



Designation: ~~C654 – 11~~ C654 – 15

Standard Specification for Porous Concrete Pipe¹

This standard is issued under the fixed designation C654; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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

1. Scope

- 1.1 This specification covers porous nonreinforced concrete pipe for use in underdrains.
- 1.2 A complete metric companion to this specification has been developed—654M; therefore, no metric equivalents are presented in this specification.

2. Referenced Documents

2.1 *ASTM Standards:*²

- [C33/C33M Specification for Concrete Aggregates](#)
- [C150/C150M Specification for Portland Cement](#)
- [C260/C260M Specification for Air-Entraining Admixtures for Concrete](#)
- [C494/C494M Specification for Chemical Admixtures for Concrete](#)
- [C497 Test Methods for Concrete Pipe, Manhole Sections, or Tile](#)
- [C595/C595M Specification for Blended Hydraulic Cements](#)
- [C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete](#)
- [C822 Terminology Relating to Concrete Pipe and Related Products](#)
- [C989/C989M Specification for Slag Cement for Use in Concrete and Mortars](#)
- [C822/C1017/C1017M Terminology Relating to Concrete Pipe and Related Products](#)
- [C1116/C1116M Specification for Fiber-Reinforced Concrete and Shotcrete](#)
- [C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete](#)

3. Terminology

- 3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology [C822](#).
- 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 of two classes identified as “Standard-Strength Porous Nonreinforced Concrete Pipe” and “Extra-Strength Porous Nonreinforced Concrete Pipe.”

5. Basis of Acceptance

- 5.1 The acceptability of the pipe shall be determined by the results of the strength and porosity or rate of infiltration tests, and by inspection to determine whether the pipe conforms to this specification as to design and freedom from defects.
- 5.2 The pipe shall be acceptable under the strength tests when they have met the requirements as prescribed in Section 10.
- 5.3 *Acceptance as to Infiltration Properties*—Pipe shall be acceptable under the infiltration test when all test pipe conform to the test requirements as prescribed in Section 10.

¹ This specification is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.01 on Non-Reinforced Concrete Sewer, Drain and Irrigation Pipe.

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² 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.

6. Materials

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

6.2 *Cementitious Materials:*

6.2.1 *Cement*—Cement shall conform to the requirements for portland cement of Specification ~~C150/C150M~~ C150/C150M or shall be portland blast-furnace slag cement, ~~or slag-modified portland~~ portland-limestone cement, or portland-pozzolan cement conforming to the requirements of Specification ~~C595/C595M~~, C595/C595M, except that the pozzolan constituent in the Type IP portland-pozzolan cement shall be fly ash.

6.2.2 *Fly Ash*—Fly ash shall conform to the requirements of Specification C618, Class F or Class C.

6.2.3 *Ground Granulated Blast Furnace Slag (GGBFS)*—~~Slag Cement—GGBFS Slag cement~~ shall conform to the requirements of Grade 100 or 120 of Specification ~~C989/C989M~~, C989/C989M.

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

6.2.4.1 Portland cement only,

6.2.4.2 Portland ~~blast furnace~~ blast-furnace slag cement only,

6.2.4.3 ~~Slag-modified portland~~ Portland-pozzolan cement only,

6.2.4.4 ~~Portland-pozzolan~~ Portland-limestone cement only,

6.2.4.5 A combination of portland cement or portland-limestone cement and fly ash,

6.2.4.6 A combination of portland cement and ground granulated blast-furnace slag, or or portland-limestone cement and slag cement,

6.2.4.7 A combination of portland cement, fly ash (not to exceed 25 % of the total cementitious weight) and ground granulated blast furnace slag (not to exceed 25 % of the total cementitious weight). cement or portland-limestone cement, fly ash, and slag cement, or

6.2.4.8 A combination of portland-pozzolan cement and fly ash.

6.3 *Aggregates*—Aggregates shall conform to the requirements of Specification ~~C33/C33M~~, C33/C33M, except that the requirement for gradation shall not apply.

6.4 *Admixtures and Blends*—~~Admixtures~~—Owner is not prohibited from obtaining the record of mix design used. The following admixtures and blends are allowable:

6.4.1 Air-entraining admixture conforming to Specification C260/C260M;

6.4.2 Chemical admixture conforming to Specification C494/C494M;

6.4.3 Chemical admixture for use in producing flowing concrete conforming to Specification C1017/C1017M; and

6.4.4 Chemical admixture or blend approved by the owner.

6.5 *Synthetic Fibers*—~~Collated fibrillated virgin polypropylene fibers are not prohibited~~ Synthetic fibers and nonsynthetic fibers shall be allowed to be used, at the manufacturer's option, in concrete pipe as a nonstructural manufacturing material. Only Type II synthetic fibers—Synthetic fibers (Type II and Type III) and nonsynthetic fiber (Type I) designed and manufactured specifically for use in concrete and conforming to the requirements of Specification ~~C1116/C1116M~~ C1116/C1116M shall be accepted.

