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AMERICAN SOCIETY FOR TESTING AND MATERIALS

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Standard Specification for CONCRETE SEWER, STORM DRAIN, CULVERT PIPE¹

This Standard is issued under the fixed designation C 14; 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.

1. Scope

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

NOTE 1—The values stated in either U.S. customary units or SI (metric) units are to be regarded separately as standard. The values stated in each system are not exact equivalents, therefore, each system must be used independent of the other. Combining values from the two systems may result in nonconformance with the specification.

NOTE 2—This specification is a manufacturing and purchase specification only and does not include requirements for bedding, backfill, or the relationship between earth coverload and the strength classification of pipe. However, experience has shown that the successful performance of this product depends upon the proper selection of the class of pipe, type of bedding and backfill, controlled manufacture in the plant, and care in the field construction work. The purchaser of the concrete pipe specified herein is cautioned that he must properly correlate the field requirements with the class of pipe specified and provide for or require adequate inspection in the manufacturing plant and at the construction site.

2. Applicable Documents

2.1 ASTM Standards:

- C 33 Specification for Concrete Aggregates²
- C 150 Specification for Portland Cement²
- C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete²
- C 443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets³
- C 497 Testing Concrete Pipe, Sections, or Tile³
- C 595 Specification for Blended Hydraulic Cements²
- C 822 Definitions of Terms Relating to Concrete Pipe and Related Products³

3. Classification

3.1 Pipe manufactured according to this specification shall be of three classes identified as "Class 1 Nonreinforced Concrete Pipe," "Class 2 Nonreinforced Concrete Pipe," and "Class 3 Nonreinforced Concrete Pipe." The corresponding strength requirements are prescribed in Tables 1 and 1A.

4. Basis of Acceptance

4.1 The acceptability of the pipe shall be determined by the results of the test prescribed in this section, when required, and by inspection to determine whether the pipe conforms to this specification as to design and freedom from defects.

4.2 *Acceptance as to Strength Properties*—Pipe shall be acceptable under the strength tests when they have met the requirements as prescribed in 9.3.

4.3 *Acceptance as to Absorption Properties*—Pipe shall be acceptable under the absorption test when they have met the requirements as prescribed in 9.4.

4.4 *Acceptance as to Permeability Properties*—Pipe shall be acceptable under the permeability test when they have met the requirements as prescribed in 9.5.

NOTE 3—Prior to purchase the purchaser may specify the hydrostatic test prescribed in 9.6 instead of the permeability test.

4.5 Acceptance as to Hydrostatic Proper-

¹ This specification is under the jurisdiction of ASTM Committee C-13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.01 on Nonreinforced Sewer Pipe.

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² Annual Book of ASTM Standards, Part 14.

³ Annual Book of ASTM Standards, Part 16.

ties—Pipe shall be acceptable under the hydrostatic test when they have met the requirements as prescribed in 9.6.

5. Materials

5.1 *Cement*—Portland cement shall conform to the requirements of Specification C 150 or shall be portland blast-furnace slag cement or portland-pozzolan cement conforming to the requirements of Specification C 595.

5.2 *Aggregates*—Aggregates shall conform to Specification C 33, except that the requirement for gradation shall not apply.

5.3 *Admixtures and Blends*—Admixtures and blends may be used with the approval of the purchaser.

6. Design

6.1 *Design Tables*—Design requirements shall be in accordance with Tables 1 and 1A. Wall thickness used may be more than but not less than the value shown, except as affected by the tolerance herein specified and by the provision for modified design.

6.2 *Modified or Special Design*—Manufacturers may submit to the purchaser for approval, prior to manufacture, wall thickness other than those shown in Tables 1 and 1A. Such pipe shall meet all of the test and performance requirements specified by the purchaser in accordance with Section 9.

7. Joints

7.1 The joints shall be of such design and the ends of the concrete pipe sections so formed that when the sections are laid together they will make a continuous line of pipe with a smooth interior free of appreciable irregularities in the flow line, all compatible with the permissible variations given in Section 10.

8. Manufacture

8.1 *Mixture*—The aggregates shall be sized, graded, proportioned, and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the test and design requirements of this specification. In no case, however, shall a proportion of portland ce-

ment in the mixture be less than 564 lb/yd³ or 330 kg/m³ of concrete.

