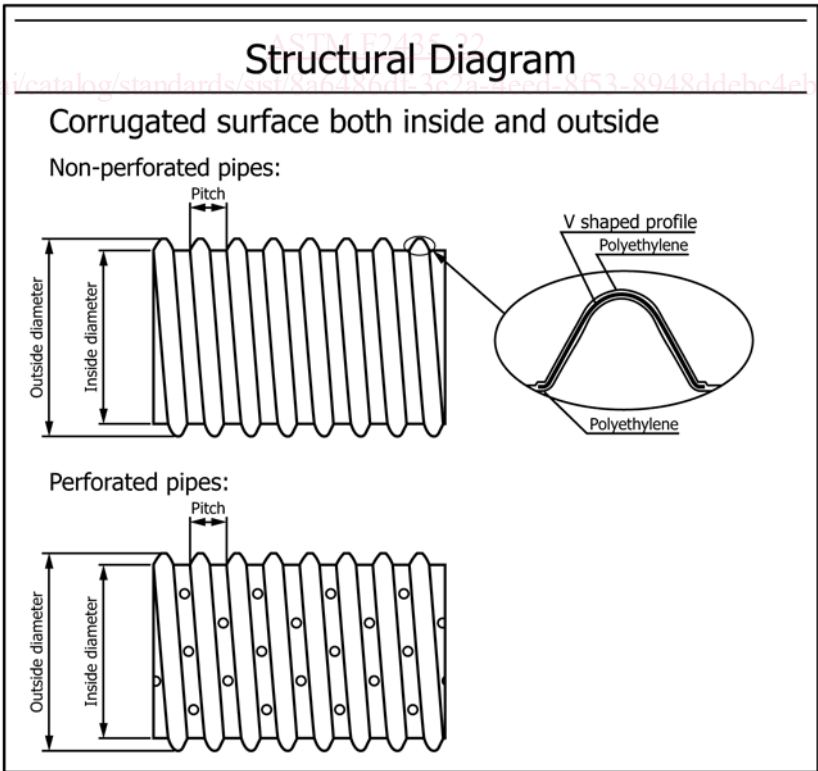


FIG. 1 Single-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV

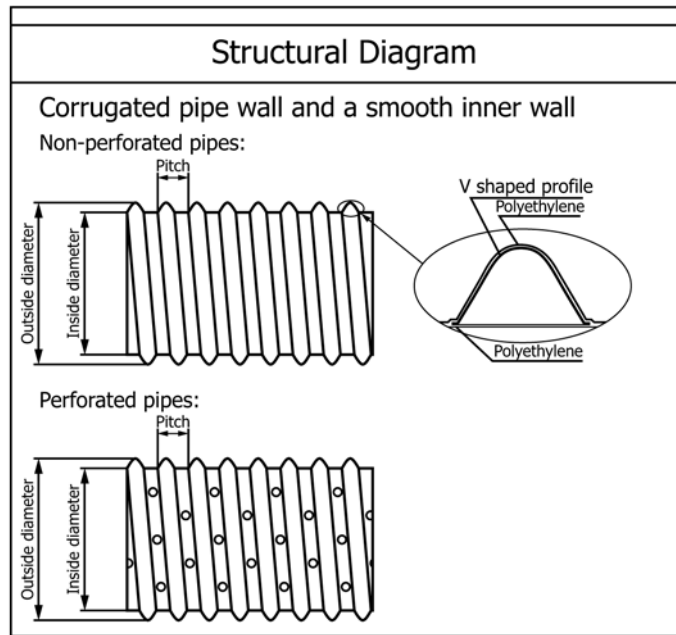


FIG. 2 Double-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV

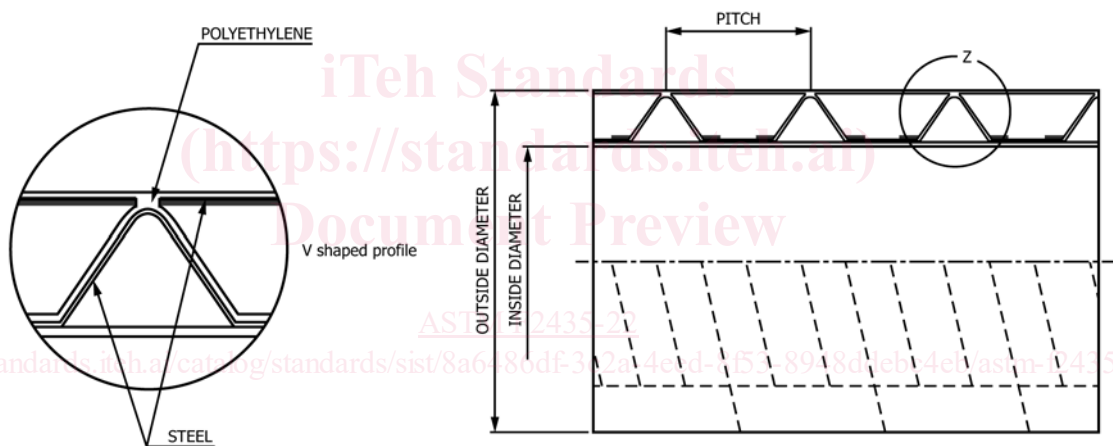


FIG. 3 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe – Type IIA

5.1.2.1 For slow crack growth resistance, the pipe shall be evaluated using the notched constant ligament stress (NCLS) test according to the procedure described in 5.1.2.2. The NCLS test shall be conducted on molded plaques, and the average failure time of the five test specimens shall exceed 41 h with no single test specimen's failure time less than 29 h.

5.1.2.2 Pipe test specimens shall be molded into test specimens from the pipe. Test 5 pipe specimens using the same protocol for molded bars in Test Method F2136 test, except for the following modifications:

(a) The applied stress for the NCLS test shall be 600 psi (4.1 MPa).

(b) The test specimen is taken from the extruded pipe and is chopped and molded into a specimen.

5.1.3 Bonding layer on steel tape.

5.1.3.1 The bonding layer shall ensure bonding between the PE layer and the steel tape, and shall either be made of a mixture of PE material with additives in compliance with Table 1, or an adhesive in compliance with Table 2.

