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

AASHTO Designation: M 207M/M 207-23¹

Technically Revised: 2023

Technical Subcommittee: 4a, Concrete Drainage Structures

ASTM Designation: C507M-20 and C507-20



American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This specification covers reinforced elliptically shaped concrete pipe to be used for the conveyance of sewage, industrial wastes, and storm water, and for the construction of culverts.
- 1.2. Pipe designed for placement with the major axis horizontal shall be designated as “horizontal elliptical pipe.” Pipe designed for placement with the major axis vertical shall be designated as “vertical elliptical pipe.”
- 1.3. This specification is applicable for orders in either SI units (M 207M) or in inch-pound units (M 207). SI units and inch-pound units are not necessarily equivalent. Inch-pound units are shown in brackets in the text for clarity, but they are the applicable values when the material is ordered to M 207.

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 the 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.

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 154M/M 154, Air-Entraining Admixtures for Concrete
 - < M 157, Ready-Mixed Concrete
 - < M 194M/M 194, Chemical Admixtures for Concrete
 - < M 240M/M 240, Blended Hydraulic Cement
 - < M 262, Concrete Pipe and Related Products

- < M 295, Coal Fly 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 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
- < 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
- < 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 according to this specification shall be of five classes each for horizontal elliptical and vertical elliptical pipe with identification as follows:

Horizontal Elliptical Pipe	Vertical Elliptical Pipe
Class HE-A	Class VE-II
Class HE-I	Class VE-III
Class HE-II	Class VE-IV
Class HE-III	Class VE-V
Class HE-IV	Class VE-VI

- 4.2. The strength requirements for horizontal elliptical pipe are prescribed in Table 1 when using SI units and Table 2 when using inch-pound units; strength requirements for vertical elliptical pipe are prescribed in Table 3 when using SI units and Table 4 when using inch-pound units.

Table 1—Design Requirements for Horizontal Elliptical (HE) Pipe (SI units)^a

Designated Diameter, Equivalent Round Size, mm	Designated Rise, mm × Span, mm	Minimum Wall Thickness, mm	Reinforcement, cm ² /Linear m									
			Class HE-A		Class HE-I		Class HE-II		Class HE-III		Class HE-IV	
			D-Loads									
			0.3 = 30 Ult = 45		0.3 = 40 Ult = 60		0.3 = 50 Ult = 75		0.3 = 65 Ult = 100		0.3 = 100 Ult = 150	
			In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage
375	300 × 480	63	1.5	—	1.5	—	1.5	—	1.9	—	3.4	—
450	365 × 575	69	1.7	—	2.3	—	3.0	—	4.0	—	5.7	—
600	490 × 770	82	2.3	—	3.2	—	4.0	—	5.5	—	8.3	—
675	550 × 865	88	3.0	—	3.8	—	4.9	—	6.6	—	9.7	—
750	610 × 960	94	2.1	2.1	2.8	2.8	3.6	3.6	4.9	4.9	7.2	7.2
825	670 × 1055	94	2.5	2.5	3.6	3.6	4.4	4.4	5.9	5.9	8.7	8.7
900	730 × 1150	113	2.3	2.3	3.2	3.2	4.0	4.0	5.5	5.5	8.3	8.3
975	795 × 1250	119	2.8	2.8	3.6	3.6	4.4	4.4	6.1	6.1	9.3	9.3
1050	855 × 1345	125	3.2	3.2	4.2	4.2	5.1	5.1	7.0	7.0	10.6	10.6
1200	975 × 1535	138	3.6	3.6	4.9	4.9	5.9	5.9	8.3	8.3	—	—
1350	1095 × 1730	150	4.2	4.2	5.7	5.7	7.2	7.2	9.5	9.5	—	—
1500	1220 × 1920	163	5.1	5.1	6.8	6.8	8.5	8.5	11.2	11.2	—	—
1650	1340 × 2110	175	5.7	5.7	7.6	7.6	9.5	9.5	12.9	12.9	—	—
1800	1465 × 2305	188	6.6	6.6	8.7	8.7	11.0	11.0	14.8	14.8	—	—
1950	1585 × 2495	200	7.2	7.2	9.5	9.5	11.9	11.9	16.5	16.5	—	—
2100	1705 × 2690	213	8.0	8.0	10.6	10.6	13.3	13.3	18.6	18.6	—	—
2250	1830 × 2880	225	—	—	—	—	—	—	—	—	—	—
2400	1950 × 3070	238	—	—	—	—	—	—	—	—	—	—
2550	2075 × 3265	244	—	—	—	—	—	—	—	—	—	—
2700	2195 × 3455	250	—	—	—	—	—	—	—	—	—	—
2850	2315 × 3648	263	—	—	—	—	—	—	—	—	—	—
3000	2440 × 3840	275	—	—	—	—	—	—	—	—	—	—
3300	2680 × 4225	300	—	—	—	—	—	—	—	—	—	—
3600	2925 × 4610	325	—	—	—	—	—	—	—	—	—	—
Concrete strength, ^b MPa			27.6		27.6		27.6		450 to 1650 mm 27.6		27.6	
									1800 to 2100 mm 34.5			

