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

This standard is issued under the fixed designation C1688/C1688M; 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 covers determining the density of freshly mixed pervious concrete under standardized conditions and gives formulas for calculating the void content of pervious concrete. Test results are not intended to represent the in-place density and void content.

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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance 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.* (**Warning**—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.[2])

1.4 The text of this test method references notes and footnotes that provide explanatory information. These notes and footnotes (excluding those in tables) shall not be considered as requirements of this test method.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C29/C29M Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
C125 Terminology Relating to Concrete and Concrete Aggregates
C127 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
C128 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C150 Specification for Portland Cement
C172 Practice for Sampling Freshly Mixed Concrete
C188 Test Method for Density of Hydraulic Cement
C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
C595 Specification for Blended Hydraulic Cements
C989 Specification for Slag Cement for Use in Concrete and Mortars
C1157 Performance Specification for Hydraulic Cement
C1240 Specification for Silica Fume Used in Cementitious Mixtures
D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3(600 kN-m/m^3))

3. Terminology

3.1 *Definitions*:

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *concrete, pervious*, *n*—hydraulic cement concrete with distributed, interconnected macroscopic voids that allow water to

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[2] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

[3] 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.

pass through the material with little resistance.

3.3 *Symbols*:

D	=	density (unit weight) of concrete kg/m^3 [lb/ft^3]
M_s	=	total mass of all materials batched, kg [lb] (see Note 1)
M_c	=	mass of the measure filled with concrete, kg [lb]
M_m	=	mass of the measure, kg [lb]
T	=	theoretical density of the concrete computed on an airfree basis, kg/m^3 [lb/ft^3] (see Note 1)
U	=	percentage of voids in the fresh pervious concrete, including entrained and entrapped air voids in the cement paste.
V_s	=	sum of the absolute volumes of the component ingredients in the batch, m^3 [ft^3]
V_m	=	volume of the measure, m^3 [ft^3]

NOTE 1—The theoretical density is a laboratory determination, and is assumed to remain constant for all batches made using identical component ingredients and proportions. It is calculated from the following equation:

$$T = \frac{M_s}{V_s}$$

The total mass of all materials batched is the sum of the masses of the cement, the fine aggregate in the saturated-surface-dry condition, the coarse aggregate in the saturated-surface-dry condition, the water in the batch (includes free water from the aggregate), and any other solid or liquid materials used.

The absolute volume of each ingredient is equal to the quotient of the mass of that ingredient divided by the product of its relative density (specific gravity) times the density of water (See Test Method C29/C29M). For the aggregate components, the relative density (specific gravity) should be based on the saturated-surface-dry condition (as determined by Test Method C127 for coarse aggregate and Test Method C128 for fine aggregate). For cements meeting Specification C150, Specification C595, and Specification C1157, the relative density should be determined by Test Method C188, and is typically available from the cement manufacturer. A value of 3.15 may be used for Portland cements manufactured to meet the requirements of Specification C150. The relative density of supplementary cementitious materials should be determined as follows: for fly ash, use Test Methods C311; for silica fume, use Specification C1240; and for slag cement, use Specification C989.

4. Summary of Test Method

4.1 A sample of fresh pervious concrete is placed and consolidated in a standard measure. The concrete is consolidated using a standard Proctor hammer. The density and void content of the pervious concrete are calculated based on the measured mass of the consolidated concrete specimen, the volume of the measure, and the total mass of materials batched.

5. Significance and Use

5.1 This test method provides a procedure for determining the density and void content of freshly mixed pervious concrete.

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

5.3 The measured fresh density may be used as verification of mixture proportions.

5.4 This method uses a standard consolidation procedure to measure fresh density and void content of a pervious concrete mixture as delivered. Test results are not intended to represent the density and void content of the in-place pervious concrete. This method shall not be used to determine the in-place void content or yield of the pervious concrete.

6. Apparatus

6.1 *Balance*—A balance or scale accurate to 50 g [0.1 lb] or to within 0.3 % of the test load, whichever is greater, at any point within the range of use. The range of use shall be considered to extend from the mass of the empty measure to the mass of the measure filled with concrete having an assumed density of 2600 kg/m^3 [160 lb/ft^3].

6.2 *Standard Proctor Hammer*—A device used to compact a pervious concrete specimen that conforms to Test Method D698.

6.3 *Measure*—A cylindrical container made of steel or other suitable metal ~~(See Note 2)~~ with a capacity of 7.0 ± 0.6 L [0.25 ± 0.02 ft^3~~] and a diameter equal to 0.75 to 1.25 times the height. The measuring bowl of a Type B air meter conforming to Test Method C231 meets the requirements for the measure. The volume of the measure shall be determined as described in Test Method~~] and a diameter equal to 0.75 to 1.25 times the height (See Note 2). The volume of the measure shall be determined as described in Test Method C29/C29M. The top rim of the container shall be plane within 0.3 mm [0.01 in.] (See Note 3).

NOTE ~~2—The metal should not be attacked readily by cement paste. However, a reactive material such as aluminum alloy may be used if, as a result of an initial reaction, a surface film is formed that protects the metal against further corrosion.~~ 2—The metal should not be attacked readily by cement paste. However, a reactive material such as aluminum alloy may be used if, as a result of an initial reaction, a surface film is formed that protects the metal against further corrosion. The measuring bowl of an air meter conforming to Test Method C231 can meet the requirements for the measure.

NOTE 3—The top rim is satisfactorily plane if a 0.3 mm [0.01-in.] wire feeler gauge cannot be inserted between the rim and a piece of 6 mm [¼-in.] or thicker plate glass laid over the top of the measure.

6.4 *Strike-Off Plate*—A flat rectangular metal plate at least 6 mm [¼ in.] thick or a glass or acrylic plate at least 12 mm [½ in.] thick with length and width that are at least 50 mm [2 in.] greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight within a tolerance of 2 mm [1⁄16 in.].