5.1.4 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 sheet shall be as listed in Tables 3-6. The steel substrate shall conform to Specification A1008/A1008M or A653/A653M, and the minimum yield strength of the steel sheet shall not be 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.

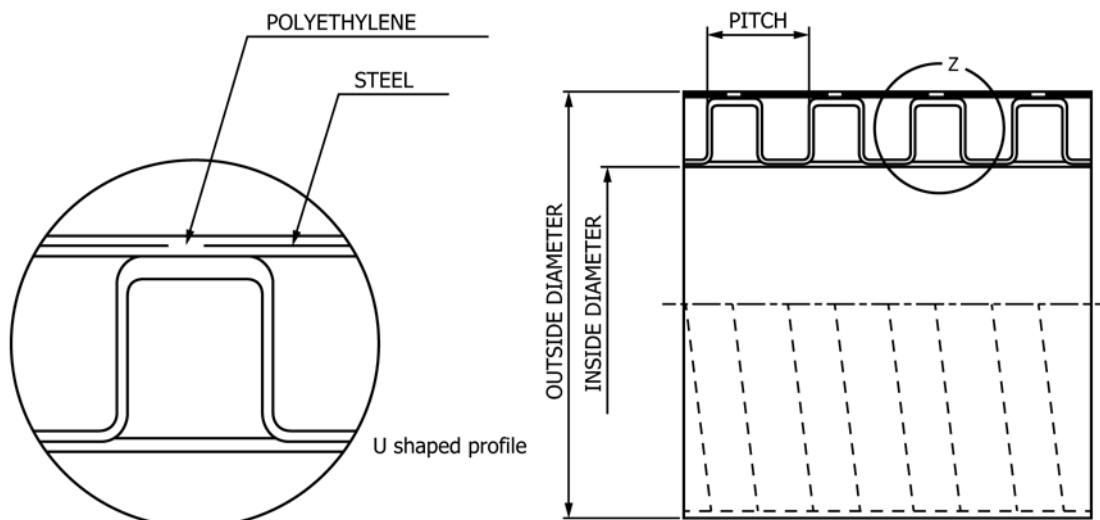


FIG. 4 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe – Type IIB

TABLE 1 Requirements for Polyethylene-based Coating Compound

Characteristic	Unit	Requirement	Test Method
Density of base resin	g/cm <sup>2</sup>	> 0.93	D1505
MFR (190 °C /2.16 kg)	g/10 min	< 0.6	D1238
Strain at break at (23 °C ±3 °C)	%	> 600	D638
Stress at yield at (23 °C ±3 °C)	MPa	> 15	D638
Water content	%	≤ 0.05	D6869
Hardness, Shore D	..	> 55	D2240
Slow crack growth	Hours	Average ≥ 41	F2136

TABLE 2 Requirements for Adhesive Material

Characteristic	Unit	Requirement	Test Method
Strain at break at (23 °C ± 2 °C)	%	> 600	D638
Density	g/cm <sup>2</sup>	> 0.92	D1505
MFR (190 °C /2.16 kg)	g/10 min	< 1.2	D1238
Stress at yield at (23 °C ± 2 °C)	MPa	> 8	D1238
Water content	%	0.05	D6869

5.2.2 *Steel Material Content*—Maximum 75 % (±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 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.