^a For size and loads beyond those shown in this table, pipe designs are available that make use of one or a combination of the following: shear steel, multiple cages, or thicker walls in accordance with the provision of Section 7.3.

^b Concrete strength for designs with reinforcement tabulated. For modified or special designs, see Section 7.3.

- Notes:
1. The test load in kilonewtons per linear meter equals D-load × inside span in millimeters.
 2. Single cage reinforcement, providing tension steel at the top, bottom, and spring line, shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be 112 percent of the tabulated inner cage area.
 3. An inner and outer cage plus quadrant mats shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be in accordance with Figure 1.
 4. An inner and outer cage plus a middle cage shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be in accordance with Figure 2.

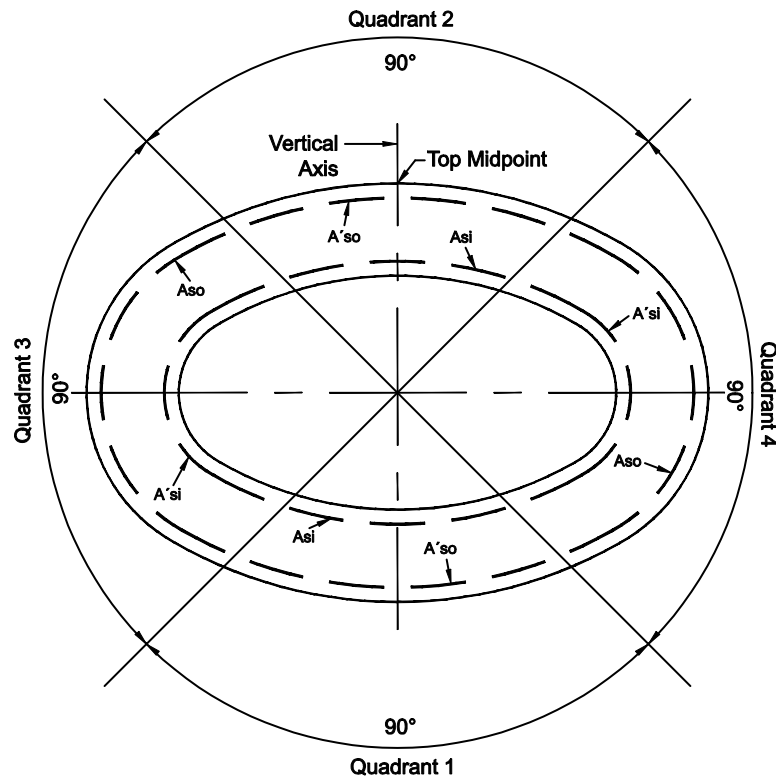
Table 2—Design Requirements for Horizontal Elliptical (HE) Pipe (inch-pound units)^a

