



Designation: **C361—19a C361 – 22**

## Standard Specification for Reinforced Concrete Low-Head Pressure Pipe<sup>1</sup>

This standard is issued under the fixed designation C361; 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.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope\*

1.1 This specification covers reinforced concrete pipe intended to be used for the construction of pressure pipelines with low internal hydrostatic heads generally not exceeding 125 ft.

1.2 This specification is the inch-pound companion to Specification C361; therefore, no SI equivalents are presented in the specification.

NOTE 1—Field tests on completed portions of the pipeline are not covered by this specification for the manufacture of the pipe but should be included in specifications for pipe laying.

1.3 *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>

- A27/A27M Specification for Steel Castings, Carbon, for General Application
- A36/A36M Specification for Carbon Structural Steel
- A283/A283M Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
- A575 Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
- A576 Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
- A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- A675/A675M Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
- A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- 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
- A1011/A1011M Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- A1064/A1064M Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field
- C33/C33M Specification for Concrete Aggregates

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.04 on Low Head Pressure Pipe.

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<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.

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

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens  
C150/C150M Specification for Portland Cement  
C260/C260M Specification for Air-Entraining Admixtures for Concrete  
C309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete  
C497M Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile (Metric)  
C595/C595M Specification for Blended Hydraulic Cements  
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete  
C655 Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe  
C822 Terminology Relating to Concrete Pipe and Related Products  
C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete  
C1619 Specification for Elastomeric Seals for Joining Concrete Structures  
D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))  
D4253 Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table  
D4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

#### 2.2 Other Standards:

ACI Code 318 Standard Building Code Requirements for Reinforced Concrete<sup>3</sup>

AISI-C 1012<sup>4</sup>

ASCE 15-93 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)

### 3. Terminology

3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology C822.

### 4. Classification

4.1 Pipe manufactured according to this specification shall be for hydrostatic heads of 25, 50, 75, 100, and 125 ft measured to the centerline of the pipe. Designs are provided in Table 1 for the above hydrostatic heads combined with external loadings of 5, 10, 15, and 20 ft (designated A, B, C, and D in Table 1) of earth cover over the top of the pipe under specific installation conditions. The specific installation conditions are covered in Appendix X1. Where the hydrostatic head, external loadings, and installation conditions vary from those given in Table 1 and Appendix X1, detailed design calculations shall be made. The design criteria for Table 1 are presented in Appendix X2.

### 5. Basis of Acceptance

5.1 Acceptability of the pipe in all diameters and classes shall be determined by the results of such material tests as are required in 6.2 through 6.9 by crushing tests on cured concrete cylinders, by hydrostatic pressure tests on units of the pipe, by joint leakage tests, and by inspection during or after manufacture to determine whether the pipe conforms to this specification as to design and freedom from defects.

5.2 *Age for Acceptance*—Pipe shall be considered ready for acceptance when they conform to the requirements, as indicated by the specified tests.

### 6. Materials

6.1 *Reinforced Concrete*—The reinforced concrete shall consist of portland cement, mineral aggregates, and water, in which steel has been embedded in such a manner that the steel and concrete act together. Fly ash or pozzolan is not prohibited when used as a partial cement replacement; see 9.1.

#### 6.2 Cementitious Materials:

##### 6.2.1 Cement:

6.2.1.1 *Portland Cement*—Portland cement shall conform to the requirements of Specification C150/C150M.

<sup>3</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

<sup>4</sup> Available from American Iron and Steel Institute (AISI), 1140 Connecticut Ave., NW, Suite 705, Washington, DC 20036, <http://www.steel.org>.





