Designation: C1754/C1754M – 12

Standard Test Method for Density and Void Content of Hardened Pervious Concrete[1]

This standard is issued under the fixed designation C1754/C1754M; 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.

1. Scope

1.1 This test method provides a procedure for determining the density and void content of hardened pervious concrete specimens.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C29/C29M Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

C125 Terminology Relating to Concrete and Concrete Aggregates

C1542/C1542M Test Method for Measuring Length of Concrete Cores

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology C125.

4. Summary of Test Method

4.1 The dimensions of a specimen of hardened pervious concrete are measured to determine its volume. The specimen is subsequently dried to constant mass and immersed in water to determine the volume of solids in the specimen. Void content is calculated using the difference between the total volume and the displaced volume when submerged.

5. Significance and Use

5.1 This test method is applicable to pervious concrete mixtures containing coarse aggregate with a nominal maximum size of 25 mm [1 in.] or smaller.

5.2 This test method applies to either core specimens or molded cylinders.

5.3 Density and void content determined by other test methods may produce different numerical results, which may not be comparable.

5.4 This test method allows one to choose one of two different drying methods. The following should be considered in selecting Drying Method A or B.

5.4.1 Drying Method A uses a lower temperature to determine the constant dry mass of the pervious specimen. Depending on the initial condition of the pervious specimen, obtaining the constant dry mass may take as long as one week or more. Drying Method B uses a much higher temperature and therefore the constant dry mass is attained much more quickly.

5.4.2 Specimens tested using Drying Method B shall not be used to determine other properties of the pervious concrete. If other physical properties such as strength or infiltration will be determined from the specimen, Drying Method A should be used for testing.

5.4.3 Drying Method B may produce lower densities and correspondingly higher void contents than Drying Method A. Results from the two methods should be treated separately and not combined.

5.4.4 Repeat testing of the same specimen using Drying Method A has been shown to produce dissimilar results. Only the first set of results should be considered.

NOTE 1—It is believed that exposure to high temperatures, as used in Drying Method B, may alter the void structure of the pervious concrete matrix by causing shrinkage cracks in the cement paste at the aggregate interface.

6. Apparatus

6.1 *Balance*—A balance or scale accurate to 0.5 g [0.001 lb]. The balance shall be equipped with suitable apparatus for determining the submerged mass of the test specimen.

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.49 on Pervious Concrete.

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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 *Jaw Caliper*—Minimum depth of jaw 65 mm [2.5 in.]. Measuring range 0 to 300 mm [0 to 12 in.]. Accuracy to 0.25 mm [0.01 in.].

6.3 *Thermometer*—Or temperature measuring device accurate to 0.5 °C [1 °F].

6.4 *Water Bath*—With dimensions large enough to allow a specimen to soak and subsequently be placed into the suspended container below the balance without being removed from the water. The water bath must be constructed to maintain a constant water depth.

6.5 *Oven*—An oven of sufficient size capable of maintaining a uniform temperature of 38 ± 3 °C [100 ± 5 °F] for Drying Method A or 110 ± 5 °C [230 ± 10 °F] for Drying Method B.

6.6 *Mallet*—A mallet (with a rubber or rawhide head) weighing approximately 0.6 ± 0.2 kg [1.25 ± 0.5 lb].

6.7 *Water-Cooled Diamond Saw*—Used to trim pervious concrete cores.

7. Test Specimens

7.1 A test specimen shall consist of a cylindrical specimen of hardened pervious concrete nominally 100 mm [4 in.] in diameter.

7.1.1 Where applicable, core specimens shall be full-depth. If this results in cores longer than 300 mm [12 in.], the cores shall be trimmed to approximately 300 mm [12 in.] in length.

7.2 A minimum of trimming shall be performed to produce a specimen with regular surface area and shape with ends generally perpendicular to the long axis.

7.2.1 Sampling of cores or trimming shall not be performed until the concrete is strong enough so the bond between mortar and the coarse aggregate is not disturbed.

7.2.2 Brush the specimen lightly with a wire brush to remove any loose particles. Avoid excessive pressure that would dislodge weakly-bonded particles.

8. Procedure

8.1 Determine the dimensions of the test specimen.

8.1.1 Determine the average length, L, of the specimen using the jaw caliper and the procedure in Test Method C1542/C1542M. Record the average length to the nearest 0.25 mm [0.01 in.].

8.1.2 Determine the average diameter, D, to the nearest 0.25 mm [0.01 in.] by averaging two diameters measured at right angles to each other about the midheight of the specimen using a jaw caliper.

