



Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete¹

This standard is issued under the fixed designation C 138/C 138M; 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 test method covers determination of the density (see Note 1) of freshly mixed concrete and gives formulas for calculating the yield, cement content, and air content of the concrete. Yield is defined as the volume of concrete produced from a mixture of known quantities of the component materials.

1.2 The values stated in either inch-pound or SI units shall be regarded separately as standard. The SI units are shown in brackets. The values stated might not be exact equivalents; therefore each system must be used independently of the other.

NOTE 1—Unit weight was the previous terminology used to describe the property determined by this test method, which is mass per unit volume.

1.3 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:

- C 29/C 29M Test Method for Bulk Density (Unit Weight) and Voids in Aggregate²
- C 150 Specification for Portland Cement³
- C 172 Practice for Sampling Freshly Mixed Concrete²
- C 188 Test Method for Density of Hydraulic Cement³
- C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method²
- C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials²

3. Terminology

3.1 Symbols:

A	= air content (percentage of voids) in the concrete
C	= actual cement content, lb/yd ³ or kg/m ³
C_b	= mass of cement in the batch, lb or kg
D	= density (unit weight) of concrete, lb/ft ³ or kg/m ³
M	= total mass of all materials batched, lb or kg (see Note 3)
M_c	= mass of the measure filled with concrete, lb or kg
M_m	= mass of the measure, lb or kg
R_y	= relative yield
T	= theoretical density of the concrete computed on an airfree basis, lb/ft ³ or kg/m ³ (see Note 2)
Y	= yield, volume of concrete produced per batch, yd ³ or m ³
Y_d	= volume of concrete which the batch was designed to produce, yd ³ or m ³
Y_f	= volume of concrete produced per batch, ft ³
V	= total absolute volume of the component ingredients in the batch, ft ³ or m ³
V_m	= volume of the measure, ft ³ or m ³

NOTE 2—The theoretical density is, customarily, a laboratory determination, the value for which is assumed to remain constant for all batches made using identical component ingredients and proportions. It is calculated from the following equation:

$$T = M/V \quad (1)$$

The absolute volume of each ingredient in cubic feet is equal to the quotient of the mass of that ingredient divided by the product of its specific gravity times 62.4. The absolute volume of each ingredient in cubic metres is equal to the mass of the ingredient in kilograms divided by 1000 times its specific gravity. For the aggregate components, the bulk specific gravity and mass should be based on the saturated, surface-dry condition. For cement, the actual specific gravity should be determined by Test Method C 188. A value of 3.15 may be used for cements manufactured to meet the requirements of Specification C 150.

NOTE 3—The total mass of all materials batched is the sum of the masses of the cement, the fine aggregate in the condition used, the coarse aggregate in the condition used, the mixing water added to the batch, and any other solid or liquid materials used.

4. Apparatus

4.1 **Balance**—A balance or scale accurate to 0.1 lb [45 g] 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

¹ This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.60 on Fresh Concrete Testing.

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² Annual Book of ASTM Standards, Vol 04.02.

³ Annual Book of ASTM Standards, Vol 04.01.