**TABLE 1 Continued**

 Circumferential reinforcement, in.<sup>2</sup>/linear ft of pipe

Internal Designated Dia., in.	36						39						42					
	Circular			Elliptical			Circular			Elliptical			Circular			Elliptical		
Type of Reinforcement	4		5		3 1/2		4		3 1/2		4 1/4		5 1/4		3 1/2		4 1/4	
Wall Thickness, in.	3/4		3/4		3/4		3/6		3/6		3/6		3/4		3/4		3/4	
Layers of Reinforcement	Inner	Outer	Inner	Outer	Inner	Outer	Single	Single	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer
Class	0.32	0.22	0.15	0.10	0.23	0.23	0.23	0.23	0.16	0.20	0.13	0.17	0.11	0.25	0.25	0.25	0.25	0.25
A-25	0.32	0.35	0.23	0.14	0.54	0.28	0.31	0.19	0.26	0.20	0.13	0.17	0.11	0.38	0.38	0.38	0.38	0.38
B-25	0.54	0.49	0.30	0.18	0.78	0.38	0.41	0.25	0.34	0.26	0.19	0.26	0.20	0.52	0.52	0.52	0.52	0.52
C-25	0.78	0.63	0.38	0.21	1.01	0.48	0.52	0.31	0.40	0.31	0.25	0.34	0.20	0.67	0.67	0.67	0.67	0.67
D-25	1.01	0.63	0.38	0.21	1.01	0.48	0.52	0.31	0.40	0.31	0.25	0.34	0.20	0.67	0.67	0.67	0.67	0.67
A-50	0.40	0.28	0.21	0.16	0.49	0.49	0.49	0.49	0.23	0.26	0.20	0.23	0.17	0.53	0.53	0.53	0.53	0.53
B-50	0.62	0.41	0.29	0.20	0.62	0.49	0.44	0.31	0.37	0.26	0.20	0.31	0.22	0.53	0.53	0.53	0.53	0.53
C-50	0.87	0.54	0.36	0.23	0.87	0.49	0.58	0.38	0.47	0.31	0.39	0.39	0.25	0.58	0.58	0.58	0.58	0.58
D-50	1.10	0.69	0.44	0.27	1.10	0.53	0.73	0.47	0.58	0.37	0.47	0.47	0.30	0.73	0.73	0.73	0.73	0.73
A-75	0.49	0.34	0.28	0.24	0.49	0.49	0.49	0.49	0.29	0.32	0.26	0.29	0.24	0.53	0.53	0.53	0.53	0.53
B-75	0.71	0.47	0.35	0.25	0.62	0.49	0.44	0.31	0.37	0.26	0.20	0.31	0.22	0.53	0.53	0.53	0.53	0.53
C-75	0.96	0.60	0.42	0.29	0.87	0.49	0.58	0.38	0.47	0.31	0.39	0.39	0.25	0.58	0.58	0.58	0.58	0.58
D-75	1.19	0.74	0.50	0.48	1.10	0.53	0.73	0.47	0.58	0.37	0.47	0.47	0.30	0.73	0.73	0.73	0.73	0.73
A-100	0.69	0.40	0.34	0.32	0.49	0.49	0.49	0.49	0.29	0.32	0.26	0.29	0.24	0.53	0.53	0.53	0.53	0.53
B-100	0.80	0.53	0.41	0.31	0.62	0.49	0.44	0.31	0.37	0.26	0.20	0.31	0.22	0.53	0.53	0.53	0.53	0.53
C-100	1.04	0.66	0.48	0.34	0.87	0.49	0.58	0.38	0.47	0.31	0.39	0.39	0.25	0.58	0.58	0.58	0.58	0.58
D-100	1.28	0.80	0.56	0.45	1.10	0.53	0.73	0.47	0.58	0.37	0.47	0.47	0.30	0.73	0.73	0.73	0.73	0.73
A-125	0.93	0.50	0.43	0.43	0.49	0.49	0.49	0.49	0.29	0.32	0.26	0.29	0.24	0.53	0.53	0.53	0.53	0.53
B-125	0.93	0.60	0.47	0.41	0.62	0.49	0.44	0.31	0.37	0.26	0.20	0.31	0.22	0.53	0.53	0.53	0.53	0.53
C-125	1.13	0.72	0.54	0.46	0.87	0.49	0.58	0.38	0.47	0.31	0.39	0.39	0.25	0.58	0.58	0.58	0.58	0.58
D-125	1.36	0.86	0.62	0.51	1.10	0.53	0.73	0.47	0.58	0.37	0.47	0.47	0.30	0.73	0.73	0.73	0.73	0.73