Designated Diameter, Equivalent Round Size, in.	Designated Rise, in. × Span, in.	Minimum Wall Thickness, in.	Reinforcement, in. ² /Linear ft									
			Class HE-A		Class HE-I		Class HE-II		Class HE-III		Class HE-IV	
			D-Loads									
			0.01 = 600 Ult = 900		0.01 = 800 Ult = 1200		0.01 =1000 Ult = 1500		0.01 = 1350 Ult = 2000		0.01 = 2000 Ult = 3000	
			In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage
15	12 × 19	2½	0.07	—	0.07	—	0.07	—	0.09	—	0.16	—
18	14 × 23	2¾	0.08	—	0.11	—	0.14	—	0.19	—	0.27	—
24	19 × 30	3¼	0.11	—	0.15	—	0.19	—	0.26	—	0.39	—
27	22 × 34	3½	0.14	—	0.18	—	0.22	—	0.31	—	0.46	—
30	24 × 38	3¾	0.10	0.10	0.13	0.13	0.17	0.17	0.22	0.22	0.34	0.34
33	27 × 42	3¾	0.12	0.12	0.17	0.17	0.21	0.21	0.27	0.27	0.41	0.41
36	29 × 45	4½	0.11	0.11	0.15	0.15	0.19	0.19	0.26	0.26	0.39	0.39
39	32 × 49	4¾	0.13	0.13	0.17	0.17	0.21	0.21	0.29	0.29	0.44	0.44
42	34 × 53	5	0.15	0.15	0.20	0.20	0.24	0.24	0.33	0.33	0.50	0.50
48	38 × 60	5½	0.17	0.17	0.23	0.23	0.27	0.27	0.39	0.39	—	—
54	43 × 68	6	0.20	0.20	0.27	0.27	0.34	0.34	0.45	0.45	—	—
60	48 × 76	6½	0.24	0.24	0.32	0.32	0.40	0.40	0.53	0.53	—	—
66	53 × 83	7	0.27	0.27	0.36	0.36	0.45	0.45	0.60	0.60	—	—
72	58 × 91	7½	0.31	0.31	0.41	0.41	0.52	0.52	0.70	0.70	—	—
78	63 × 98	8	0.34	0.34	0.45	0.45	0.56	0.56	0.78	0.78	—	—
84	68 × 106	8½	0.38	0.38	0.50	0.50	0.63	0.63	0.88	0.88	—	—
90	72 × 113	9	—	—	—	—	—	—	—	—	—	—
96	77 × 121	9½	—	—	—	—	—	—	—	—	—	—
102	82 × 128	9¾	—	—	—	—	—	—	—	—	—	—
108	87 × 136	10	—	—	—	—	—	—	—	—	—	—
114	92 × 143	10½	—	—	—	—	—	—	—	—	—	—
120	97 × 151	11	—	—	—	—	—	—	—	—	—	—
132	106 × 166	12	—	—	—	—	—	—	—	—	—	—
144	116 × 180	13	—	—	—	—	—	—	—	—	—	—
Concrete strength, ^b psi			4000		4000		4000		18 to 66 in. 4000		4000	
									72 to 84 in. 5000			

^a For sizes and loads beyond those shown in this table, pipe designs are available that make use of one or a combination of the following: shear steel, multiple cages, or thicker walls in accordance with the provision of Section 7.3.

^b Concrete strength for designs with reinforcement tabulated. For modified or special designs, see Section 7.3.

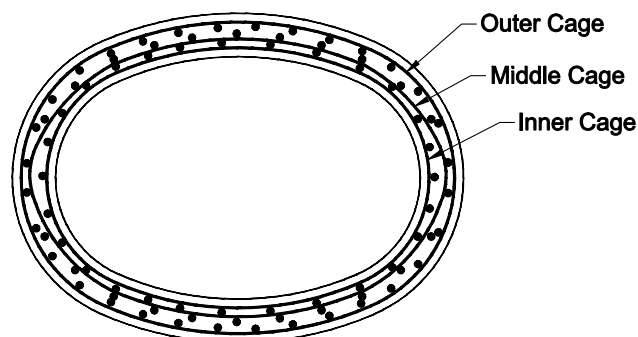
- Notes:
1. The test load in pounds per linear foot equals D-load × inside span in feet.
 2. Single cage reinforcement, providing tension steel at the top, bottom, and spring line, shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be 112 percent of the tabulated inner cage area.
 3. An inner and outer cage plus quadrant mats shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be in accordance with Figure 1.
 4. An inner and outer cage plus a middle cage shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be in accordance with Figure 2.