8.2 *Curing*—Pipe shall be subjected to any one of the methods of curing described 8.2.1 through 8.2.4 or to any other method or combination of methods approved by the purchaser that will give satisfactory results. The pipe shall be cured for a sufficient length of time so that the concrete will develop the specified strength requirement at 28 days or less.

8.2.1 *Steam Curing*—Pipe may be placed in a curing chamber, free from outside drafts, and cured in a moist atmosphere maintained by the injection of steam for such time and such temperature as may be needed to enable the pipe to meet the strength requirements. The curing chamber shall be so constructed as to allow full circulation of steam around the entire pipe.

8.2.2 *Water Curing*—Concrete pipe may be water-cured by covering with water-saturated material or by a system of perforated pipes, mechanical sprinklers, porous hose, or by any other approved method that will keep the pipe moist during the specified curing period.

8.2.3 The manufacturer may, at his option, combine the methods described in 8.2.1 and 8.2.2 provided the specified strength is attained.

8.2.4 *Membrane Curing*—A sealing membrane conforming to the requirements Specification C 309 may be applied and left intact until the specified strength requirements are met. The concrete at the time of application shall be within 10°F or 6°C of the atmospheric temperature. All surfaces shall be kept moist prior to the application of the compounds and shall be damp when the compound is applied.

8.3 Specials:

8.3.1 *General Requirements*—Special shapes or fittings such as wyes, tees, bends, and adapters for use with concrete pipe conforming to this specification shall conform to the applicable requirements for concrete pipe of corresponding class and internal diameter. Joints shall be compatible with those used in adjoining concrete pipes.

8.3.2 *Fabricated Branches*—Fabricated branches for wyes and tees shall be securely attached to the wall of the pipe in such a

manner as not to restrict or otherwise interfere with the flow characteristics of the pipe.

Physical Requirements

9.1 *Test Specimen*—The pipe to be tested shall be selected by the purchaser or his representative, and shall be pipe that would not otherwise be rejected under this specification. The selection shall be made at the point or points designated by the purchaser when placing the order. The test pipe shall first be freed from all visible moisture. When dry, each pipe shall be measured and inspected. The results of these observations shall be recorded.

9.2 *Number and Type of Test Specimens Required*—The manufacturer or seller shall furnish pipe for crushing and absorption tests, up to 0.5% of the number of pipe of each size included in the order, except that in no case shall less than two pipe be furnished. For the permeability test, 2 % of the number of pipe of each size included in the order, but in no case less than two pipe shall be furnished. For the hydrostatic test, 0.5% of the number of pipe of each size included in the order, but in no case less than two pipe shall be furnished.

9.3 *External Load Crushing Test Requirements*—The crushing strength of nonreinforced concrete pipe shall conform to the requirements prescribed in Tables 1 and 1A. The individual results of the various tests for each size of pipe and for each shipment and plant shall be tabulated separately so as to show the percentage that fails to conform to the requirements of each test. The crushing strength shall ordinarily be applied to not less than 75 % of the pipe received for purpose of test. All tests shall be made in accordance with Method C 497. Pipe shall be acceptable under the strength test requirements when all test pipe conform to the test requirements. Should any of the preliminary test pipe provided in 9.2 fail to meet the test requirements, then the manufacturer will be allowed a retest on two additional pipe of each pipe that failed, and the pipe shall be acceptable only when all of these retest pipe meet the strength requirements.

9.4 *Absorption Test*—When required by the purchaser, absorption shall be determined by either Method A or Method B in accordance

with Methods C 497 for the boiling absorption test and shall not exceed 9 % for Method A or 8.5 % for Method B. The individual results of the various tests for each size of pipe for each shipment and plant shall be tabulated separately so as to show the percentage that fails to conform to the requirements of each test. All tests shall be made in accordance with Methods C 497. The number of absorption test specimens shall be equal to the number of pipe provided for crushing strength testing. These test specimens shall be obtained from pipe that are acceptable as to strength, and shall be taken from pipe used in making the strength test after the test is made. These specimens shall be marked with the number or identification mark of the pipe from which they were taken. Each Method A specimen shall have an area of 12 to 20 in.² or 77 to 129 cm², as measured on one surface of the pipe, and a thickness equal to the pipe wall, and shall be free of visible cracks. Pipes shall be acceptable under the absorption test when all test pipe conform to the test requirements. When not more than 20 % of the absorption test specimens fail to pass the requirements of this section, the manufacturer may cull his stock and may eliminate whatever quantity of pipe he desires and must so mark those pipe so that they will not be shipped. The required tests shall be made on the balance of the order and they shall be acceptable if they conform to the test requirements.