**TABLE 1 Continued**

Internal Designated Dia., in.		Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe															
		45				48				51							
Type of Reinforcement	Wall Thickness, in.	Circular				Circular				Circular				Elliptical			
		3/8	4 3/4	5 3/4	5 3/4	3/8	4 3/4	5	5 3/4	4 1/8	4 1/4	5	4 1/4	5 1/4	6	4 1/4	5 1/4
Layers of Reinforcement		Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer
		Class															
A-25		0.27	0.19	0.23	0.16	0.20	0.14	0.29	0.29	0.29	0.29	0.20	0.14	0.20	0.16	0.27	0.27
B-25		0.44	0.28	0.36	0.23	0.31	0.19	0.44	0.44	0.44	0.44	0.20	0.14	0.20	0.16	0.37	0.37
C-25		0.60	0.38	0.48	0.29	0.40	0.24	0.60	0.60	0.60	0.60	0.30	0.24	0.30	0.24	0.47	0.47
D-25		0.78	0.47	0.61	0.36	0.50	0.29	0.78	0.78	0.78	0.78	0.40	0.29	0.40	0.29	0.56	0.56
A-50		0.34	0.26	0.30	0.23	0.27	0.20	0.61	0.61	0.61	0.61	0.27	0.20	0.27	0.20	0.37	0.37
B-50		0.51	0.35	0.43	0.30	0.37	0.26	0.61	0.61	0.61	0.61	0.30	0.26	0.30	0.26	0.47	0.47
C-50		0.67	0.45	0.55	0.36	0.47	0.30	0.67	0.67	0.67	0.67	0.40	0.30	0.40	0.30	0.56	0.56
D-50		0.85	0.54	0.67	0.43	0.56	0.35	0.85	0.85	0.85	0.85	0.50	0.35	0.50	0.35	0.67	0.67
A-75		0.42	0.33	0.37	0.30	0.34	0.27	0.61	0.61	0.61	0.61	0.34	0.27	0.34	0.27	0.47	0.47
B-75		0.58	0.43	0.50	0.37	0.44	0.32	0.61	0.61	0.61	0.61	0.37	0.32	0.37	0.32	0.50	0.50
C-75		0.74	0.52	0.61	0.43	0.53	0.37	0.80	0.80	0.80	0.80	0.44	0.37	0.44	0.37	0.56	0.56
D-75		0.91	0.61	0.74	0.50	0.63	0.42	0.98	0.98	0.98	0.98	0.50	0.42	0.50	0.42	0.63	0.63
A-100		0.49	0.41	0.47	0.39	0.47	0.40	0.61	0.61	0.61	0.61	0.47	0.40	0.47	0.40	0.56	0.56
B-100		0.65	0.50	0.57	0.43	0.51	0.39	0.70	0.70	0.70	0.70	0.51	0.39	0.51	0.39	0.63	0.63
C-100		0.81	0.59	0.68	0.50	0.60	0.44	0.87	0.87	0.87	0.87	0.60	0.44	0.60	0.44	0.72	0.72
D-100		0.98	0.68	0.80	0.56	0.69	0.48	1.05	1.05	1.05	1.05	0.69	0.48	0.69	0.48	0.80	0.80
A-125		0.62	0.53	0.62	0.54	0.62	0.54	0.67	0.67	0.67	0.67	0.62	0.54	0.62	0.54	0.71	0.71
B-125		0.73	0.57	0.64	0.51	0.64	0.51	0.78	0.78	0.78	0.78	0.51	0.51	0.64	0.51	0.73	0.73
C-125		0.88	0.66	0.75	0.57	0.66	0.50	0.95	0.95	0.95	0.95	0.66	0.50	0.66	0.50	0.79	0.79
D-125		1.05	0.75	0.87	0.63	0.76	0.55	1.13	1.13	1.13	1.13	0.76	0.55	0.76	0.55	0.91	0.91