Notes:

1. The total reinforcement area (A_{si}) of the inner cage plus the quadrant mat in Quadrants 1 and 2 shall not be less than that specified for the inner cage in Table 1 or Table 2.
2. The total reinforcement area (A_{so}) of the outer cage plus the quadrant mat in Quadrants 3 and 4 shall not be less than that specified for the outer cage in Table 1 or Table 2.
3. The reinforcement area (A'_{si}) of the inner cage in Quadrants 3 and 4 shall not be less than 25 percent of that specified for the inner cage in Table 1 or Table 2.
4. The reinforcement area (A'_{so}) of the outer cage in Quadrants 1 and 2 shall not be less than 25 percent of that specified for the outer cage in Table 1 or Table 2.

Figure 1—Quadrant Reinforcement, Horizontal Elliptical Pipe



Notes:

1. The total reinforcement area of the inner cage plus the middle cage shall not be less than that specified for the inner cage in Table 1 or Table 2.
2. The total reinforcement area of the outer cage plus the middle cage shall not be less than that specified for the outer cage in Table 1 or Table 2.

Figure 2—Horizontal Elliptical Pipe

Table 3—Design Requirements for Vertical Elliptical (VE) Pipe (SI units)^a

Designated Diameter, Equivalent Round Size, mm	Designated Rise, mm × Span, mm	Minimum Wall Thickness, mm	Reinforcement, cm ² /Linear m									
			Class VE-II		Class VE-III		Class VE-IV		Class VE-V		Class VE-VI	
			D-Loads									
			0.3 = 50 Ult = 75		0.3 = 65 Ult = 100		0.3 = 100 Ult = 150		0.3 = 140 Ult = 175		0.3 = 190 Ult = 235	
			In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage
900	1150 × 730	113	1.7	1.1	2.3	1.5	3.4	2.1	4.9	3.0	6.6	4.0
975	1250 × 795	119	1.9	1.1	2.5	1.5	3.8	2.3	5.5	3.4	7.4	4.4
1050	1345 × 855	125	2.1	1.3	2.8	1.7	4.2	2.5	6.1	3.6	8.0	4.9
1200	1535 × 975	138	2.3	1.5	3.2	1.9	4.7	2.8	7.0	4.2	9.3	5.5
1350	1730 × 1095	150	2.8	1.7	3.8	2.3	5.7	3.4	8.5	5.1	11.2	5.8
1500	1920 × 1220	163	3.4	2.1	4.4	2.8	6.6	4.0	9.9	5.9	—	—
1650	2110 × 1340	175	3.8	2.3	5.3	3.2	7.6	4.7	11.6	7.0	—	—
1800	2305 × 1465	188	4.4	2.8	5.9	3.6	8.7	5.3	—	—	—	—
1950	2495 × 1585	200	4.9	3.0	6.6	4.0	9.9	5.9	—	—	—	—
2100	2690 × 1705	213	5.5	3.4	7.4	4.4	11.2	6.8	—	—	—	—
2250	2880 × 1830	225	—	—	—	—	—	—	—	—	—	—
2400	3070 × 1950	238	—	—	—	—	—	—	—	—	—	—
2550	3265 × 2075	244	—	—	—	—	—	—	—	—	—	—
2700	3455 × 2195	250	—	—	—	—	—	—	—	—	—	—
2850	3648 × 2315	263	—	—	—	—	—	—	—	—	—	—
3000	3840 × 2440	275	—	—	—	—	—	—	—	—	—	—
3300	4225 × 2680	300	—	—	—	—	—	—	—	—	—	—
3600	4610 × 2925	325	—	—	—	—	—	—	—	—	—	—
Concrete strength, ^b MPa			27.6		27.6		27.6		34.5		41.4	

^a For size and loads beyond those shown in this table, pipe designs are available that make use of one or a combination of the following: shear steel, multiple cages, or thicker walls in accordance with the provision of Section 7.3.

^b Concrete strength for designs with reinforcement tabulated. For modified or special designs, see Section 7.3.

- Notes:
1. Test load in kilonewtons per linear meter equals D-load × inside span in millimeters.
 2. An inner and outer cage plus quadrant mats shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be in accordance with Figure 3.
 3. Single cage reinforcement, providing tension steel at the top, bottom, and spring line, shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be 112 percent of the tabulated inner cage area.
 4. An inner and outer cage plus a middle cage shall be permitted instead of double cage reinforcement. The area of such reinforcement shall be in accordance with Figure 4.