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 buckling resistance.

## 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 3, Table 5, and Table 6 for single-wall and double-wall pipe and Table 4 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 ±2.0 %, when measured in accordance with section 8.3.

6.2.3 *Outside Diameter*—The tolerance on the nominal outside diameter shall be ±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 3-6) 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.<sup>2</sup>/ft (21 cm<sup>2</sup>/m) of pipe.

**TABLE 3 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
	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	psi (MPa)
8	8.0 (203)	9.1 (231.1)	2.16 (54.9)	0.13 (3.3)	0.0118 (0.30)	58 (0.40)
10	10.0 (254)	10.95 (278.1)	2.16 (54.9)	0.13 (3.3)	0.0118 (0.30)	58 (0.40)
12	12.0 (305)	13.12 (333.2)	2.16 (54.9)	0.13 (3.3)	0.0118 (0.30)	58 (0.40)
18	18.0 (457)	19.58 (497.3)	2.63 (66.8)	0.165 (4.2)	0.0157 (0.40)	58 (0.40)
24	24.0 (610)	26.56 (674.6)	3.42 (86.9)	0.165 (4.2)	0.0157 (0.40)	58 (0.40)
28	28.0 (711)	30.85 (783.6)	3.85 (97.8)	0.204 (5.2)	0.0157 (0.40)	58 (0.40)
32	32.0 (813)	35.11 (891.8)	4.25 (108.0)	0.212 (5.4)	0.0157 (0.40)	58 (0.40)
36	36.0 (914)	39.4 (1000.8)	4.88 (124.0)	0.272 (6.9)	0.0157 (0.40)	58 (0.40)
40	40.0 (1016)	47.2 (1198.9)	6.69 (169.9)	0.382 (9.7)	0.0157 (0.40)	58 (0.40)
45	44.0 (1118)	51.73 (1313.9)	7.48 (190.0)	0.402 (10.2)	0.0157 (0.40)	58 (0.40)
48	48.0 (1219)	56.42 (1432.1)	8.07 (205.0)	0.425 (10.8)	0.0157 (0.40)	58 (0.40)
54	54.0 (1372)	63.12 (1603.2)	8.85 (224.8)	0.449 (11.4)	0.0157 (0.40)	58 (0.40)
61	61.0 (1524)	70.41 (1788.4)	9.25 (235.0)	0.469 (11.9)	0.0157 (0.40)	58 (0.40)
67	67.0 (1676)	76.4 (1940.6)	9.25 (235.0)	0.492 (12.5)	0.0157 (0.40)	58 (0.40)
73	73.0 (1829)	82.98 (2107.7)	9.25 (235.0)	0.512 (13.0)	0.0157 (0.40)	58 (0.40)
80	80.0 (2032)	91.25 (2317.8)	9.25 (235.0)	0.512 (13.0)	0.0157 (0.40)	58 (0.40)

