Designation: D854 – 23

Standard Test Methods for Specific Gravity of Soil Solids by the Water Displacement Method[1]

This standard is issued under the fixed designation D854; 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 These test methods cover the determination of the specific gravity of soil solids that pass the ⅜-in. (9.5-mm) or smaller sieve by means of the water displacement method. When the total sample contains larger particles, it is separated into a coarser and finer portion using a ⅜-in. (9.5-mm) or No. 4 (4.75-mm) or finer sieve. Separation on the No. 4 sieve is the referee method. Test Method C127 shall be used to obtain the specific gravity of the coarser portion. The D854 test methods shall be used to obtain the specific gravity of the finer portion. The total sample specific gravity is computed from the two portions as described in 12.5.

1.1.1 These test methods do not apply to solids which can be altered by these methods, contaminated with a substance that prohibits the use of these methods, or are highly organic, such as fibrous matter which floats in water (see Note 1).

NOTE 1—Test Method D5550 may be used to determine the specific gravity of soil solids having solids, which readily dissolve in water or float in water, or where it is impracticable to use water.

1.2 This standard provides two methods for performing the specific gravity test. The method to be used shall be specified by the requesting authority, except when testing the types of soils listed in 1.2.1.

1.2.1 *Method A—Procedure for Moist Specimens,* described in 11.1. This procedure is the preferred method. Method A shall be used for organic soils; highly plastic, fine-grained soils; tropical soils; and soils containing halloysite.

1.2.2 *Method B—Procedure for Oven-Dry Specimens,* described in 11.2. This procedure requires less time and may be used for clean sands.

1.3 *Units*—The values stated in SI units are to be regarded as standard, except the sieve designations. The sieve designations are identified using the "alternative" system in accordance with Practice E11, such as 3-in. and No. 200, instead of the "standard" designation of 75-mm and 75-μm, respectively. Reporting of test results in units other than SI shall not be regarded as non-conformance with this test method. The use of balances or scales recording pounds of mass (lbm) shall not be regarded as nonconformance with this standard.

1.4 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.

1.4.1 The procedures used to specify how data are collected/recorded and 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; 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 design.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Glassware under vacuum has the potential for implosion. Proper personal protective equipment shall be used at all times. See Section 8.*

1.6 *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]

[1] This standard is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity and Density Characteristics of Soils.

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[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**

C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D5550 Test Method for Specific Gravity of Soil Solids by Gas Pycnometer
D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data
D7928 Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E1406 Specification for Laboratory Glass Filter Flasks

3. Terminology

3.1 *Definitions:*

3.1.1 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 *specific gravity of soil solids, G_s, n*—the ratio of the mass of a unit volume of a soil solids to the mass of the same volume of gas-free pure water at 20 °C.

3.2.2 *equilibrated test water, n*—test water that is in air equilibrium at room temperature and pressure.

3.2.2.1 *Discussion*—Exposing test water to the atmosphere for several hours allows dissolved air to escape and prevents formation of air bubbles during the test.

3.2.3 *reduced sample, n*—the minus ⅜-in. (9.5-mm) sieve, No. 4 (4.75-mm) sieve, or finer material that has been separated from the sample and then split to reduce the mass while still having sufficient quantity to meet the minimum dry mass requirements of Table 1.

4. Summary of Test Method

4.1 A representative reduced sample is prepared in either a moist (Method A) or dry (Method B) state. For moist preparation, a subspecimen of the reduced sample is dispersed and blended into a slurry using one of four options. The dry mass of the test specimen is determined at the end of the test. For dry preparation, the material is oven dried prior to testing and the specimen mass is measured once the material is placed in the pycnometer. Test water is added to immerse the specimen. One of three techniques are used to deair the specimen: boiling, vacuuming, or a combination of both. Equilibrated test water is added to fill the pycnometer. The pycnometer, thermometric device, and additional test water are placed into an insulating container to achieve thermal equilibrium. The mass and temperature are recorded after adjusting the water volume. The calibrated mass of the pycnometer with water, mass of the dry specimen, and mass of the specimen and pycnometer filled with water are used for calculation of specific gravity. The final specific gravity is reported relative to water density at 20°C.

5. Significance and Use

5.1 The specific gravity of soil solids is used in calculating the phase relationships of soils, such as void ratio and degree of saturation.

5.1.1 The specific gravity of soil solids is used to calculate the density of the soil solids. This is done by multiplying the specific gravity by the density of water at 20°C. The soil solids density is nearly independent of temperature.

5.2 The term soil solids is typically assumed to mean naturally occurring mineral particles or soil like particles that are not readily soluble in water. Therefore, the specific gravity of soil solids containing extraneous matter, such as cement, lime, and the like, water-soluble matter, such as sodium chloride, and soils containing matter with a specific gravity less than one, typically require special treatment (see Note 2) or a qualified definition of their specific gravity.

NOTE 2—For some soils containing a significant fraction of organic matter, kerosene is a better wetting agent than water and may be used in place of test water for oven-dried specimens. Kerosene is a flammable liquid that must be used with extreme caution. This standard should not be used when using kerosene as the test fluid.

5.3 The balances, pycnometer sizes, and specimen masses are specified to obtain test results reportable to four significant digits.

NOTE 3—The quality of the result produced by these test methods 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/etc. Users of these test methods 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 evaluating some of those factors.

6. Apparatus

6.1 *Pycnometer*—The pycnometer (see Note 4) shall be either a stoppered flask, stoppered iodine flask, or volumetric flask with a minimum capacity of 250 mL (see Note 5). The stopper and flask shall remain a matched pair and labeled accordingly. The volume of the pycnometer shall be 2 to 3 times greater than the volume of the soil-water mixture used during the deairing portion of the test.

NOTE 4—Heavy duty pycnometers are commonly used to perform this test using the vacuum method. However, there are no products on the market that are certified for vacuum applications. See the Hazards section (Section 8) for more information.

NOTE 5—The stoppered flask mechanically sets the volume. The