
Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

AASHTO Designation: M 170-24

Technically Revised: 2024

Technical Subcommittee: 4a, Concrete Drainage Structures

ASTM Designation: C76-22a



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

- 1.1.

This specification covers reinforced concrete pipe intended to be used for the conveyance of sewage, industrial wastes, and storm water, and for the construction of culverts.
- 1.2.

A complete metric companion to M 170 has been developed—M 170M; therefore, no metric equivalents are presented in this specification.

Note 1—This specification is a manufacturing and purchase specification only, and does not include requirements for bedding, backfill, or the relationship between field load condition and the strength classification of pipe. However, experience has shown that the successful performance of this product depends on the proper selection of the class of pipe, type of bedding and backfill, and care that installation conforms to the construction specifications. Owners of the reinforced concrete pipe specified herein are cautioned that they must correlate the field requirements with the class of pipe specified and provide inspection at the construction site.

Note 2—Attention is called to the specification for reinforced concrete D-load culvert, storm drain, and sewer pipe (M 242M/M 242).

2. REFERENCED DOCUMENTS

- 2.1.

AASHTO Standards:

■ M 6, Fine Aggregate for Hydraulic Cement Concrete

■ M 31M/M 31, Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement

■ M 80, Coarse Aggregate for Hydraulic Cement Concrete

■ M 85, Portland Cement

■ M 86M/M 86, Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe

■ M 154M/M 154, Air-Entraining Admixtures for Concrete

■ M 157, Ready-Mixed Concrete

■ M 170M, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe [Metric]

■ M 194M/M 194, Chemical Admixtures for Concrete

■ M 240M/M 240, Blended Hydraulic Cement

■ M 242M/M 242, Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

■ M 262, Concrete Pipe and Related Products

- M 295, Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- M 302, Slag Cement for Use in Concrete and Mortars
- M 336M/M 336, Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement
- M 339M/M 339, Thermometers Used in the Testing of Construction Materials
- T 280M/T 280, Concrete Pipe, Manhole Sections, or Tile

2.2. *ASTM Standards:*

- A36/A36M, Standard Specification for Carbon Structural Steel
- A706/A706M, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete (withdrawn 2022; use latest historical version)
- C1116/C1116M, Standard Specification for Fiber-Reinforced Concrete
- E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standard:*

- IEC 60584-1:2013, Thermocouples - Part 1: EMF Specifications and Tolerances

3. TERMINOLOGY

- 3.1. *Definitions*—For definitions of terms relating to concrete pipe, see M 262.

4. CLASSIFICATION

- 4.1. Pipe manufactured in accordance with this specification shall be of five classes identified as Class I, Class II, Class III, Class IV, and Class V. The corresponding strength requirements are prescribed in Tables 1 to 5.

Table 1—Design Requirements for Class I Reinforced Concrete Pipe^a

Reinforcement, in. ² /Linear ft of Pipe Wall										
Internal Designated Diameter, in.	Wall A					Wall B				
	Concrete Strength, 4000 psi					Concrete Strength, 4000 psi				
	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c		Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c	
		Inner Cage	Outer Cage				Inner Cage	Outer Cage		
60	5	0.25	0.15	0.28	6	0.21	0.13	0.23		
66	5½	0.30	0.18	0.33	6½	0.25	0.15	0.28		
72	6	0.35	0.21	0.39	7	0.29	0.17	0.32		
78	6½	0.40	0.24	0.44	7½	0.32	0.19	0.36		
84	7	0.45	0.27	0.50	8	0.37	0.22	0.41		
90	7½	0.49	0.29	0.54	8½	0.41	0.25	0.46		
96	8	0.54	0.32	0.60	9	0.46	0.28	0.51		
102	8½	Concrete Strength, 5000 psi			Inner Circular Plus Elliptical	0.25 0.38	Concrete Strength, 5000 psi			
		0.63	0.38	0.54			0.32	Inner Circular Plus Elliptical	0.22 0.32	
108	9	0.68	0.41	Inner Circular Plus Elliptical	0.27 0.41	10	0.61	0.37	Inner Circular Plus Elliptical	0.24 0.37
114	a	—	—	—	—	a	—	—	—	—
120	a	—	—	—	—	a	—	—	—	—
126	a	—	—	—	—	a	—	—	—	—
132	a	—	—	—	—	a	—	—	—	—
138	a	—	—	—	—	a	—	—	—	—
144	a	—	—	—	—	a	—	—	—	—