TABLE 1 Continued

Internal Designated Dia., in.		Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe																							
		54						57						60											
Type of Reinforcement	Wall Thickness, in.	Circular						Circular						Circular						Circular					
		4½		5½		6¼		4½		5½		6½		4¾		5¾		6		6¾		5		6	
Layers of Reinforcement		Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer
Class																									
A-25		0.33	0.23	0.29	0.19	0.26	0.18	0.35	0.35	0.35	0.24	0.30	0.21	0.28	0.19	0.37	0.37	0.37	0.25	0.32	0.32	0.22	0.30	0.20	0.39
B-25		0.54	0.35	0.44	0.28	0.40	0.25	0.54	0.44	0.44	0.36	0.47	0.30	0.42	0.26	0.56	0.47	0.47	0.38	0.49	0.49	0.31	0.45	0.28	0.58
C-25		0.74	0.46	0.60	0.36	0.53	0.32	0.74	0.60	0.60	0.49	0.63	0.39	0.57	0.34	0.78	0.63	0.63	0.51	0.67	0.67	0.41	0.60	0.36	0.81
D-25		0.96	0.59	0.75	0.45	0.66	0.39	0.96	0.75	0.75	0.61	0.80	0.48	0.70	0.41	1.00	0.80	0.80	0.64	0.85	0.85	0.51	0.75	0.44	1.05
A-50		0.42	0.31	0.37	0.28	0.34	0.26	0.74	0.74	0.74	0.44	0.33	0.29	0.37	0.27	0.78	0.78	0.78	0.46	0.35	0.41	0.31	0.39	0.29	0.82
B-50		0.62	0.43	0.52	0.36	0.48	0.33	0.74	0.74	0.74	0.45	0.55	0.38	0.50	0.35	0.78	0.78	0.78	0.47	0.58	0.58	0.40	0.53	0.37	0.82
C-50		0.82	0.55	0.68	0.44	0.61	0.40	0.82	0.74	0.74	0.57	0.72	0.47	0.65	0.42	0.86	0.78	0.78	0.60	0.76	0.76	0.50	0.69	0.45	0.90
D-50		1.04	0.66	0.83	0.53	0.74	0.46	1.04	0.83	0.83	0.69	0.88	0.56	0.78	0.49	1.08	0.88	0.88	0.72	0.93	0.93	0.59	0.83	0.53	1.13
A-75		0.50	0.40	0.45	0.36	0.42	0.34	0.53	0.53	0.53	0.42	0.48	0.38	0.45	0.36	0.55	0.55	0.55	0.44	0.50	0.50	0.40	0.48	0.38	0.82
B-75		0.71	0.52	0.60	0.44	0.55	0.41	0.73	0.73	0.73	0.54	0.63	0.47	0.59	0.43	0.76	0.76	0.76	0.56	0.67	0.67	0.49	0.62	0.45	0.90
C-75		0.90	0.63	0.75	0.52	0.68	0.47	0.94	0.88	0.88	0.66	0.80	0.55	0.73	0.50	0.99	0.99	0.99	0.68	0.84	0.84	0.58	0.77	0.53	0.90
D-75		1.11	0.74	0.91	0.61	0.81	0.54	1.16	1.04	1.04	0.78	0.96	0.64	0.86	0.58	1.21	1.21	1.21	0.81	1.01	1.01	0.68	0.91	0.61	1.13
A-100		0.59	0.49	0.57	0.47	0.57	0.47	0.62	0.62	0.62	0.51	0.60	0.50	0.60	0.50	0.65	0.65	0.65	0.53	0.63	0.63	0.52	0.63	0.52	0.82
B-100		0.79	0.60	0.68	0.52	0.63	0.49	0.82	0.82	0.82	0.63	0.72	0.55	0.67	0.51	0.85	0.85	0.85	0.65	0.76	0.76	0.58	0.71	0.54	0.82
C-100		0.98	0.71	0.83	0.61	0.76	0.55	1.03	1.03	1.03	0.74	0.88	0.64	0.81	0.59	1.07	1.07	1.07	0.77	0.93	0.93	0.67	0.86	0.62	0.90
D-100		1.19	0.83	0.98	0.69	0.89	0.62	1.24	1.24	1.24	0.86	1.04	0.72	0.94	0.66	1.29	1.29	1.29	0.90	1.09	1.09	0.76	1.00	0.70	0.82
A-125		0.75	0.64	0.75	0.64	0.75	0.64	0.79	0.79	0.79	0.67	0.79	0.68	0.79	0.68	0.84	0.84	0.84	0.71	0.83	0.83	0.71	0.83	0.71	0.82
B-125		0.87	0.69	0.77	0.61	0.77	0.62	0.91	0.91	0.91	0.71	0.82	0.65	0.82	0.65	0.94	0.94	0.94	0.74	0.86	0.86	0.68	0.86	0.68	0.82
C-125		1.07	0.79	0.91	0.69	0.84	0.63	1.11	1.11	1.11	0.83	0.96	0.72	0.89	0.67	1.16	1.16	1.16	0.86	1.02	1.02	0.76	0.94	0.71	0.82
D-125		1.27	0.91	1.06	0.77	0.97	0.70	1.32	1.32	1.32	0.95	1.12	0.81	1.02	0.74	1.38	1.38	1.38	0.99	1.18	1.18	0.85	1.08	0.78	0.82

