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

AASHTO Designation: T 121M/T 121-23

Technically Revised: 2023

Technical Subcommittee: 3b, Fresh Concrete

ASTM Designation: C138/C138M-17a



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This method covers determination of the density (see Note 1) of freshly mixed concrete and gives formulas for calculating the yield, cement content, and the 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. Nonplastic concrete, such as is commonly used in the manufacture of pipe and unit masonry, is not covered by this test method.
- 1.3. The values stated in either SI or inch-pound units shall be regarded separately as standard. The inch-pound 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.
- 1.4. 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.
- 1.5. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns 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.
- 1.6. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- M 85, Portland Cement
- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- R 60M/R 60, Sampling Freshly Mixed Concrete
- R 61, Establishing Requirements for Equipment Calibrations, Standardizations, and Checks
- R 100M/R 100, Making and Curing Concrete Test Specimens in the Field
- T 19M/T 19, Bulk Density (“Unit Weight”) and Voids in Aggregate
- T 119M/T 119, Slump of Hydraulic Cement Concrete
- T 133, Density of Hydraulic Cement
- T 152, Air Content of Freshly Mixed Concrete by the Pressure Method
- T 196M/T 196, Air Content of Freshly Mixed Concrete by the Volumetric Method

3. TERMINOLOGY

3.1. *Definitions:*

3.1.1. *Symbols:*

- A = air content (percentage of voids) in the concrete;
- C = actual cement content, kg/m³ [lb/yd³];
- C_b = mass of cement in the batch, kg [lb];
- M = total mass of all materials batched, kg [lb] (see Section 3.14);
- M_c = mass of the measure filled with concrete, kg [lb];
- M_m = mass of the measure, kg [lb];
- R_y = relative yield;
- T = theoretical density of the concrete computed on an airfree basis, kg/m³ [lb/ft³] (see Section 3.1.2);
- V = total absolute volume of the component ingredients in the batch, m³ [ft³] (see Note 2);
- V_m = volume of the measure, m³ [ft³];
- Y = yield, volume of concrete produced per batch, m³ or [yd³];
- Y_d = yield, volume of concrete that the batch was designed to produce, m³ [yd³];
- Y_f = yield, volume of concrete produced per batch, ft³; and
- ρ = density (unit weight) of concrete, kg/m³ [lb/ft³].

Note 2—The theoretical density is, customarily, a laboratory determination. The value for the theoretical density is assumed to remain constant for all batches made using identical component ingredients and proportions.

3.1.2. *absolute volume (V)*—The absolute volume of each ingredient in cubic feet is equal to the quotient of the mass of the ingredient divided by the product of its specific gravity times 62.4. The absolute volume of each ingredient in cubic meters is equal to the mass of the ingredient in kilograms divided by 1000 times its specific gravity.

3.1.3. *bulk specific gravity and mass*—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 T 133. A value of 3.15 may be used for cements manufactured to meet the requirements of M 85. The specific gravity used for other cements and supplementary