^a For modified or special designs, see Section 7.2 or, with the permission of the owner, use the provision of M 242M/M 242. Steel areas may be interpolated between those shown for variations in diameter, loading, or wall thickness. Pipe more than 96 in. in diameter shall have two circular cages or an inner circular cage plus one elliptical cage.

^b As an alternative to design requiring both inner and outer circular cages, the reinforcement may be positioned and proportioned in one of the following manners: (1) an inner circular cage plus an elliptical cage such that the area of the elliptical cage shall not be less than that specified for the outer cage in the table, and the total area of the inner circular cage plus the elliptical cage shall not be less than that specified for the inner cage in the table; (2) an inner and outer cage plus quadrant mats in accordance with Figure 1; or (3) an inner and outer cage plus an elliptical cage in accordance with Figure 2.

^c Elliptical and quadrant steel must be held in place by means of holding rods, chairs, or other positive means throughout the entire casting operation.

Note: See Section 5 for basis of acceptance specified by the owner. The strength test requirements in pounds-force per linear foot of pipe under the three-edge-bearing method are listed below as the D-load (test load expressed in pounds-force per linear foot per foot of diameter) to produce a 0.01-in. crack and the ultimate load multiplied by the internal diameter of the pipe in feet. For acceptance testing requirements, see Section 11.3.1.

D-load to produce a 0.01-in. crack	800
D-load to produce the ultimate load	1200

Table 2—Design Requirements for Class II Reinforced Concrete Pipe^a

Internal Designated Diameter, in.	Reinforcement, in. ² /Linear ft of Pipe Wall											
	Wall A				Wall B				Wall C			
	Concrete Strength, 4000 psi				Concrete Strength, 4000 psi				Concrete Strength, 4000 psi			
	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c
		Inner Cage	Outer Cage			Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	1 ³ / ₄	0.07 ^d	—	—	2	0.07 ^d	—	—	2 ³ / ₄	0.07 ^d	—	—
15	1 ⁷ / ₈	0.07 ^d	—	—	2 ¹ / ₄	0.07 ^d	—	—	3	0.07 ^d	—	—
18	2	0.07 ^d	—	0.07 ^d	2 ¹ / ₂	0.07 ^d	—	0.07 ^d	3 ¹ / ₄	0.07 ^d	—	0.07 ^d
21	2 ¹ / ₄	0.12	—	0.10	2 ³ / ₄	0.07 ^d	—	0.07 ^d	3 ¹ / ₂	0.07 ^d	—	0.07 ^d
24	2 ¹ / ₂	0.13	—	0.11	3	0.07 ^d	—	0.07 ^d	3 ³ / ₄	0.07 ^d	—	0.07 ^d
27	2 ⁵ / ₈	0.15	—	0.13	3 ¹ / ₄	0.13	—	0.11	4 ^e	0.07 ^d	—	0.07 ^d
30	2 ³ / ₄	0.15	—	0.14	3 ¹ / ₂	0.14	—	0.12	4 ¹ / ₄	0.07 ^d	—	0.07 ^d
33	2 ⁷ / ₈	0.16	—	0.15	3 ³ / ₄	0.15	—	0.13	4 ¹ / ₂	0.07 ^d	—	0.07 ^d
36	3	0.14	0.08	0.15	4 ^e	0.12	0.07	0.13	4 ³ / ₄	0.07	0.07	0.08
42	3 ¹ / ₂	0.16	0.10	0.18	4 ¹ / ₂	0.15	0.09	0.17	5 ¹ / ₄	0.10	0.07	0.11
48	4	0.21	0.13	0.23	5	0.18	0.11	0.20	5 ³ / ₄	0.14	0.08	0.15
54	4 ¹ / ₂	0.25	0.15	0.28	5 ¹ / ₂	0.22	0.13	0.24	6 ¹ / ₄	0.17	0.10	0.19
60	5	0.30	0.18	0.33	6	0.25	0.15	0.28	6 ³ / ₄	0.22	0.13	0.24
66	5 ¹ / ₂	0.35	0.21	0.39	6 ¹ / ₂	0.31	0.19	0.34	7 ¹ / ₄	0.25	0.15	0.28
72	6	0.41	0.25	0.45	7	0.35	0.21	0.39	7 ³ / ₄	0.30	0.18	0.33
78	6 ¹ / ₂	0.46	0.28	0.51	7 ¹ / ₂	0.40	0.24	0.44	8 ¹ / ₄	0.35	0.21	0.39
84	7	0.51	0.31	0.57	8	0.46	0.28	0.51	8 ³ / ₄	0.41	0.25	0.46
90	7 ¹ / ₂	0.57	0.34	0.63	8 ¹ / ₂	0.51	0.31	0.57	9 ¹ / ₄	0.48	0.29	0.53
96	8	0.62	0.37	0.69	9	0.57	0.34	0.63	9 ³ / ₄	0.55	0.33	0.61

