Designation: C567/C567M – 14

Standard Test Method for Determining Density of Structural Lightweight Concrete[1]

This standard is issued under the fixed designation C567/C567M; 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 U.S. Department of Defense.

1. Scope*

1.1 This test method provides procedures to determine the oven-dry and equilibrium densities of structural lightweight concrete.

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. Some values have only SI units because the inch-pound equivalents are not used in practice.

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]

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C125 Terminology Relating to Concrete and Concrete Aggregates

C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

C172 Practice for Sampling Freshly Mixed Concrete

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

3. Terminology

3.1 Terminology used in this test method is defined in Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *equilibrium density, n*—the density as determined in 8.2 reached by structural lightweight concrete after exposure to relative humidity of 50 ± 5 % and a temperature of 23 ± 2 °C [73.5 ± 3.5 °F] for a period of time sufficient to reach constant mass.

3.2.2 *oven-dry density*—the density as determined in 8.3 reached by structural lightweight concrete after being placed in a drying oven at 110 ± 5 °C [230 ± 9 °F] for a period of time sufficient to reach constant mass.

4. Summary of Test Method

4.1 This test method provides procedures for determining the oven-dry and equilibrium densities of structural lightweight concrete, by calculation or measurement. The calculated oven-dry density is determined from batch quantities and volume of a given batch of concrete. The calculated equilibrium density is approximated by adding a fixed quantity to the oven-dry density. Measured densities are obtained from determinations of the mass of cylindrical specimens after specified treatments.

5. Significance and Use

5.1 The measured or calculated equilibrium density of structural lightweight concrete determines whether specified density requirements have been met. Unless otherwise specified, determine equilibrium density by calculation using the procedures in 9.2.

5.2 Test Method C138/C138M shall be used to determine the density of freshly mixed lightweight concrete for compliance with concrete placement specifications.

NOTE 1—The fresh density of lightweight aggregate concrete is a function of mixture proportions, air content, water demand, and the specific density and moisture content of the lightweight aggregate. Decrease in density of a specific lightweight concrete is due to moisture

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregatesand is the direct responsibility of Subcommittee C09.21 on Lightweight Aggregates and Concrete.

Current edition approved April 1, 2014. Published May 2014. Originally approved in 1965. Last previous edition approved in 2011 as C567–11. DOI: 10.1520/C0567_C0567M-14.

[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.

***A Summary of Changes section appears at the end of this standard**

loss that, in turn, is a function of aggregate moisture content, ambient conditions, and the ratio of the surface area to the volume of the concrete member. For most structural lightweight concretes, equilibrium density is approached at about 90 days. For most high-strength lightweight concretes, equilibrium density is approached at about 180 days. Extensive tests demonstrate that despite variations in the initial moisture content of lightweight aggregate, the equilibrium density will be approximately 50 kg/m^3 [3.0 lb/ft^3] greater than the oven-dry density.

6. Apparatus

6.1 *Tamping Rod, Mallet, Measure, Balance, and Molds*—These shall conform to the requirements of Test Method C138/C138M and Specification C470/C470M.

6.1.1 *Measure*—A 14-L [0.5-ft^3] measure shall be the standard (see Note 3).

6.2 *Controlled Humidity Enclosure*—A room controlled at 50 ± 5 % relative humidity and 23 ± 2 °C [73.5 ± 3 °F] or a small chamber meeting the requirements of Practice E104.

6.3 *Drying Oven*—An oven of appropriate size capable of maintaining a uniform temperature of 110± 5 °C [230 ± 9 °F], and an average evaporation rate of at least 25 g/h. Determine evaporation rate in accordance with Test Method C88.

7. Sampling, and Making, and Curing Test Specimens

7.1 *Sampling*—Sample field-mixed concrete in accordance with Practice C172.

7.2 *Specimens for Determining Equilibrium Density and Oven-dry Density*—Determine the equilibrium density and oven-dry density on 150 by 300-mm [6 by 12-in.] concrete cylinders.

7.2.1 Make test cylinders in accordance with Practice C192/C192M or C31/C31M, whichever is applicable. Make three cylinders for equilibrium density measurements, and make three cylinders for oven-dry density measurements.