**TABLE 4 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	Minimum Pipe Stiffness
	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	Type IIA psi (MPa)	Type IIB psi (MPa)
12	11.89 (302)	13.46 (342)	1.18 (30)	0.039 (1.0)	0.0118 (0.30)	...	50.75 (0.35)
14	13.66 (347)	15.55 (395)	1.38 (35)	0.047 (1.2)	0.0118 (0.30)	...	50.75 (0.35)
15	14.76 (375)	16.73 (425)	1.50 (38)	0.055 (1.4)	0.0118 (0.30)	...	43.50 (0.30)
16	15.75 (400)	17.72 (450)	1.50 (38)	0.055 (1.4)	0.0118 (0.30)	...	40.60 (0.28)
18	18.07 (459)	20.31 (518)	1.57 (40)	0.055 (1.4)	0.0118 (0.30)	...	40.60 (0.28)
20	19.69 (500)	22.24 (565)	1.77 (45)	0.059 (1.5)	0.0118 (0.30)	...	40.60 (0.28)
21	20.67 (525)	23.23 (590)	1.77 (45)	0.059 (1.5)	0.0118 (0.30)	...	40.60 (0.28)
24	24.02 (610)	26.85 (682)	2.17 (55)	0.059 (1.5)	0.0118 (0.30)	...	39.15 (0.27)
27	26.57 (675)	30.51 (775)	2.60 (66)	0.067 (1.7)	0.0118 (0.30)	...	39.15 (0.27)
28	27.72 (704)	31.50 (800)	2.60 (66)	0.083 (2.1)	0.0118 (0.30)	...	39.15 (0.27)
30	29.53 (750)	33.31 (846)	2.60 (66)	0.083 (2.1)	0.0118 (0.30)	...	39.15 (0.27)
32	31.50 (800)	35.83 (910)	2.91 (74)	0.083 (2.1)	0.0118 (0.30)	...	39.15 (0.27)
36	35.43 (900)	40.39 (1026)	3.15 (80)	0.118 (3.0)	0.0118 (0.30)	...	39.15 (0.27)
40	39.37 (1000)	45.28 (1150)	3.39 (86)	0.122 (3.1)	0.0118 (0.30)	...	39.15 (0.27)
42	41.34 (1050)	47.24 (1200)	3.39 (86)	0.122 (3.1)	0.0118 (0.30)	...	39.15 (0.27)
44	43.31 (1100)	50.98 (1295)	7.48 (190)	0.157 (4.0)	0.0118 (0.30)	58 (0.40)	...
48	47.24 (1200)	54.92 (1395)	7.48 (190)	0.157 (4.0)	0.0118 (0.30)	58 (0.40)	...
54	53.15 (1350)	60.83 (1545)	7.48 (190)	0.177 (4.5)	0.0118 (0.30)	58 (0.40)	...
60	59.06 (1500)	67.44 (1713)	8.07 (205)	0.177 (4.5)	0.0118 (0.30)	58 (0.40)	...
66	64.96 (1650)	73.35 (1863)	8.07 (205)	0.177 (4.5)	0.0118 (0.30)	58 (0.40)	...
71	70.87 (1800)	79.25 (2013)	8.07 (205)	0.177 (4.5)	0.0118 (0.30)	58 (0.40)	...
80	78.74 (2000)	87.13 (2213)	8.07 (205)	0.177 (4.5)	0.0118 (0.30)	58 (0.40)	...

**TABLE 5 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type III (V-shaped profile)**

Nominal Size	Inside Diameter	Outside Diameter	Pitch	Waterway Wall Thickness (min)	Minimum Steel Thickness	Minimum Pipe Stiffness
	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	psi (MPa)
8	8.0 (203)	9.1 (231.1)	2.36 (60.0)	0.059 (1.5)	0.0118 (0.30)	80 (0.55)
10	10.0 (254)	10.95 (278.1)	2.36 (60.0)	0.059 (1.5)	0.0118 (0.30)	80 (0.55)
12	12.0 (305)	13.3 (338.0)	2.36 (60.0)	0.059 (1.5)	0.0118 (0.30)	80 (0.55)
15	15.0 (381)	16.3 (413.0)	2.36 (60.0)	0.059 (1.5)	0.0118 (0.30)	65 (0.45)
18	18.0 (457)	19.3 (489.0)	2.44 (62.0)	0.059 (1.5)	0.0157 (0.40)	58 (0.40)
24	24.0 (610)	25.7 (653.0)	2.76 (70.0)	0.059 (1.5)	0.0157 (0.40)	58 (0.40)
30	30.0 (762)	32.2 (817.0)	3.54 (90.0)	0.079 (2.0)	0.0157 (0.40)	58 (0.40)
36	36.0 (915)	38.2 (970.0)	3.94 (100.0)	0.079 (2.0)	0.0157 (0.40)	58 (0.40)
42	42.0 (1067)	44.4 (1128.0)	3.94 (100.0)	0.079 (2.0)	0.0157 (0.40)	58 (0.40)
48	48.0 (1220)	52.0 (1320.0)	6.30 (160.0)	0.157 (4.0)	0.0157 (0.40)	58 (0.40)
60	60.0 (1524)	65.2 (1656.0)	7.68 (195.0)	0.157 (4.0)	0.0157 (0.40)	58 (0.40)