



Designation: ~~D6023~~—~~07~~ D6023 – 15

Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM)¹

This standard is issued under the fixed designation D6023; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This test method explains determination of the density (**Note 1**) of freshly mixed Controlled Low-Strength Material (CLSM) and gives formulas for calculating the yield, cement content, and the air content of the CLSM. This test method is based on Test Method **C138/C138M** for Concrete.

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

1.2 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice **D6026**.

1.2.1 ~~The method procedures used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.~~ collected/recorded and calculated in the standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering data.

1.3 ~~The values stated in SI units are to be regarded as standard. The inch-pound equivalents are shown for information only; values given in parentheses are mathematical conversions to inch-pound units, which are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this test method.~~

1.3.1 ~~The converted inch-pound units use the gravitational system of units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs. The converted slug is not given, unless dynamic ($F=ma$) calculations are involved.~~

1.3.2 ~~It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This implicitly combines two separate system of units; that is, the absolute system and the gravitational system. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit for mass. However, the use of balances or scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.~~

1.4 CLSM is also known as flowable fill, controlled density fill, soil-cement slurry, soil-cement grout, unshrinkable fill, “K-Krete,” and other similar names.

1.5 ~~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 **Warning: Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.**)~~

¹ This test method is under the jurisdiction of ASTM Committee **D18** on Soil and Rock and is the direct responsibility of Subcommittee **D18.15** on Stabilization With Admixtures.

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

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

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

~~C128~~ Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

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

~~C150/C150M~~ Specification for Portland Cement

~~E23/E23.1/C231M~~ Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

~~D653~~ Terminology Relating to Soil, Rock, and Contained Fluids

~~D3740~~ Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

~~D4832~~ Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

~~D597/D597.1/D597.1M~~ Practice for Sampling Freshly Mixed Controlled Low-Strength Material

~~D6024/D6024M~~ Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application

~~D6026~~ Practice for Using Significant Digits in Geotechnical Data

~~D6103~~ Test Method for Flow Consistency of Controlled Low Strength Material (CLSM) (Withdrawn 2013)⁴

3. Terminology

3.1 Definitions:

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology standards ~~C125~~ and ~~D653~~.

3.1.2 ~~Controlled Low Strength Material (CLSM), *n*—a mixture of soil or aggregates, cementitious material, fly ash, soil, aggregates (sand, gravel, or both), cementitious materials, potable water, and sometimes chemical admixtures, that hardens into a material with a higher strength than the soil, but less than 8400 kPa (1200 psi).~~

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.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

3.1.2.1 Discussion—

Used as a replacement for compacted backfill, CLSM can be placed as a slurry, a mortar, or a compacted material and typically has strengths of 350 to 700 kPa (50 to 100 psi) for most applications.

3.1.3 ~~mass, *n*—the quantity of matter in a body. (See *weight*.)~~

3.1.3.1 Discussion—

Units of mass are the kilogram (kg), the pound (lb) or units derived from these. Masses are compared by weighing the bodies, which amounts to comparing the forces of gravitation acting on them.

3.1.4 ~~weight, *n*—the force exerted on a body by gravity. (see *mass*.)~~

3.1.4.1 Discussion—

Weight is equal to the mass of the body multiplied by the acceleration due to gravity. Weight may be expressed in absolute units (Newton, poundals) or in gravitational units (kgf, lbf). Since weight is equal to mass times the acceleration due to gravity, the weight of a body will vary with the location where the weight is determined, while the mass of the body remains constant. On the surface of the earth, the force of gravity imparts to a body that is free to fall an acceleration of approximately 9.81 m/s² (32.2 ft/s²).

3.1.3 ~~yield—~~the volume of CLSM produced from a mixture of known quantities of the component materials.

4. Summary of Test Method

4.1 The density of the CLSM is determined by filling a measure with CLSM, determining the mass, and calculating the volume of the measure. The density is then calculated by dividing the mass by the volume. The yield, cement content, and the air content of the CLSM is calculated based on the masses and volumes of the batch components.