9.5 *Permeability*—When subject to the permeability test as specified in Methods C 497 the outer pipe surface of not less than 80 % of the pipe tested shall show no moist or damp spots at the end of the test period due to water passing through the walls of the pipe. When more than 20 % of the test pipe fail to pass the requirements of this section, the manufacturer may cull his stock and may eliminate whatever quantity of pipe he desires and must so mark those pipe that they will not be shipped. The required tests shall be made on the balance of the order and they shall be accepted if they conform to the test requirements. If the second test fails the whole lot may be rejected.

9.6 *Hydrostatic Tests*—If subjected to the internal hydrostatic pressures of 10 psi or 70 kPa for 10 min as described in Methods C 497,



the pipe shall show no leakage. Moisture appearing on the surface of the pipe in the form of patches or beads adhering to the surface shall not be considered leakage. When not more than 20 % of the test pipe fail to pass the requirements of this section, the manufacturer may cull his stock and may eliminate whatever quantity of pipe he desires and must so mark those pipe that they will not be shipped. The required tests shall be made on the balance of the order and they shall be accepted if they conform to the test requirements. If the second test fails, the whole lot may be rejected.

9.7 At the time of initial inspection, under the permeability test, if the pipe shows moist or damp spots on the outer surface of the pipe, the test shall be continued for a period not to exceed 24 h at the option of the manufacturer or seller. If the pipe shows no moist or damp spots on the outer surface of the pipe at some time during the extended period, it shall be considered to have passed the test.

9.8 At the time of initial inspection, under the hydrostatic test, if the pipe shows leakage, the test shall be continued for a period not to exceed 24 h at the option of the manufacturer or seller. If the pipe shows no leakage, at some time during the extended period, it shall be considered to have passed the test.

9.9 When the hydrostatic test is used for acceptance of the pipe joint as specified in Section 8 of Specification C 443 the same joint test runs may be used as the basis of acceptance for the pipe hydrostatic test allowed under 4.5 and 9.6 of this specification.

9.10 *Defective Pipe*—Pipe that is observed to have cracks or other defects in form or dimensions in excess of the limits permitted in this specification, shall be discarded and replaced with additional pipe from the shipment.

10. Dimensions and Permissible Variations

10.1 *Sizes and Dimensions*—Pipe shall be furnished of the sizes, internal diameters, and dimensions prescribed in Tables 1 and 1A.

10.2 *Permissible Variations in Dimensions*—Permissible variations in dimensions shall be limited to the following:

10.2.1 *Internal Diameter*—The internal diameter shall not be more or less than the

designated diameter by more than $\frac{3}{16}$ in. for pipe designated as 12 in. and under in diameter; by more than $\frac{1}{4}$ in. for pipe designated as 15 or 18 in. in diameter; by more than $\frac{5}{16}$ in. for pipe designated as 21 in. in diameter; and by more than $\frac{3}{8}$ in. for pipe designated as 24 in. and over in diameter. Permissible variations utilizing SI units are as prescribed in Table 2A.

10.2.2 *Thickness of Wall*—The wall thickness shall be not less than the values shown in Table 1 or 1A or the manufacturer's designated thickness if greater than shown in Table 1 or 1A by more than $\frac{1}{16}$ in. or 2 mm for pipe 10 in. or 250 mm or less in diameter; by more than $\frac{1}{8}$ in. or 3 mm for pipe 12 to 24 in. or 300 to 600 mm in diameter; and by more than $\frac{3}{16}$ in. or 5 mm for pipe more than 24 in. or 600 mm in diameter; or by more than 5 % of the tabulated or designated wall thickness, whichever is greater. Localized variations in wall thickness exceeding those specified above shall be accepted if the physical test requirements specified herein are met.

10.2.3 *Length*—The length of any section of pipe shall vary not more than $-\frac{1}{2}$ in. or -13 mm from a specified or designated design length.

10.2.4 *Length of Two Opposite Sides*—The length of two opposite sides of any section of pipe shall vary not more than $\frac{1}{4}$ in. or 6 mm or 2 % of the designated diameter, whichever is larger.

10.2.5 *Straightness*—Pipe intended to be straight shall not vary in alignment more than $\frac{1}{8}$ in./ft or 10 mm/m of length.