7.3 *Curing Specimens:*

7.3.1 Unless otherwise specified, test cylinders used for the determination of equilibrium density shall be cured in accordance with Practice C192/C192M or the standard curing procedure in Practice C31/C31M.

NOTE 2—Cylinders may be stripped after 24 h and wrapped securely with a plastic sheet or bag to prevent loss of moisture, or may remain in covered molds until the time of test.

7.3.2 Unless otherwise specified, for the first 24 h or until the time of test, store the test cylinders used for the determination of oven-dry density under conditions that maintain a temperature adjacent to the cylinders in the range from 16 to 27 °C [60 to 80 °F] and that prevent loss of moisture from the cylinders.

8. Procedure

8.1 *Measurement of Freshly Mixed Concrete Density*—Determine the density of the freshly mixed concrete in accordance with Test Method C138/C138M.

NOTE 3—Numerous observations indicate that the same compactive effort used on smaller concrete specimens will cause the fresh densities to be higher. The fresh density as determined from measurements on 150 by 300-mm [6 by 12-in.] cylinders of lightweight concrete consolidated by rodding, in accordance with Practice C192/C192M or Practice C31/C31M will average 40 kg/m^3 [2.5 lb/ft^3] higher than the fresh density as measured using a 14-L [0.5-ft^3] measure in accordance with Test Method C138/C138M.

8.2 *Measurement of Equilibrium Density*—To measure the equilibrium density, remove the cylinders from their curing condition on the seventh day after molding and immerse in water at 23 ± 2 °C [73.5 ± 3.5 °F] for 24 h. Measure the apparent mass of the cylinders while suspended and completely submerged in water and record as "C," the mass of the suspended-immersed cylinder. Remove from the water and allow to drain for 1 min by placing the cylinder on a 9.5-mm [⅜-in.] or coarser sieve cloth. Remove visible water with a damp cloth, determine the mass and record as "B," the mass of the saturated-surface-dry cylinder. Dry the cylinders with all surfaces exposed, in a controlled humidity enclosure as described in 6.2 until the mass of the specimen changes not more than 0.5 % (gain or loss) in successive determinations of mass 28 days apart. Determine the mass of the dried cylinders and record as "A," the mass of the dried cylinder. Calculate the equilibrium density of the concrete from Eq 1 and 2.

$$E_m(Density,\ kg/m^3) = (A \times 997)/(B - C) \quad (1)$$

$$E_m\,(Density,\ [lb/ft^3]) = (A \times 62.3)/(B - C)) \quad (2)$$

where:

E_m = measured equilibrium density, kg/m^3 [lb/ft^3],
A = mass of cylinder as dried, kg [lb],
B = mass of saturated surface-dry cylinder, kg [lb], and
C = apparent mass of suspended-immersed cylinder, kg [lb].

8.3 *Measurement of Oven-Dry Density*—After 24 h but not to exceed 32 h, remove the cylinders from the mold (see Note 4). Measure the apparent mass of the cylinders while suspended and completely submerged in water and record as "G" the mass of the suspended-immersed cylinders. Remove from the water and allow to drain for 1 min by placing the cylinders on a 9.5-mm [⅜-in.] or coarser sieve cloth. Remove visible water with a damp cloth, determine the mass and record as "F," the mass of the saturated surface-dry cylinders. Place the cylinders in the drying oven at 110 ± 5 °C [230 ± 9 °F] for 72 h. Allow cylinders to cool for at least thirty minutes but not more than 1 hour and determine the mass. Repeat oven-drying, cooling, and determination of mass at 24-h intervals until the change in mass is not more than 0.5 %. Record this mass as "D", the mass of the oven-dried cylinder. Determine the oven-dry density from Eq 3 and 4.

$$O_m(Density,\ kg/m^3) = (D \times 997)/(F - G) \quad (3)$$

$$O_m(Density,\ [lb/ft^3]) = (D \times 62.3)/(F - G)) \quad (4)$$

where:

O_m = measured oven-dry density, kg/m^3 [lb/ft^3],
D = mass of oven-dry cylinder, kg [lb],
F = mass of saturated surface-dry cylinder, kg [lb], and
G = apparent mass of suspended-immersed cylinder, kg [lb].

NOTE 4—Determination of oven-dry density may be specified to begin