5. Significance and Use

5.1 This test method provides the user with a procedure to calculate the density of freshly mixed CLSM for determination of compliance with specifications, for determining mass/volume relationships or conversions such as those found in purchase agreements, and also for quality control purposes.

5.2 This test method is intended to assist the user for quality control purposes and when specified to determine compliance for air content, yield, and cement content of freshly mixed CLSM.

5.3 This test method is not meant to predict the air content of hardened CLSM, which may be either higher or lower than that determined by this test method.

5.4 This test is one of a series of quality control tests that can be performed on CLSM during construction to monitor compliance with specification requirements. The other tests that can be used during construction control are Test Methods [D4832](#), [D6024](#)/[D6024M](#), and [D6103](#).

NOTE 2—The quality of the results produced by this standard is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice [D3740](#) are generally considered capable of competent and objective testing/sampling/inspection/ and the like. Users of this standard are cautioned that compliance with Practice [D3740](#) does not in itself assure reliable results. Reliable results depend on many factors; Practice [D3740](#) provides a means of evaluation some of those factors.

6. Apparatus

6.1 *Balance*—A balance or scale accurate to within 0.3 % of the test load at any point within the range of use. The range of use shall be considered to extend from the mass of the measure empty to the mass of the measure plus the CLSM.

6.2 *Filling Apparatus*—Scoop, bucket or pail of sufficient capacity to facilitate filling the measure in a rapid, efficient manner.

6.3 *Sampling and Mixing Receptacle*—The receptacle shall be a suitable container, wheelbarrow, and the like of sufficient capacity to allow easy sampling and remixing of the CLSM.

6.4 *Measure*—A cylindrical container made of steel or other suitable metal (Note 3). It shall be watertight and sufficiently rigid to retain its form and calibrated volume under rough usage. Measures that are machined to accurate dimensions on the inside and provided with handles are preferred. All measures, except for measuring bowls of air meters shall conform to the requirements of Test Method [C29/C29M](#). The minimum capacity of the measure shall conform to the requirements of [Table 1](#). When measuring bowls of air meters are used, they shall conform to the requirements of Test Method [C231/C231M](#). The top rim of the air meter bowls shall be smooth and plane within 0.3 mm (0.01 in.) (Note 4).

NOTE 3—The metal should not be readily subject to attack by cement paste. However, reactive materials such as aluminum alloys may be used in instances where, as a consequence of an initial reaction, a surface film is rapidly formed, which protects the metal against further corrosion.

NOTE 4—The top rim is satisfactorily plane if a 0.3-mm (0.01-in.) feeler gage 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.

6.5 *Strike-Off Plate*—A flat rectangular metal plate at least 6 mm (strike-off plate conforming ¼ in.) thick or a glass or acrylic plate at least 12 mm (½ in.) thick with a length and width 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 and smooth within a tolerance of 2 mm to the requirements of Test Method [C138/C138M](#) (¼ in.).

6.6 *Calibration Equipment*—A piece of plate glass, preferably at least 6 mm (¼ in.) thick and at least 25 mm (1 in.) larger than the diameter of the measure to be calibrated. A thin film of vacuum, water pump or chassis grease smeared on the flange of the bowl will make a watertight joint between the glass plate and the top of the bowl.

7. Sample

7.1 Obtain the sample for freshly mixed CLSM in accordance with Practice [D5971/D5971M](#).

7.2 The size of the sample shall be approximately 125 to 200 % of the quantity required to fill the measure.

TABLE 1 Minimum Capacity of Measure

Nominal Maximum Size of Coarse Aggregate ^A		Capacity of Measure, min ^B	
in.	mm	ft ³	L
1	25.0	0.2	6
1½	37.5	0.4	11
2	50	0.5	14

^AAggregate of a given nominal maximum size may contain up to 10 % of particles retained on the sieve referred to.

^BTo provide for wear, measures may be up to 5 % smaller than indicated in this table.