11. Workmanship and Finish

11.1 Pipe shall be substantially free of fractures and excessive interior surface roughness.

11.2 The planes of the ends of the pipe shall be perpendicular to the longitudinal axis, subject to the limits of variation as shown in 10.2.4.

12. Repairs

12.1 Pipe may be repaired, if necessary, because of occasional imperfections in manufacture or injury during handling and will be acceptable if, in the opinion of the purchaser, the repairs are sound and properly finished

and cured and the repaired pipe conforms to the requirements of this specification.

13. Inspection

13.1 The quality of all materials and the finished pipe shall be subject to inspection and approval by an inspector employed by the purchaser. Such inspection may be performed at the point of manufacture or delivery.

14. Rejection

14.1 Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements. Individual sections of pipe may be rejected because of any of the following:

14.1.1 Fractures or cracks passing through the wall or joints, except that a single crack not exceeding 2 in. or 50 mm in length at either end of a pipe or a single fracture or spall in the joints not exceeding 3 in. or 75 mm around the circumference of the pipe nor

2 in. or 50 mm in length into joint shall not be considered cause for rejection unless these defects exist in more than 5 % of the entire shipment or delivery.

14.1.2 Defects that indicate imperfect mixing and molding.

14.1.3 Cracks sufficient to impair the strength, durability, or serviceability of the pipe.

15. Marking

15.1 The following information shall be clearly marked on each pipe:

15.1.1 The pipe class and specification designation.

15.1.2 The date of manufacture.

15.1.3 The name or trademark of the manufacturer, and

15.1.4 Identification of the plant.

15.2 Marking shall be indented on the pipe section or painted thereon with waterproof paint.

TABLE 1 Physical and Dimensional Requirements for Nonreinforced Concrete Pipe (U.S. Customary Units)^a

Internal Designated Diameter, in.	Class 1		Class 2		Class 3	
	Minimum Thickness of Wall, in.	Minimum Strength, lbf/linear ft. Three-Edge Bearing	Minimum Thickness of Wall, in.	Minimum Strength, lbf/linear ft. Three-Edge Bearing	Minimum Thickness of Wall, in.	Minimum Strength, lbf/linear ft. Three-Edge Bearing
4	5/8	1500	3/4	2000	3/4	2400
6	5/8	1500	3/4	2000	3/4	2400
8	3/4	1500	7/8	2000	1 1/8	2400
10	7/8	1600	1	2000	1 1/4	2400
12	1	1800	1 1/8	2250	1 3/4	2600
15	1 1/4	2000	1 3/8	2600	1 7/8	2900
18	1 1/2	2200	2	3000	2 1/4	3300
21	1 3/4	2400	2 1/4	3300	2 3/4	3850
24	2 1/8	2600	3	3600	3 3/4	4400
27	3 1/4	2800	4	3950	4	4600
30	3 1/2	3000	4 1/4	4300	4 1/4	4750
33	3 3/4	3150	4 1/2	4400	4 1/2	4875
36	4	3300	4 3/4	4500	4 3/4	5000

^a Subject to Tolerances in Section 10.

TABLE 1A Physical and Dimensional Requirements for Nonreinforced Concrete Pipe (SI Units)^a

Internal Designated Diameter, mm	Class 1		Class 2		Class 3	
	Minimum Thickness of Wall, mm	Minimum Strength, kN/linear m, Three-Edge Bearing	Minimum Thickness of Wall, mm	Minimum Strength, kN/linear m, Three-Edge Bearing	Minimum Thickness of Wall, mm	Minimum Strength, kN/linear m, Three-Edge Bearing
100	16	22.0	19	29.0	19	35.0
150	16	22.0	19	29.0	22	35.0
200	19	22.0	22	29.0	29	35.0
250	22	23.5	25	29.0	32	35.0
300	25	26.5	35	33.0	44	38.0
375	32	29.0	41	38.0	47	42.0
450	38	32.0	50	44.0	57	48.0
525	44	35.0	57	48.0	69	56.0
600	54	38.0	75	52.5	94	64.0
675	82	41.0	100	57.5	100	67.0
750	88	44.0	107	63.0	107	69.5
825	94	46.0	113	64.0	113	71.0
900	100	48.0	119	65.5	119	73.0

^a Subject to Tolerance in Section 10.

