



**Designation: C 14 – 99**

## **Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe<sup>1</sup>**

This standard is issued under the fixed designation C 14 – 99; 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 Department of Defense.*

### **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.

1.2 A complete metric companion to Specification C 14 has been developed—C 14M; 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 conditions 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, and care that the installation conforms to the construction specifications. The owner is cautioned that he must correlate the field requirements with the class of pipe specified and provide for or require inspection at the construction site.

### **2. Referenced Documents**

#### *2.1 ASTM Standards:*

C 33 Specification for Concrete Aggregates<sup>2</sup>

C 150 Specification for Portland Cement<sup>3</sup>

C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete<sup>2</sup>

C 443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets<sup>4</sup>

C 497 Test Methods for Concrete Pipe, Manhole Sections, or Tile<sup>4</sup>

C 595 Specification for Blended Hydraulic Cements<sup>3</sup>

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete<sup>2</sup>

C 822 Terminology Relating to Concrete Pipe and Related Products<sup>4</sup>

C 1116 Specification for Fiber-Reinforced Concrete and Shotcrete<sup>2</sup>

### **3. Terminology**

3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology C 822.

### **4. Classification**

4.1 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 Table 1.

### **5. Basis of Acceptance**

5.1 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.

5.2 *Acceptance as to Strength Properties*—Pipe shall be acceptable under the strength tests when they have met the requirements as prescribed in 10.3.

5.3 *Acceptance as to Absorption Properties*—Pipe shall be acceptable under the absorption test when they have met the requirements as prescribed in 10.4.

5.4 *Acceptance as to Permeability Properties*—Pipe shall be acceptable under the permeability test when they have met the requirements as prescribed in 10.5.

NOTE 2—Prior to purchase, the owner may specify the hydrostatic test prescribed in 10.6 instead of the permeability test.

5.5 *Acceptance as to Hydrostatic Properties*—Pipe shall be acceptable under the hydrostatic test when they have met the requirements as prescribed in 10.6.

### **6. Materials**

6.1 *Concrete*—The concrete shall consist of cementitious materials, mineral aggregates, and water.

#### *6.2 Cementitious Materials:*

6.2.1 *Cement*—Cement shall conform to the requirements for portland cement of Specification C 150 or shall be portland blast-furnace slag cement or portland-pozzolan cement conforming to the requirements of Specification C 595, except that the pozzolan constituent in the Type IP portland-pozzolan cement shall be fly ash.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C-13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.01 on Reinforced Concrete Sewer, Drain, and Irrigation Pipe.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 04.05.



**TABLE 1 Physical and Dimensional Requirements for Nonreinforced Concrete Pipe<sup>A</sup>**

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	7/8	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 3/8	2250	1 3/4	2600
15	1 1/4	2000	1 5/8	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 3/8	4400
27	3 1/4	2800	3 3/4	3950	3 3/4	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

<sup>A</sup> Subject to tolerances in Section 11.

6.2.2 *Fly Ash*—Fly ash shall conform to the requirements of Specification C 618, Class F or Class C.

6.2.3 *Allowable Combinations of Cementitious Materials*—The combination of cementitious materials used in the concrete shall be one of the following:

- 6.2.3.1 Portland cement only,
- 6.2.3.2 Portland blast furnace slag cement only;
- 6.2.3.3 Portland pozzolan cement only, or
- 6.2.3.4 A combination of portland cement and fly ash.

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

6.4 *Admixtures and Blends*—Admixtures and blends may be used with the approval of the owner.

6.5 *Synthetic Fibers*—Collated fibrillated virgin polypropylene fibers may be used, at the manufacturer's option, in concrete pipe as a nonstructural manufacturing material. Only Type III synthetic fibers designed and manufactured specifically for use in concrete and conforming to the requirements of Specification C 1116 shall be accepted.

## 7. Design

7.1 *Design Tables*—Design requirements shall be in accordance with Table 1. 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.

7.2 *Modified or Special Design*—Manufacturers may submit to the owner for approval, prior to manufacture, wall thicknesses other than those shown in Table 1. Such pipe shall meet all of the physical requirements listed in Section 10 that are specified by the owner.

## 8. Joints

8.1 The joints shall be of such design and the ends of the concrete pipe sections so formed, that the pipe can be laid together to make a continuous line of pipe compatible with the permissible variations given in Section 11.

## 9. Manufacture

9.1 *Mixture*—The aggregates shall be sized, graded, proportioned, and mixed with such proportions of cementitious materials 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. All concrete shall have a water-cementitious materials ratio not exceeding 0.53 by weight. Cementitious materials shall be as specified in 6.2 and shall be added to the mix in a proportion not less than 470 lb/yd<sup>3</sup> unless mix designs with a lower cementitious material content demonstrate that the quality and performance of the pipe meet the requirements of this specification.

9.2 *Curing*—Pipe shall be subjected to any one of the methods of curing described in 9.2.19.2.29.2.39.2.4 or to any other method or combination of methods approved by the owner that will give satisfactory results. The pipe shall be adequately cured to obtain the strength properties as described in 5.2.

