Designation: C 654M – 05

METRIC

Standard Specification for Porous Concrete Pipe [Metric][1]

This standard is issued under the fixed designation C 654M; 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 (ε) 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 porous nonreinforced concrete pipe for use in underdrains.

1.2 This specification is the metric counterpart of Specification C 654.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 33 Specification for Concrete Aggregates

C 150 Specification for Portland Cement

C 497M Test Methods for Concrete Pipe, Manhole Sections, or Tile [Metric]

C 595 Specification for Blended Hydraulic Cements

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C 822 Terminology Relating to Concrete Pipe and Related Products

C 989 Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

C 1116 Specification for Fiber-Reinforced Concrete and Shotcrete

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 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.

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 slag-modified portland 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.

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

6.2.3 *Ground Granulated Blast Furnace Slag (GGBFS)*—GGBFS shall conform to the requirements of Grade 100 or 120 of Specification C 989.

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 slag cement only,

6.2.4.3 Slag modified portland cement only,

6.2.4.4 Portland pozzolan cement only,

6.2.4.5 A combination of portland cement and fly ash,

[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.

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

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).

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 shall only be used with the approval of the owner.

6.5 *Synthetic Fibers*—Collated fibrillated virgin polypropylene fibers are not prohibited 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 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, *D*	Minimum[A] Wall Thickness, *T*	Minimum Laying Length[A]	Minimum Socket Depth, L_s	Minimum Strength Three-Edge-Bearing	Minimum Infiltration
mm	mm	mm	mm	kN/m	L/s·m
100	25	600	25	14.5	0.8
150	25	600	25	16.0	1.0
200	32	600	32	19.0	1.5
250	35	600	35	20.5	2.0
300	38	600	38	22.0	2.5
375	44	600	44	25.5	3.0
450	50	600	50	29.0	3.5
525	57	600	57	32.0	4.0
600	63	600	63	35.0	4.5

[A] Normally the minimum laying length is 600 mm in length, but if the owner has no objections, then 450-mm length pipe up to 300 mm in diameter shall be acceptable.

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

Internal Designated Diameter, *D*	Minimum[A] Wall Thickness, *T*	Minimum Laying Length[A]	Minimum Socket Depth, L_s	Minimum Strength Three-Edge-Bearing	Minimum Infiltration
mm	mm	mm	mm	kN/m	L/s·m
150	32	600	32	32.0	1.0
200	38	600	38	38.0	1.5
250	41	600	41	41.0	2.0
300	50	600	50	44.0	2.5
375	57	600	57	46.5	3.0
450	63	600	63	46.5	3.5

[A] Normally the minimum laying length is 600 mm in length, but if the owner has no objections, then 450-mm length pipe up to 300 mm in diameter shall be acceptable.

TABLE 3 Permissible Variations in Dimensions of Porous Concrete Pipe

Internal Designated Diameter,	Limits of Permissible Variation			
	Wall Thickness,[A]	Length, Two Opposite Sides	Length,	Depth of Socket,[A]
mm	mm	mm	mm/m	mm
100	–2	6	–20	–3
150	–2	6	–20	–3
200	–2	8	–20	–6
250	–2	10	–20	–6
300	–2	10	–20	–6
375	–2	11	–20	–6
450	–2	13	–20	–6
525	–3	14	–20	–6
600	–3	14	–31	–6

[A] The minus sign (–) indicates that the plus variation is not limited.

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.