8.2 Determine the constant dry mass of the specimen to the nearest 0.5 g [0.001 lb]. Dry the specimen using one of the two following methods:

8.2.1 *Drying Method A*—Dry the specimen in an oven at a temperature of 38 ± 3 °C [100 ± 5 °F] for 24 ± 1 h. Remove and determine the mass. Return the specimen to the oven for 24 ± 1 h and again determine the mass. Repeat this procedure in 24-h increments until the difference between any two subsequent mass determinations is less than 0.5 %. Record this dry mass as A.

8.2.2 *Drying Method B*—Dry the specimen in an oven at a temperature of 110 ± 5 °C [230 ± 10 °F] for 24 ± 1 h. Allow the specimen to cool in air at room temperature for 1 to 3 h, or until the specimen has cooled to a temperature that is comfortable to handle (approximately 50 °C), and determine the mass. Return the specimen to the oven for two hours, and again determine the mass after the cooling period. Repeat this procedure in two hour increments until the difference between any two subsequent mass determinations is less than 0.5 %. Record this dry mass as A.

8.3 Submerge the specimen completely in the water bath and allow it to sit upright for 30 ± 5 min. Keeping the specimen underwater, tap the side of the specimen 10 times with the rubber mallet, fully submerging the mallet below the water (see Note 2). Rotate the specimen slightly after each tap so that taps are equally spaced around the circumference of the specimen. Still keeping the specimen submerged, invert it and determine the submerged mass, B, to the nearest 0.5 g [0.001 lb].

NOTE 2—The purpose of tapping the specimen is to promote the release of trapped air bubbles inside the pervious concrete.[3] Avoid tapping near the edges to prevent breakage and loss of material from the specimen. If this occurs, ensure that all particles are included in the subsequent mass measurements.

8.4 Measure the temperature of the water in the water bath used in the determination of the submerged mass of the specimen.

9. Calculations

9.1 *Density:*

9.1.1 Calculate the Density of the specimen as follows:

$$\text{Density} = \frac{K \times A}{D^2 \times L} \quad (1)$$

where:

A = dry mass of the specimen, g [lb],
D = average diameter of the specimen, mm [in.],
L = average length of the specimen, mm [in.], and
K = 1 273 240 in SI units or 2 200 in [inch-pound] units.

NOTE 3—The factor K has units of $(mm^3kg)/(m^3g)$ $[in.^3/ft^3]$ and is needed to convert the recorded data (A, D, and L) to the density in kg/m^3 $[lb/ft^3]$.

9.2 *Void Content:*

9.2.1 Determine the density of water, ρ_w, at the temperature determined in 8.4 by interpolation of the values given in Test Method C29/C29M or other water density table.

9.2.2 Calculate the void content of the specimen as follows:

$$\text{Void Content} = \left[1 - \left(\frac{K \times (A - B)}{\rho_w \times D^2 \times L} \right) \right] \times 100 \quad (2)$$

where:

B = submerged mass of the specimen, g [lb], and
ρ_w = density of water at temperature of the water bath, kg/m^3 $[lb/ft^3]$.

[3] See Montes, F., Valavala, S., and L.M. Haselbach, "A New Test Method for Porosity Measurements of Portland Cement Pervious Concrete," *Journal of ASTM International*, January 2005, Vol. 2, No. 1.

10. Report

10.1 Report the following information:

10.1.1 Origin and nature of the test specimen.

10.1.2 Average diameter of the test specimen to the nearest 0.25 mm [0.01 in.].

10.1.3 Length of the test specimen to the nearest 0.25 mm [0.01 in.].

10.1.4 Method used for drying.

10.1.5 Density to the nearest 1 kg/m^3 [0.1 lb/ft^3].

10.1.6 Void Content to the nearest 0.1 %.

10.1.7 Age of specimen when tested.

10.1.8 Deviations from the test method.

11. Precision and Bias

11.1 Repeatability testing was performed on six core specimens from each of three trial placements.

11.1.1 *Density*—The single-operator coefficient of variation for density of pervious concrete using Drying Method A has been found to be 1.82 %. The single-operator coefficient of variation for density of pervious concrete using Drying Method B has been found to be 1.76 %.

NOTE 4—The density of the specimens ranged from 1650 kg/m^3 [103.0 lb/ft^3] to 1943 kg/m^3 [121.3 lb/ft^3].

11.1.2 *Void Content*—The single-operator coefficient of variation for void content of pervious concrete using Drying Method A has been found to be 5.82 %. The single-operator coefficient of variation for void content of pervious concrete using Drying Method B has been found to be 5.46 %.

NOTE 5—The void content of the specimens ranged from 22.6 % to 37.0 %.

11.2 The multi-laboratory coefficient of variation data has not been developed. This is being determined and will be available on or before July 2016.

11.3 This test method has no bias because the density and void content of hardened pervious concrete is defined only in terms of this method.

12. Keywords

12.1 density; hardened density; pervious concrete; void content