9.2.1 *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.

9.2.2 *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.

9.2.3 The manufacturer may, at his option, combine the methods described in 9.2.1 and 9.2.2 provided the specified strength is attained.

9.2.4 *Membrane Curing*— A sealing membrane conforming to the requirements of 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 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.

### 9.3 Specials:

9.3.1 *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.

9.3.2 *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.

## 10. Physical Requirements

10.1 *Test Specimen*— The specified number of pipe required for the tests shall be furnished by the manufacturer and shall be selected at random by the owner, 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 owner 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.

10.2 *Number and Type of Test Specimens Required*— The manufacturer 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.

10.3 *External Load Crushing Requirement*—The crushing strength of nonreinforced concrete pipe shall conform to the requirements prescribed in Table 1. The individual results of the various tests for each size of pipe and for each shipment and plant shall be tabulated separately. 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 Test Methods C 497. Pipe shall be acceptable when all test pipe conform to the specified requirement. Should any of the test pipe provided in 10.2 fail to meet the strength requirement, the manufacturer will be allowed to test two pipe for each pipe that failed, and the pipe shall be acceptable only when all of these additional test pipe meet the strength requirement.

10.4 *Absorption Requirement*—When required by the owner, an absorption test shall be performed by either Test Method A or Test Method B in accordance with Test Methods C 497 for the boiling absorption test. Absorption shall not exceed 9 % for Test Method A or 8.5 % for Test Method B. The individual results of the various tests for each size of pipe for each shipment and plant shall be tabulated separately. All tests shall be made in accordance with Test Methods C 497. The number of absorption test specimens shall be equal to the number of pipe provided for crushing strength testing. These 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 Test Method A specimen shall have an area of 12 to 20 in.<sup>2</sup>, as measured on one surface of the pipe, and a thickness equal to the pipe wall, and shall be free of visible cracks. Pipe shall be acceptable when all test pipe conform to the specified absorption requirement.

10.5 *Permeability Requirement*—When subjected to the

permeability test, as specified in Test 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.

10.6 *Hydrostatic Requirement*—When subjected to the hydrostatic test, as described in Test Methods C 497, the pipe shall show no leakage during 10 min at 10 psi. Moisture appearing on the surface of the pipe in the form of patches or beads adhering to the surface shall not be considered leakage. The test pipe shall be filled with water and held under 10 psi pressure for 24 h prior to the test, except that at the option of the manufacturer, this presoak time or pressure, or both, may be reduced. The test may be continued up to 24 h, and the pipe will be considered to have passed when, during any 10-min period, no leakage is observed. When the hydrostatic requirement is used for acceptance of the pipe joint as specified in Section 10 of Specification C 443, the same joint test runs may be used as the basis of acceptance for pipe hydrostatic requirements allowed in accordance with 5.5 and 10.6 of this specification.

10.7 *Retest*—Should more than 20 % of the samples fail to meet the specified requirements for the permeability or not more than 20 % of the samples fail to meet the specified requirement for absorption or hydrostatic 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 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 specified requirements. If the second sample fails to meet the specified requirements, the whole lot may be rejected.

## 11. Dimensions and Permissible Variations

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

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

11.2.1 *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.

11.2.2 *Thickness of Wall*—The wall thickness shall be not less than the values shown in Table 1 or the manufacturer's designated thickness if greater than shown in Table 1 by more than  $\frac{1}{16}$  in. for pipe 10 in. or less in diameter; by more than  $\frac{1}{8}$  in. for pipe 12 to 24 in. in diameter; and by more than  $\frac{3}{16}$  in. for pipe more than 24 in. 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.

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

11.2.4 *Length of Two Opposite Sides*— The length of two opposite sides of any section of pipe shall vary not more than



¼ in. or 2 % of the designated diameter, whichever is larger.

11.2.5 *Straightness*— Pipe intended to be straight shall not vary in alignment more than 1/8 in./ft of length.

## 12. Repairs

12.1 Pipe may be repaired, if necessary, because of imperfections in manufacture or damage during handling and will be acceptable if, in the opinion of the owner, 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 the owner. Such inspection may be performed at the point of manufacture or delivery. The method of marking as to acceptance or rejection of pipe shall be agreed upon, prior to inspection, between the owner and the manufacturer. Rejected pipe shall be replaced by the manufacturer with pipe that meets the requirements of this specification.

## 14. Rejection

14.1 Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements. This specification is a manufacturing and purchase specification only. Therefore, damage to pipe during installation or caused by field loading in the installed condition shall not be cause for rejection on the basis of not meeting this specification. 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. in length at either end of a pipe or a single fracture or spall in the joints not exceeding 3 in. around the circumference of the pipe, nor 2 in. 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 The planes of the ends of the pipe are not perpendicular to the longitudinal axis, subject to the limits of variation as shown in 11.2.4.

14.1.3 Defects that indicate mixing and molding not in accordance with 9.1.

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

## 15. Product Marking

15.1 The following information shall be legibly 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.

## 16. Keywords

16.1 concrete sewer; culvert; nonreinforced; pipe; storm drain

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