TABLE 2A Permissible Variation in Internal Diameter (SI Units)

Designated Diameter of Pipe, mm	Permissible Variation, Internal Diameter of Pipe	
	Minimum, mm	Maximum, mm
100	100	110
150	150	160
200	200	210
250	250	260
300	300	310
375	375	390
450	450	465
525	525	545
600	600	620
675	675	695
750	750	775
825	825	850
900	900	925

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4.2 *Acceptance as to Strength Properties*—Pipe shall be acceptable under the strength tests when they have met the requirements as prescribed in 9.3.

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5.2 *Aggregates*—Aggregates shall conform to Specification C 33, except that the requirement for gradation shall not apply.

5.3 *Admixtures and Blends*—Admixtures and blends may be used with the approval of the purchaser.

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7.1 The joints shall be of such design and the ends of the concrete pipe sections so formed that when the sections are laid together they will make a continuous line of pipe with a smooth interior free of appreciable irregularities in the flow line, all compatible with the permissible variations given in Section 10.

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8.2.3 The manufacturer may, at his option, combine the methods described in 8.2.1 and 8.2.2 provided the specified strength is attained.

8.2.4 *Membrane Curing*—A sealing membrane conforming to the requirements Specification C 309 may be applied and left intact until the specified strength requirements are met. The concrete at the time of application shall be within 10°F or 6°C of the atmospheric temperature. All surfaces shall be kept moist prior to the application of the compounds and shall be damp when the compound is applied.

8.3 *Specials*:

8.3.1 *General Requirements*—Special shapes or fittings such as wyes, tees, bends, and adapters for use with concrete pipe conforming to this specification shall conform to the applicable requirements for concrete pipe of corresponding class and internal diameter. Joints shall be compatible with those used in adjoining concrete pipes.

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9.3 *External Load Crushing Test Requirements*—The crushing strength of nonreinforced concrete pipe shall conform to the requirements prescribed in Tables 1 and 1A. The individual results of the various tests for each size of pipe and for each shipment and plant shall be tabulated separately so as to show the percentage that fails to conform to the requirements of each test. The crushing strength shall ordinarily be applied to not less than 75 % of the pipe received for purpose of test. All tests shall be made in accordance with Method C 497. Pipe shall be acceptable under the strength test requirements when all test pipe conform to the test requirements. Should any of the preliminary test pipe provided in 9.2 fail to meet the test requirements, then the manufacturer will be allowed a retest on two additional pipe of each pipe that failed, and the pipe shall be acceptable only when all of these retest pipe meet the strength requirements.

9.4 *Absorption Test*—When required by the purchaser, absorption shall be determined by either Method A or Method B in accordance

with Methods C 497 for the boiling absorption test and shall not exceed 9 % for Method A or 8.5 % for Method B. The individual results of the various tests for each size of pipe for each shipment and plant shall be tabulated separately so as to show the percentage that fails to conform to the requirements of each test. All tests shall be made in accordance with Methods C 497. The number of absorption test specimens shall be equal to the number of pipe provided for crushing strength testing. These test specimens shall be obtained from pipe that are acceptable as to strength, and shall be taken from pipe used in making the strength test after the test is made. These specimens shall be marked with the number or identification mark of the pipe from which they were taken. Each Method A specimen shall have an area of 12 to 20 in.² or 77 to 129 cm², as measured on one surface of the pipe, and a thickness equal to the pipe wall, and shall be free of visible cracks. Pipes shall be acceptable under the absorption test when all test pipe conform to the test requirements. When not more than 20 % of the absorption test specimens fail to pass the requirements of this section, the manufacturer may cull his stock and may eliminate whatever quantity of pipe he desires and must so mark those pipe so that they will not be shipped. The required tests shall be made on the balance of the order and they shall be acceptable if they conform to the test requirements.

9.5 *Permeability*—When subject to the permeability test as specified in Methods C 497 the outer pipe surface of not less than 80 % of the pipe tested shall show no moist or damp spots at the end of the test period due to water passing through the walls of the pipe. When more than 20 % of the test pipe fail to pass the requirements of this section, the manufacturer may cull his stock and may eliminate whatever quantity of pipe he desires and must so mark those pipe that they will not be shipped. The required tests shall be made on the balance of the order and they shall be accepted if they conform to the test requirements. If the second test fails the whole lot may be rejected.