6.6 *Water*—Water used in the production of concrete shall be potable or nonpotable water that meets the requirements of Specification C1602/C1602M.

7. Design

7.1 *Design Tables*—Design requirements shall be in accordance with Table 1 and Table 2 and Fig. 1. Wall thickness used shall be not less than the value shown, except as affected by the tolerance herein specified.

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 7.

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.

9.2 *Curing*—Pipe shall be subjected to any one of the methods of curing described in 9.2.1 through 9.2.3, or to any other method or combination of methods approved by the owner 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.

TABLE 1 Physical and Dimensional Requirements of Porous Concrete Pipe

| Internal Designated Diameter, <i>D</i> | Minimum ^A Wall Thickness, <i>T</i> | Minimum Laying Length ^A | Minimum Socket Depth, <i>L_s</i> | Minimum Strength Three-Edge-Bearing | Minimum Infiltration |
|--|---|------------------------------------|--|-------------------------------------|----------------------|
| in. | in. | in. | in. | lb/ft | gal/min-ft |
| 4 | 1 | 24 | 1 | 1000 | 4 |
| 6 | 1 | 24 | 1 | 1100 | 6 |
| 8 | 1¼ | 24 | 1¼ | 1300 | 8 |
| 10 | 1⅝ | 24 | 1⅝ | 1400 | 10 |
| 12 | 1½ | 24 | 1½ | 1500 | 12 |
| 15 | 1¾ | 24 | 1¾ | 1750 | 15 |
| 18 | 2 | 24 | 2 | 2000 | 18 |
| 21 | 2¼ | 24 | 2¼ | 2200 | 21 |
| 24 | 2½ | 24 | 2½ | 2400 | 24 |

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|--|---|------------------------------------|--|-------------------------------------|----------------------|
| in. | in. | in. | in. | lb/ft | gal/min-ft |
| 4 | 1 | 24 | 1 | 1000 | 4 |
| 6 | 1 | 24 | 1 | 1100 | 6 |
| 8 | 1¼ | 24 | 1¼ | 1300 | 8 |
| 10 | 1⅝ | 24 | 1⅝ | 1400 | 10 |
| 12 | 1½ | 24 | 1½ | 1500 | 12 |
| 15 | 1¾ | 24 | 1¾ | 1750 | 15 |
| 18 | 2 | 24 | 2 | 2000 | 18 |
| 21 | 2¼ | 24 | 2¼ | 2200 | 21 |
| 24 | 2½ | 24 | 2½ | 2400 | 24 |

^A Normally the minimum laying length is 24 in. in length, but if the owner has no objections, then 18-in. length pipe up to 12 in. in diameter shall be acceptable.

TABLE 2 Physical and Dimensional Requirements of Extra-Strength Porous Concrete Pipe

| Internal Designated Diameter, <i>D</i> | Minimum Wall Thickness, <i>T</i> | Minimum Laying Length ^A | Minimum Socket Depth, <i>L_s</i> | Minimum Strength Three-Edge-Bearing | Minimum Infiltration |
|--|----------------------------------|------------------------------------|--|-------------------------------------|----------------------|
| in. | in. | in. | in. | lb/ft | gal/min-ft |
| 8 | 1½ | 24 | 1½ | 2600 | 8 |
| 10 | 1⅝ | 24 | 1⅝ | 2800 | 10 |
| 12 | 2 | 24 | 2 | 3000 | 12 |
| 15 | 2¼ | 24 | 2¼ | 3200 | 15 |
| 18 | 2½ | 24 | 2½ | 3200 | 18 |

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|--|----------------------------------|------------------------------------|--|-------------------------------------|----------------------|
| in. | in. | in. | in. | lb/ft | gal/min-ft |
| 8 | 1½ | 24 | 1½ | 2600 | 8 |
| 10 | 1⅝ | 24 | 1⅝ | 2800 | 10 |
| 12 | 2 | 24 | 2 | 3000 | 12 |
| 15 | 2¼ | 24 | 2¼ | 3200 | 15 |
| 18 | 2½ | 24 | 2½ | 3200 | 18 |

^A Normally the minimum laying length is 24 in. in length, but if the owner has no objections, then 18-in. length pipe up to 12 in. in diameter shall be acceptable.

9.2.1 *Steam Curing*—Pipe shall 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 at such temperature as needed to enable the pipe to meet the strength requirements. The curing chamber shall be constructed as to allow full circulation of steam around the entire pipe.

9.2.2 *Water Curing*—Concrete pipe shall 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 has the option to combine the methods described in 9.2.1 and 9.2.2 provided the specified strength is attained.

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 be made of porous or nonporous concrete in such manner as will provide strength at least equal to the class of the adjacent pipe to which they are joined; and shall conform to all other requirements specified for pipe of corresponding class and internal diameter, except minimum infiltration. Joints shall be the same type as used in the adjoining pipe.

9.3.2 *Wyes and Tees*—Fabricated branches for wyes and tees shall be securely attached to the wall of the pipe and shall be flush with the inside surface of the pipe.