TABLE 1 Continued

Internal Designated Dia., in.	66												69											
	63						66						69											
	Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe						Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe						Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe											
Type of Reinforcement	Circular						Circular						Elliptical											
	5 1/4		6 1/4		7		5 1/2		6 1/2		7 1/4		5 1/2		6 1/2									
Wall Thickness, in.	5 1/4		6 1/4		7		5 1/2		6 1/2		7 1/4		5 1/2		6 1/2									
	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer								
Layers of Reinforcement	5 1/4		6 1/4		7		5 1/2		6 1/2		7 1/4		5 1/2		6 1/2									
	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer								
Class																								
A-25	0.39	0.27	0.35	0.24	0.32	0.22	0.41	0.28	0.37	0.25	0.34	0.23	0.43	0.30	0.39	0.26	0.36	0.24	0.44					
B-25	0.62	0.40	0.52	0.33	0.48	0.30	0.64	0.41	0.55	0.35	0.50	0.31	0.64	0.43	0.58	0.37	0.53	0.33	0.67					
C-25	0.87	0.54	0.72	0.44	0.65	0.39	0.87	0.56	0.76	0.46	0.69	0.41	0.90	0.64	0.80	0.49	0.72	0.44	0.94					
D-25	1.11	0.68	0.90	0.54	0.81	0.47	1.11	0.70	0.95	0.57	0.85	0.50	1.16	0.95	1.00	0.60	0.90	0.53	1.20					
A-50	0.49	0.37	0.44	0.33	0.42	0.31	0.86	0.38	0.47	0.35	0.44	0.33	0.90	0.54	0.49	0.36	0.46	0.34	0.94					
B-50	0.71	0.49	0.62	0.43	0.57	0.39	0.86	0.51	0.65	0.45	0.60	0.41	0.90	0.77	0.67	0.47	0.63	0.43	0.94					
C-50	0.96	0.63	0.81	0.53	0.74	0.48	0.96	0.66	0.85	0.56	0.78	0.51	1.00	0.90	0.89	0.59	0.82	0.53	1.04					
D-50	1.20	0.77	0.99	0.63	0.89	0.56	1.20	0.80	1.04	0.66	0.94	0.59	1.24	1.04	1.09	0.70	0.99	0.63	1.29					
A-75	0.59	0.47	0.54	0.43	0.51	0.40	0.62	0.49	0.56	0.45	0.54	0.42	0.64	0.51	0.59	0.47	0.56	0.45	0.64					
B-75	0.81	0.59	0.71	0.52	0.66	0.48	0.84	0.61	0.74	0.54	0.69	0.51	0.90	0.87	0.77	0.57	0.73	0.53	0.94					
C-75	1.05	0.73	0.90	0.62	0.83	0.57	1.09	0.76	0.94	0.65	0.87	0.60	1.13	1.13	0.99	0.69	0.92	0.63	1.04					
D-75	1.28	0.86	1.08	0.72	0.98	0.65	1.33	0.89	1.13	0.76	1.03	0.69	1.24	1.38	1.19	0.79	1.09	0.72	1.29					
A-100	0.69	0.57	0.66	0.55	0.66	0.55	0.72	0.59	0.70	0.57	0.70	0.57	0.75	0.61	0.73	0.60	0.73	0.60	0.81					
B-100	0.90	0.69	0.80	0.61	0.75	0.58	0.94	0.71	0.84	0.64	0.79	0.60	0.96	0.97	0.88	0.67	0.82	0.63	0.99					
C-100	1.14	0.82	0.99	0.72	0.92	0.66	1.19	0.85	1.04	0.75	0.96	0.70	1.23	1.23	1.09	0.78	1.01	0.73	1.04					
D-100	1.37	0.95	1.17	0.81	1.07	0.74	1.42	0.99	1.22	0.85	1.12	0.78	1.48	1.48	1.28	0.89	1.18	0.82	1.29					
A-125	0.88	0.74	0.88	0.74	0.88	0.74	0.92	0.78	0.92	0.78	0.92	0.78	0.96	0.96	0.96	0.81	0.96	0.81	0.96					
B-125	1.00	0.78	0.90	0.72	0.90	0.72	1.04	0.81	0.95	0.75	0.95	0.75	1.07	1.07	0.99	0.78	0.99	0.78	0.99					
C-125	1.23	0.92	1.08	0.81	1.01	0.75	1.28	0.95	1.13	0.85	1.06	0.79	1.33	1.33	1.19	0.89	1.11	0.83	1.04					
D-125	1.46	1.04	1.26	0.90	1.16	0.83	1.52	1.08	1.32	0.95	1.22	0.88	1.57	1.57	1.38	0.99	1.28	0.92	1.29					