9.6 *Hydrostatic Tests*—If subjected to the internal hydrostatic pressures of 10 psi or 70 kPa for 10 min as described in Methods C 497,

the pipe shall show no leakage. Moisture appearing on the surface of the pipe in the form of patches or beads adhering to the surface shall not be considered leakage. When not more than 20 % of the test pipe fail to pass the requirements of this section, the manufacturer may cull his stock and may eliminate whatever quantity of pipe he desires and must so mark those pipe that they will not be shipped. The required tests shall be made on the balance of the order and they shall be accepted if they conform to the test requirements. If the second test fails, the whole lot may be rejected.

9.7 At the time of initial inspection, under the permeability test, if the pipe shows moist or damp spots on the outer surface of the pipe, the test shall be continued for a period not to exceed 24 h at the option of the manufacturer or seller. If the pipe shows no moist or damp spots on the outer surface of the pipe at some time during the extended period, it shall be considered to have passed the test.

9.8 At the time of initial inspection, under the hydrostatic test, if the pipe shows leakage, the test shall be continued for a period not to exceed 24 h at the option of the manufacturer or seller. If the pipe shows no leakage, at some time during the extended period, it shall be considered to have passed the test.

9.9 When the hydrostatic test is used for acceptance of the pipe joint as specified in Section 8 of Specification C 443 the same joint test runs may be used as the basis of acceptance for the pipe hydrostatic test allowed under 4.5 and 9.6 of this specification.

9.10 *Defective Pipe*—Pipe that is observed to have cracks or other defects in form or dimensions in excess of the limits permitted in this specification, shall be discarded and replaced with additional pipe from the shipment.

10. Dimensions and Permissible Variations

10.1 *Sizes and Dimensions*—Pipe shall be furnished of the sizes, internal diameters, and dimensions prescribed in Tables 1 and 1A.

10.2 *Permissible Variations in Dimensions*—Permissible variations in dimensions shall be limited to the following:

10.2.1 *Internal Diameter*—The internal diameter shall not be more or less than the

designated diameter by more than $\frac{3}{16}$ in. for pipe designated as 12 in. and under in diameter; by more than $\frac{1}{4}$ in. for pipe designated as 15 or 18 in. in diameter; by more than $\frac{5}{16}$ in. for pipe designated as 21 in. in diameter; and by more than $\frac{3}{8}$ in. for pipe designated as 24 in. and over in diameter. Permissible variations utilizing SI units are as prescribed in Table 2A.

10.2.2 *Thickness of Wall*—The wall thickness shall be not less than the values shown in Table 1 or 1A or the manufacturer's designated thickness if greater than shown in Table 1 or 1A by more than $\frac{1}{16}$ in. or 2 mm for pipe 10 in. or 250 mm or less in diameter; by more than $\frac{1}{8}$ in. or 3 mm for pipe 12 to 24 in. or 300 to 600 mm in diameter; and by more than $\frac{3}{16}$ in. or 5 mm for pipe more than 24 in. or 600 mm in diameter; or by more than 5 % of the tabulated or designated wall thickness, whichever is greater. Localized variations in wall thickness exceeding those specified above shall be accepted if the physical test requirements specified herein are met.

10.2.3 *Length*—The length of any section of pipe shall vary not more than $-\frac{1}{2}$ in. or -13 mm from a specified or designated design length.

10.2.4 *Length of Two Opposite Sides*—The length of two opposite sides of any section of pipe shall vary not more than $\frac{1}{4}$ in. or 6 mm or 2 % of the designated diameter, whichever is larger.

10.2.5 *Straightness*—Pipe intended to be straight shall not vary in alignment more than $\frac{1}{8}$ in./ft or 10 mm/m of length.

11. Workmanship and Finish

11.1 Pipe shall be substantially free of fractures and excessive interior surface roughness.

11.2 The planes of the ends of the pipe shall be perpendicular to the longitudinal axis, subject to the limits of variation as shown in 10.2.4.

12. Repairs

12.1 Pipe may be repaired, if necessary, because of occasional imperfections in manufacture or injury during handling and will be acceptable if, in the opinion of the purchaser, the repairs are sound and properly finished

and cured and the repaired pipe conforms to the requirements of this specification.

13. Inspection

13.1 The quality of all materials and the finished pipe shall be subject to inspection and approval by an inspector employed by the purchaser. Such inspection may be performed at the point of manufacture or delivery.