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Table 2—Design Requirements for Class II Reinforced Concrete Pipe^a (Continued)

Internal Designated Diameter, in.	Reinforcement, in. ² /Linear ft of Pipe Wall														
	Wall A					Wall B					Wall C				
	Concrete Strength, 4000 psi					Concrete Strength, 4000 psi					Concrete Strength, 4000 psi				
	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c		Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c		Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c	
		Inner Cage	Outer Cage				Inner Cage	Outer Cage				Inner Cage	Outer Cage		
Concrete Strength, 5000 psi															
102	8½	0.76	0.46	Inner Circular Plus Elliptical	0.30 0.46	9½	0.68	0.41	Inner Circular Plus Elliptical	5.8 8.6	10¼	0.62	0.37	Inner Circular Plus Elliptical	0.25 0.37
108	9	0.85	0.51	Inner Circular Plus Elliptical	0.34 0.51	10	0.76	0.46	Inner Circular Plus Elliptical	6.4 9.7	10¾	0.70	0.42	Inner Circular Plus Elliptical	0.28 0.42
114	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—
120	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—
126	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—
132	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—
138	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—
144	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—	<i>a</i>	—	—	—	—

^a For modified or special designs, see Section 7.2 or, with the permission of the owner, use the provision of M 242M/M 242. Steel areas may be interpolated between those shown for variations in diameter, loading, or wall thickness. Pipe more than 96 in. in diameter shall have two circular cages or an inner circular cage plus one elliptical cage.

^b As an alternative to designs requiring both inner and outer circular cages, the reinforcement may be positioned and proportioned in one of the following manners: (1) an inner circular cage plus an elliptical cage such that the area of the elliptical cage shall not be less than that specified for the outer cage in the table, and the total area of the inner circular cage plus the elliptical cage shall not be less than that specified for the inner cage in the table; (2) an inner and outer cage plus quadrant mats in accordance with Figure 1; or (3) an inner and outer cage plus an elliptical cage in accordance with Figure 2.

^c Elliptical and quadrant steel must be held in place by means of holding rods, chairs, or other positive means throughout the entire casting operation.

^d For these classes and sizes, the minimum practical steel reinforcement is specified. The specified ultimate strength of nonreinforced pipe is greater than the minimum specified strength for the equivalent diameters (see M 86M/M 86).

^e As an alternative, single-cage reinforcement may be used. The reinforcement area in square in. per linear foot shall be 0.20 for Wall B and 0.16 for Wall C.

Note: See Section 5 for basis of acceptance specified by the owner. The strength test requirements in pound-force per linear foot of pipe under the three-edge-bearing method are listed below as the D-load (test load expressed in pound-force per linear foot per foot of diameter) to produce the 0.01-in. crack and the ultimate load multiplied by the internal diameter of the pipe in feet. For acceptance testing requirements, see Section 11.3.1.