**TABLE 1 Continued**

Internal Designated Dia., in.		Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe																				
		72				78				84												
Type of Reinforcement	Wall Thickness, in.	Circular				Elliptical				Circular												
		6		7		7 <sup>3</sup> / <sub>4</sub>		6		7		7 <sup>1</sup> / <sub>2</sub>		8 <sup>1</sup> / <sub>4</sub>		7		8		8 <sup>3</sup> / <sub>4</sub>		
Layers of Reinforcement	Thickness, in.	Inner	Outer	Inner	Outer	Inner	Outer	Single	Single	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	
Class																						
A-25	0.48	0.33	0.43	0.29	0.40	0.27	0.48	0.46	0.52	0.35	0.47	0.32	0.44	0.30	0.44	0.56	0.41	0.70	0.51	0.64	0.47	0.35
B-25	0.73	0.47	0.63	0.40	0.58	0.36	0.73	0.63	0.79	0.50	0.69	0.44	0.63	0.40	0.63	0.75	0.51	0.96	0.66	0.87	0.59	0.47
C-25	0.88	0.65	0.88	0.54	0.80	0.48	1.05	0.88	1.12	0.69	0.96	0.58	0.87	0.53	0.87	0.98	0.64	1.30	0.85	1.14	0.75	0.63
D-25	1.34	0.81	1.10	0.66	0.99	0.58	1.34	1.10	1.43	0.87	1.20	0.72	1.09	0.64	1.09	1.20	0.75	1.61	1.03	1.42	0.90	0.78
A-50	0.60	0.44	0.54	0.40	0.51	0.38	0.98	0.98	0.65	0.48	0.59	0.44	0.56	0.41	0.70	0.56	0.41	0.70	0.51	0.64	0.47	0.35
B-50	0.84	0.58	0.74	0.51	0.68	0.47	0.98	0.98	0.90	0.62	0.80	0.55	0.75	0.51	0.96	0.75	0.51	1.30	0.66	0.87	0.59	0.47
C-50	1.15	0.76	0.98	0.64	0.90	0.59	1.15	0.98	1.23	0.81	1.07	0.70	0.98	0.64	1.30	0.98	0.64	1.61	0.85	1.14	0.75	0.63
D-50	1.44	0.92	1.21	0.77	1.09	0.69	1.44	1.21	1.53	0.98	1.31	0.83	1.20	0.75	1.61	1.20	0.75	1.96	1.03	1.42	0.90	0.78
A-75	0.71	0.56	0.65	0.51	0.62	0.49	0.98	0.98	0.77	0.60	0.71	0.55	0.68	0.53	0.82	0.68	0.53	0.82	0.64	0.77	0.60	0.47
B-75	0.95	0.70	0.85	0.62	0.79	0.58	0.98	0.98	1.02	0.74	0.92	0.67	0.86	0.63	1.09	0.86	0.63	1.30	0.79	0.99	0.72	0.59
C-75	1.26	0.87	1.09	0.75	1.00	0.69	1.15	0.98	1.34	0.92	1.18	0.81	1.09	0.75	1.42	1.09	0.75	1.61	0.98	1.26	0.87	0.72
D-75	1.54	1.02	1.31	0.87	1.19	0.79	1.44	1.21	1.64	1.09	1.42	0.94	1.30	0.87	1.72	1.30	0.87	1.96	1.15	1.53	1.02	0.90
A-100	0.82	0.67	0.76	0.62	0.76	0.62	0.98	0.98	0.89	0.72	0.83	0.67	0.83	0.67	0.95	0.83	0.67	0.95	0.77	0.89	0.73	0.59
B-100	1.07	0.81	0.96	0.73	0.90	0.69	0.98	0.98	1.14	0.86	1.03	0.79	0.98	0.74	1.21	0.98	0.74	1.34	0.92	1.11	0.84	0.73
C-100	1.36	0.98	1.19	0.86	1.11	0.80	1.15	0.98	1.46	1.04	1.29	0.93	1.20	0.86	1.54	1.20	0.86	1.66	1.10	1.38	0.99	0.84
D-100	1.64	1.13	1.41	0.98	1.29	0.90	1.44	1.21	1.75	1.21	1.53	1.06	1.41	0.98	1.84	1.41	0.98	1.96	1.27	1.65	1.14	0.90
A-125	1.01	0.85	1.01	0.85	1.00	0.85	0.98	0.98	1.09	0.91	1.09	0.92	1.09	0.92	1.18	1.09	0.92	1.18	0.98	1.18	0.98	0.89
B-125	1.18	0.92	1.07	0.84	1.03	0.82	0.98	0.98	1.26	0.98	1.15	0.90	1.12	0.88	1.34	1.12	0.88	1.40	1.05	1.24	0.97	0.89
C-125	1.47	1.09	1.30	0.97	1.21	0.90	1.15	0.98	1.57	1.16	1.40	1.04	1.31	0.98	1.66	1.31	0.98	1.76	1.23	1.50	1.11	0.95
D-125	1.74	1.24	1.51	1.08	1.40	1.00	1.00	0.98	1.86	1.32	1.64	1.17	1.52	1.09	1.96	1.52	1.09	2.00	1.40	1.76	1.26	1.06