14. Rejection

14.1 Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements. Individual sections of pipe may be rejected because of any of the following:

14.1.1 Fractures or cracks passing through the wall or joints, except that a single crack not exceeding 2 in. or 50 mm in length at either end of a pipe or a single fracture or spall in the joints not exceeding 3 in. or 75 mm around the circumference of the pipe nor

2 in. or 50 mm in length into joint shall not be considered cause for rejection unless these defects exist in more than 5 % of the entire shipment or delivery.

14.1.2 Defects that indicate imperfect mixing and molding.

14.1.3 Cracks sufficient to impair the strength, durability, or serviceability of the pipe.

15. Marking

15.1 The following information shall be clearly marked on each pipe:

15.1.1 The pipe class and specification designation.

15.1.2 The date of manufacture.

15.1.3 The name or trademark of the manufacturer, and

15.1.4 Identification of the plant.

15.2 Marking shall be indented on the pipe section or painted thereon with waterproof paint.

TABLE 1 Physical and Dimensional Requirements for Nonreinforced Concrete Pipe (U.S. Customary Units)¹

Internal Designated Diameter, in.	Class 1		Class 2		Class 3	
	Minimum Thickness of Wall, in.	Minimum Strength, lbf/linear ft. Three-Edge Bearing	Minimum Thickness of Wall, in.	Minimum Strength, lbf/linear ft. Three-Edge Bearing	Minimum Thickness of Wall, in.	Minimum Strength, lbf/linear ft. Three-Edge Bearing
4	$\frac{5}{8}$	1500	$\frac{3}{4}$	2000	$\frac{3}{4}$	2400
6	$\frac{5}{8}$	1500	$\frac{3}{4}$	2000	$\frac{7}{8}$	2400
8	$\frac{3}{4}$	1500	$\frac{7}{8}$	2000	$1\frac{1}{8}$	2400
10	$\frac{7}{8}$	1600	1	2000	$1\frac{1}{4}$	2400
12	1	1800	$1\frac{3}{8}$	2250	$1\frac{3}{4}$	2600
15	$1\frac{1}{4}$	2000	$1\frac{5}{8}$	2600	$1\frac{7}{8}$	2900
18	$1\frac{1}{2}$	2200	2	3000	$2\frac{1}{4}$	3300
21	$1\frac{3}{4}$	2400	$2\frac{1}{4}$	3300	$2\frac{3}{4}$	3850
24	$2\frac{1}{8}$	2600	3	3600	$3\frac{3}{4}$	4400
27	$3\frac{1}{4}$	2800	4	3950	4	4600
30	$3\frac{1}{2}$	3000	$4\frac{1}{4}$	4300	$4\frac{1}{4}$	4750
33	$3\frac{3}{4}$	3150	$4\frac{1}{2}$	4400	$4\frac{1}{2}$	4875
36	4	3300	$4\frac{3}{4}$	4500	$4\frac{3}{4}$	5000

¹ Subject to Tolerances in Section 10.

TABLE 1A Physical and Dimensional Requirements for Nonreinforced Concrete Pipe (SI Units)^a

Internal Designated Diameter, mm	Class 1		Class 2		Class 3	
	Minimum Thickness of Wall, mm	Minimum Strength, kN/linear m, Three-Edge Bearing	Minimum Thickness of Wall, mm	Minimum Strength, kN/linear m, Three-Edge Bearing	Minimum Thickness of Wall, mm	Minimum Strength, kN/linear m, Three-Edge Bearing
100	16	22.0	19	29.0	19	35.0
150	16	22.0	19	29.0	22	35.0
200	19	22.0	22	29.0	29	35.0
250	22	23.5	25	29.0	32	35.0
300	25	26.5	35	33.0	44	38.0
375	32	29.0	41	38.0	47	42.0
450	38	32.0	50	44.0	57	48.0
525	44	35.0	57	48.0	69	56.0
600	54	38.0	75	52.5	94	64.0
675	82	41.0	100	57.5	100	67.0
750	88	44.0	107	63.0	107	69.5
825	94	46.0	113	64.0	113	71.0
900	100	48.0	119	65.5	119	73.0

^a Subject to Tolerance in Section 10.

TABLE 2A Permissible Variation in Internal Diameter (SI Units)

Designated Diameter of Pipe, mm	Permissible Variation, Internal Diameter of Pipe	
	Minimum, mm	Maximum, mm
100	100	110
150	150	160
200	200	210
250	250	260
300	300	310
375	375	390
450	450	465
525	525	545
600	600	620
675	675	695
750	750	775
825	825	850
900	900	925

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