



Designation: D5030/D5030M – 21

Standard Test Methods for Density of In-Place Soil and Rock Materials by the Water Replacement Method in a Test Pit¹

This standard is issued under the fixed designation D5030/D5030M; 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 These test methods cover the determination of the in-place density of soil and rock materials using water to fill a lined test pit to determine the volume of the test pit. The use of the word “rock” in these test methods is used to imply that the material being tested will typically only contain particles larger than 3 in. [75 mm].

1.2 These test methods are best suited for test pits with a volume between approximately 3 and 100 ft³ [0.08 and 3 m³]. In general, the materials tested would have maximum particle sizes over 5 in. [125 mm]. These test methods may be used for larger sized excavations if desirable.

1.2.1 This procedure is usually performed using circular metal templates with inside diameters of 3 ft [0.9 m] or more. Other shapes or materials may be used providing they meet the requirements of these test methods and the guidelines given in **Annex A1** for the minimum volume of the test pit.

1.2.2 Test Method **D4914** may be used as an alternative method. Its use, however, is usually only practical for volume determination of test pits between approximately 1 and 6 ft³ [0.03 and 0.2 m³].

1.2.3 Test Method **D1556** or Test Method **D2167** is usually used to determine the volume of test holes smaller than 1 ft³ [0.03 m³].

1.3 The two procedures are described as follows:

1.3.1 *Procedure A*—In-Place Density and Density of Total Material (Section **12**).

1.3.2 *Procedure B*—In-Place Density and Density of Control Fraction (Section **13**).

1.4 *Selection of Procedure:*

1.4.1 Procedure A is used when the in-place density of the total material is to be determined. Procedure A can also be used to determine percent compaction or percent relative density when the maximum particle size present in the in-place material being tested does not exceed the maximum particle

size allowed in the laboratory compaction test (Test Methods **D698**, **D1557**, **D4253**, **D4254**, and **D7382**). For Test Methods **D698** and **D1557** only, the density determined in the laboratory compaction test may be corrected for larger particle sizes in accordance with, and subject to the limitations of, Practice **D4718**.

1.4.2 Procedure B is used when percent compaction or percent relative density is to be determined and the in-place material contains particles larger than the maximum particle size allowed in the laboratory compaction test methods previously described or when Practice **D4718** is not applicable for the laboratory compaction test method. Then, the material is considered to consist of two fractions, or portions. The material obtained from the in-place density test is physically divided into a control fraction and an oversize fraction based on a designated sieve size. The density of the control fraction is calculated and compared with the density(ies) established by the laboratory compaction test method(s).

1.4.3 Often, the control fraction is the minus No. 4 [4.75-mm] sieve size material for cohesive or nonfree-draining materials and the minus 3-in. [75-mm] sieve size material for cohesionless, free-draining materials. While other sizes may be used for the control fraction such as $\frac{3}{8}$, $\frac{3}{4}$ -in. [9.5, 19-mm], these test methods have been prepared using only the No. 4 [4.75-mm] and the 3-in. [75-mm] sieve sizes for clarity.

1.5 Any soil and rock material can be tested, provided that the material being tested has sufficient cohesion or particle attraction to maintain stable side walls during excavation of the test pit and through completion of this test. It should also be firm enough not to deform or slough due to the minor pressures exerted while digging the hole and filling it with water.

1.6 These test methods are generally limited to material in an unsaturated or partially saturated condition above the ground water table and is not recommended for materials that are soft or friable (crumble easily) or in a moisture condition such that water seeps into the excavated hole. The accuracy of the test may be affected for materials that deform easily or that may undergo volume change in the excavated hole from standing or walking near the hole while performing the test.

1.7 *Units*—The values stated in either inch-pound units or SI units [presented in brackets] are to be regarded separately as standard. The values stated in each system may not be exact

¹ These test methods are under the jurisdiction of ASTM Committee **D18** on Soil and Rock and is the direct responsibility of Subcommittee **D18.08** on Special and Construction Control Tests.

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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.

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

1.7.2 In the engineering profession, it is customary practice to use, interchangeably, units representing both mass and force, unless dynamic calculations ($F = ma$) are involved. This implicitly combines two separate systems of units, that is, the absolute system and the gravimetric system. It is scientifically undesirable to combine the use of two separate systems within a single standard. These test methods have been written using inch-pound units (absolute system) where the pound (lbm) represents a unit of mass; however, conversions are given in the SI system. The use of balances or scales recording pounds of weight (lbf), or the recording of density in lbf/ft^3 should not be regarded as nonconformance with this standard.

1.8 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice **D6026**, unless superseded by this test method.

1.8.1 The procedures used to specify how data are collected, recorded or calculated in this 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; 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 this standard to consider significant digits used in analysis methods for engineering data.

1.9 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For a specific hazard statement, see Section 9.

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- C127** Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
- C138/C138M** Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

- C566** Test Method for Total Evaporable Moisture Content of Aggregate by Drying
- D653** Terminology Relating to Soil, Rock, and Contained Fluids
- D698** Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D1556** Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
- D1557** Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
- D2167** Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- D2216** Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D3740** Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4253** Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- D4254** Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- D4718** Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
- D4753** Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
- D4914** Test Methods for Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit
- D6026** Practice for Using Significant Digits in Geotechnical Data
- D7382** Test Methods for Determination of Maximum Dry Unit Weight of Granular Soils Using a Vibrating Hammer
- E11** Specification for Woven Wire Test Sieve Cloth and Test Sieves
- F2362** Specification for Temperature Monitoring Equipment

3. Terminology

3.1 For definitions of common technical terms used in this standard, refer to Terminology **D653**.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *control fraction, n*—the portion of a soil sample consisting of particles smaller than a designated sieve size.

3.2.1.1 *Discussion*—This fraction is used to compare in-place densities with densities obtained from standard laboratory compaction test methods. The control sieve size depends on the laboratory test used.

3.2.2 *oversize particles, n*—the portion of a soil sample consisting of the particles larger than a designated sieve size.

3.2.2.1 *Discussion*—This designated sieve size is often the same sieve size used to determine the control fraction.

4. Summary of Test Method

4.1 The ground surface at the test location is prepared and a template (metal ring) is placed and fixed into position. A liner is laid in the template and the volume of the space between a selected level within the template and the ground surface is

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.