**TABLE 1 Continued**

		Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe																						
Internal Designated Dia, in.	Type of Reinforcement	90				96				102				108				120		132		144		
		7½		8		8		8½		8½		9		9		9½		10		11		12		
Wall Thickness, in.	Layers of Reinforcement	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer	
Class																								
A-25		0.62	0.41	0.59	0.39	0.67	0.45	0.64	0.43	0.72	0.48	0.69	0.46	0.77	0.51	0.75	0.49	0.89	0.58	1.01	0.66	1.14	0.74	
B-25		0.90	0.57	0.85	0.54	0.96	0.61	0.91	0.58	1.02	0.65	0.97	0.62	1.08	0.69	1.04	0.66	1.22	0.77	1.36	0.86	1.52	0.96	
C-25		1.25	0.77	1.16	0.72	1.31	0.81	1.23	0.76	1.39	0.86	1.31	0.81	1.46	0.90	1.38	0.85	1.62	1.00	1.78	1.10	1.96	1.21	
D-25		<b>1.59</b>	<b>0.97</b>	1.50	0.91	<b>1.69</b>	<b>1.03</b>	1.61	0.97	<b>1.79</b>	<b>1.09</b>	<b>1.69</b>	<b>1.02</b>	<b>1.88</b>	<b>1.15</b>	<b>1.77</b>	<b>1.07</b>	S	S	S	S	S	S	
A-50		0.75	0.55	0.72	0.53	0.81	0.59	0.78	0.57	0.87	0.63	0.84	0.61	0.93	0.67	0.90	0.65	1.06	0.76	1.19	0.85	1.34	0.94	
B-50		1.03	0.71	0.98	0.67	1.09	0.75	1.04	0.71	1.16	0.80	1.11	0.76	1.23	0.84	1.18	0.81	1.38	0.94	1.54	1.04	1.71	1.15	
C-50		1.37	0.90	1.29	0.85	1.44	0.95	1.36	0.90	1.52	1.00	1.45	0.95	1.60	1.05	1.53	1.00	1.77	1.16	1.95	1.28	2.14	1.40	
D-50		<b>1.71</b>	<b>1.10</b>	1.62	1.03	<b>1.82</b>	<b>1.16</b>	1.73	1.10	<b>1.93</b>	<b>1.23</b>	<b>1.82</b>	<b>1.16</b>	<b>2.02</b>	<b>1.29</b>	<b>1.91</b>	<b>1.22</b>	S	S	S	S	S	S	
A-75		0.89	0.69	0.86	0.66	0.95	0.73	0.92	0.71	1.02	0.78	0.99	0.76	1.08	0.83	1.06	0.81	1.23	0.93	1.38	1.03	1.54	1.14	
B-75		1.16	0.84	1.11	0.80	1.23	0.89	1.18	0.85	1.31	0.94	1.26	0.91	1.38	1.00	1.34	0.96	1.55	1.11	1.72	1.23	1.90	1.35	
C-75		1.49	1.03	1.41	0.97	1.58	1.09	1.50	1.03	1.66	1.14	1.58	1.09	1.75	1.20	1.67	1.15	1.93	1.33	2.12	1.46	2.33	1.59	
D-75		<b>1.83</b>	<b>1.22</b>	1.74	1.16	<b>1.95</b>	<b>1.30</b>	1.86	1.24	<b>2.06</b>	<b>1.37</b>	<b>1.96</b>	<b>1.30</b>	<b>2.16</b>	<b>1.44</b>	<b>2.06</b>	<b>1.37</b>	S	S	S	S	S	S	
A-100		1.02	0.82	0.99	0.80	1.09	0.88	1.06	0.85	1.17	0.93	1.14	0.91	1.24	0.99	1.21	0.96	1.40	1.10	1.56	1.22	1.74	1.35	
B-100		1.29	0.97	1.24	0.94	1.37	1.03	1.32	1.00	1.45	1.09	1.40	1.06	1.54	1.15	1.49	1.12	1.71	1.28	1.90	1.41	2.09	1.55	
C-100		1.62	1.16	1.54	1.10	1.71	1.22	1.63	1.17	1.80	1.29	1.72	1.24	1.90	1.36	1.82	1.30	2.09	1.49	2.30	1.64	2.51	1.79	
D-100		<b>1.96</b>	<b>1.35</b>	1.86	1.29	<b>2.08</b>	<b>1.43</b>	1.99	1.37	<b>2.20</b>	<b>1.52</b>	<b>2.09</b>	<b>1.45</b>	<b>2.30</b>	<b>1.59</b>	<b>2.20</b>	<b>1.52</b>	S	S	S	S	S	S	
A-125		1.27	1.05	1.26	1.05	1.35	1.12	1.35	1.12	1.44	1.18	1.44	1.18	1.53	1.25	1.53	1.25	1.70	1.38	1.88	1.52	2.06	1.65	
B-125		1.42	1.11	1.37	1.07	1.51	1.17	1.46	1.14	1.60	1.24	1.55	1.20	1.69	1.31	1.64	1.27	1.88	1.45	2.08	1.60	2.29	1.75	
C-125		1.75	1.29	1.67	1.24	1.84	1.36	1.77	1.31	1.94	1.44	1.87	1.38	2.04	1.51	1.97	1.46	2.25	1.66	2.47	1.82	2.70	1.98	
D-125		<b>2.08</b>	<b>1.48</b>	1.99	1.41	<b>2.21</b>	<b>1.57</b>	2.27	1.50	<b>2.34</b>	<b>1.66</b>	<b>2.23</b>	<b>1.59</b>	<b>2.45</b>	<b>1.74</b>	<b>2.35</b>	<b>1.67</b>	S	S	S	S	S	S	

**TABLE 2 Design Requirements for Reinforced Concrete Low-Head Pressure Pipe [12 Through 144 in. Diameter], Concrete Design Strength 5000 psi except as noted, Steel Reinforcement Yield Strength 60 000 psi**

NOTE 1—See Appendix for specific installation conditions and design criteria conditions required in conjunction with the use of Table 2.