D-load to produce a 0.01-in. crack	1000
D-load to produce the ultimate load	1500

Table 3—Design Requirements for Class III Reinforced Concrete Pipe^a

Internal Designated Diameter, in.	Reinforcement, in. ² /Linear ft of Pipe Wall											
	Wall A				Wall B				Wall C			
	Concrete Strength, 4000 psi				Concrete Strength, 4000 psi				Concrete Strength, 4000 psi			
	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c	Wall Thickness, in.	Circular Reinforcement ^b		Elliptical Reinforcement ^c
		Inner Cage	Outer Cage			Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	1 ³ / ₄	0.07 ^d	—	—	2	0.07 ^d	—	—	2 ³ / ₄	0.07 ^d	—	—
15	1 ⁷ / ₈	0.07 ^d	—	—	2 ¹ / ₄	0.07 ^d	—	—	3	0.07 ^d	—	—
18	2	0.07 ^d	—	0.07 ^d	2 ¹ / ₂	0.07 ^d	—	0.07 ^d	3 ¹ / ₄	0.07 ^d	—	0.07 ^d
21	2 ¹ / ₄	0.14	—	0.11	2 ³ / ₄	0.07 ^d	—	0.07 ^d	3 ¹ / ₂	0.07 ^d	—	0.07 ^d
24	2 ¹ / ₂	0.17	—	0.14	3	0.07 ^d	—	0.07 ^d	3 ³ / ₄	0.07	—	0.07 ^d
27	2 ⁵ / ₈	0.18	—	0.16	3 ¹ / ₄	0.16	—	0.14	4	0.08	—	0.07 ^d
30	2 ³ / ₄	0.19	—	0.18	3 ¹ / ₂	0.18	—	0.15	4 ¹ / ₄	0.10	—	0.08
33	2 ⁷ / ₈	0.21	—	0.20	3 ³ / ₄	0.20	—	0.17	4 ¹ / ₂	0.12	—	0.10
36	3	0.21	0.13	0.23	4 ^e	0.17	0.10	0.19	4 ³ / ₄ ^e	0.08	0.07	0.09
42	3 ¹ / ₂	0.25	0.15	0.28	4 ¹ / ₂	0.21	0.13	0.23	5 ¹ / ₄	0.12	0.07	0.13
48	4	0.32	0.19	0.35	5	0.24	0.14	0.27	5 ³ / ₄	0.16	0.10	0.18
54	4 ¹ / ₂	0.38	0.23	0.42	5 ¹ / ₂	0.29	0.17	0.32	6 ¹ / ₄	0.21	0.13	0.23
60	5	0.44	0.26	0.49	6	0.34	0.20	0.38	6 ³ / ₄	0.25	0.15	0.28
66	5 ¹ / ₂	0.50	0.30	0.55	6 ¹ / ₂	0.41	0.25	0.46	7 ¹ / ₄	0.31	0.19	0.34
72	6	0.57	0.34	0.63	7	0.49	0.29	0.54	7 ³ / ₄	0.36	0.22	0.40
Concrete Strength, 5000 psi												
78	6 ¹ / ₂	0.64	0.38	0.71	7 ¹ / ₂	0.57	0.34	0.63	8 ¹ / ₄	0.42	0.25	0.47
84	7	0.72	0.43	0.80	8	0.64	0.38	0.71	8 ³ / ₄	0.50	0.30	0.56
Concrete Strength, 5000 psi												
90	7 ¹ / ₂	0.81	0.49	0.90	8 ¹ / ₂	0.69	0.41	0.77	9 ¹ / ₄	0.59	0.35	0.66
96	8	0.93	0.56	1.03	9	0.76	0.46	0.84	9 ³ / ₄	0.70	0.42	Inner Circular Plus Elliptical 0.28 0.42
102	8 ¹ / ₂	1.03	0.62	Inner Circular Plus Elliptical 0.41 0.62	9 ¹ / ₂	0.90	0.54	Inner Circular Plus Elliptical 0.36 0.54	10 ¹ / ₄	0.83	0.50	Inner Circular Plus Elliptical 0.33 0.50

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