NOTE 2—Designations, A, B, C, and D, for class of pipe, denote 5, 10, 15, and 20 ft of earth cover over top of pipe. Figures 25, Figures 50, Figures 75, etc. for class of pipe, denote hydrostatic pressure heads in feet measured to centerline of pipe.

NOTE 3—An “s” in place of a steel area indicates the pipe class is a special design requiring stirrup reinforcement. Stirrups may be eliminated by changing wall thickness, main reinforcement, concrete strength, or a combination thereof.

NOTE 4—The **boldfaced** value denotes 6000 psi concrete strength required.

Internal Designated Dia, in.	Circumferential reinforcement, in. <sup>2</sup> /linear ft of pipe																
	12		15		18		21		24		27						
	Circular		Circular		Circular		Circular		Circular		Circular						
2	3	2	3	2 1/4	3	2 1/4	3	2%	3	2 1/2	3	2%	3	3 1/4	4 1/4	2 5/8	3 1/4
Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Inner	Outer	Single	Single
Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Single	Inner	Outer	Single	Single
0.05	0.05	0.06	0.06	0.07	0.12	0.10	0.09	0.14	0.14	0.12	0.11	0.15	0.15	0.13	0.06	0.07	0.17
0.07	0.05	0.10	0.08	0.12	0.12	0.16	0.13	0.16	0.14	0.19	0.17	0.19	0.17	0.20	0.14	0.11	0.23
0.09	0.07	0.13	0.10	0.17	0.14	0.22	0.18	0.22	0.18	0.27	0.23	0.27	0.23	0.28	0.19	0.14	0.33
0.11	0.08	0.17	0.12	0.22	0.17	0.29	0.23	0.29	0.23	0.36	0.30	0.36	0.30	0.45	0.24	0.18	0.45
0.10	0.10	0.13	0.13	0.15	0.25	0.18	0.18	0.29	0.29	0.29	0.20	0.33	0.33	0.23	0.13	0.10	0.37
0.10	0.10	0.13	0.13	0.15	0.25	0.19	0.18	0.29	0.29	0.23	0.21	0.33	0.33	0.28	0.17	0.12	0.37
0.11	0.10	0.16	0.13	0.20	0.25	0.25	0.25	0.29	0.29	0.31	0.27	0.33	0.33	0.32	0.22	0.14	0.38
0.13	0.10	0.20	0.15	0.25	0.25	0.32	0.26	0.32	0.29	0.40	0.34	0.40	0.34	0.49	0.27	0.17	0.49
0.16	0.16	0.20	0.20	0.24	0.24	0.28	0.28	0.28	0.28	0.33	0.33	0.37	0.37	0.37	0.20	0.16	0.49
0.16	0.16	0.20	0.20	0.24	0.24	0.28	0.28	0.28	0.28	0.33	0.33	0.37	0.37	0.37	0.21	0.16	0.49
0.16	0.16	0.20	0.20	0.24	0.24	0.28	0.28	0.28	0.28	0.35	0.33	0.42	0.37	0.25	0.17	0.22	0.49
0.16	0.16	0.22	0.20	0.28	0.24	0.36	0.30	0.44	0.38	0.44	0.38	0.54	0.45	0.30	0.20	0.23	0.49
0.23	0.23	0.29	0.29	0.35	0.35	0.40	0.40	0.46	0.46	0.46	0.46	0.52	0.52	0.28	0.24	0.28	0.49
0.23	0.23	0.29	0.29	0.35	0.35	0.40	0.40	0.46	0.46	0.46	0.46	0.52	0.52	0.29	0.23	0.29	0.49
0.23	0.23	0.29	0.29	0.35	0.35	0.40	0.40	0.46	0.46	0.48	0.46	0.58	0.52	0.30	0.22	0.30	0.49
0.23	0.23	0.29	0.29	0.35	0.35	0.40	0.40	0.46	0.46	0.48	0.46	0.58	0.52	0.33	0.23	0.31	0.49
0.31	0.31	0.39	0.39	0.46	0.46	0.54	0.54	0.62	0.62	0.62	0.62	0.69	0.69	0.37	0.32	0.37	0.49
0.31	0.31	0.39	0.39	0.46	0.46	0.54	0.54	0.62	0.62	0.62	0.62	0.69	0.69	0.38	0.31	0.38	0.49
0.31	0.31	0.39	0.39	0.46	0.46	0.54	0.54	0.62	0.62	0.62	0.62	0.69	0.69	0.39	0.30	0.39	0.49
0.31	0.31	0.39	0.39	0.46	0.46	0.54	0.54	0.62	0.62	0.62	0.62	0.69	0.69	0.40	0.29	0.40	0.49

