Designation: D5550 – 23

Standard Test Method for Specific Gravity of Soil Solids by Gas Pycnometer[1]

This standard is issued under the fixed designation D5550; 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 This test method covers the determination of the specific gravity of soil solids by means of a gas pycnometer. Particle size is limited by the dimensions of the test specimen container of the particular pycnometer being used.

1.2 Test Method D854 may be used instead of or in conjunction with this test method for performing specific gravity tests on soils. Note that Test Method D854 does not require the specialized test apparatus needed by this test method. However, Test Method D854 may not be used if the test specimen contains matter that can readily dissolve in water, whereas this test method does not have that limitation.

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

1.3.1 For purposes of comparing a measured or calculated value(s) with specified limits, the measured or calculated value(s) shall be rounded to the nearest decimal or significant digits in the specified limits.

1.3.2 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 should generally 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 this standard to consider significant digits used in analysis methods for engineering design.

1.4 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are provided for information only and are not considered standard.

1.4.1 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 converted slug unit is not given, unless dynamic (F = ma) calculations are involved.

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.*

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]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

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

D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D4542 Test Methods for Pore Water Extraction and Determination of the Soluble Salt Content of Soils by Refractometer

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

3. Terminology

3.1 *Definitions:*

[1] This test method 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

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

4. Summary of Test Method

4.1 This test method is used to determine the specific gravity of soil grains using a gas pycnometer. This test method also contains equations for correcting the initial specific gravity value for dissolved matter within the pore fluid.

5. Significance and Use

5.1 The specific gravity value is used in many phase relation equations to determine relative volumes of particle, water, and gas mixtures.

5.2 The term soil particle typically refers to a naturally occurring mineral grain that is not readily soluble in water. Therefore, the specific gravity of soils that contain extraneous matter (such as cement, lime, and the like) or water-soluble material (such as salt) must be corrected for the precipitate that forms on the test specimen after drying. If the precipitate has a specific gravity less than the parent soil grains, the uncorrected test result will be too low. If the precipitate has a higher specific gravity, then the uncorrected test value will be too high.

5.3 Heating during drying may diagenetically alter the structure of some clay minerals.[3] Therefore caution should be exercised if the mineral composition of a clay test specimen is going to be determined after drying. It is possible to dry the test specimen at a lower temperature. However, the effect on water content[4] and hence specific gravity should be investigated. In addition, some materials other than clay may be affected by drying at 110°C, such as gypsum, soils containing organics, fly ash containing residual coal, island sands. Test Method D2216 includes recommendations for drying gypsum using a lower temperature, such as 60°C.

NOTE 1—The quality of the result 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. Users of this standard are cautioned that compliance with Practice D3740 does not in itself ensure 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 gas pycnometer shall be one of the commercially available models that determines the volume of a solid test specimen. Some pycnometers measure the pressure drop that occurs after a gas at a known pressure is allowed to flow into another chamber (typically the first chamber contains the solid material being tested). The amount of pressure drop is related to the volume of soil present. Some others place a known volume of gas into a chamber containing the test specimen. The increase in pressure is related to the volume of the material. Either type of instrument is acceptable provided that the required accuracy of the instrument produces a volume measurement that is ±0.2 % of the test specimen volume. The use of gas pycnometry described in this test method pertains to both types of pycnometers used for test specimen volume determination, so no further method differentiation and apparatus description is needed, regardless of which type of pycnometer is used. In addition, the pycnometer chosen will use one or more test specimen containers of specific dimensions. Refer to manufacturer's documentation for test specimen container dimensions, as the container dimensions will limit the size of the test specimen.

NOTE 2—Commercially available instruments should be checked using materials with known specific gravities to ensure that they provide acceptable precision and accuracy for the range of soil types to be tested. Some instruments require an operator to manually perform the test (that is, physically move the working components of the apparatus), whereas, other instruments are fully automatic (after the test specimen has been loaded) and can produce a digital display of the volume and specific gravity value (the test specimen mass has to be input). Some instruments can also send the test results to a separate printer. Obviously, inherent errors are more possible with one type of equipment than another. Furthermore, some instruments are constructed differently than others and can therefore produce more accurate and reproducible results.

6.2 *Balance*—Balance meeting the requirements of Specifications D4753 and readable, without estimation, to at least 0.1 % of the test specimen mass.

6.3 *Compressed Gas System*—Typically research grade helium is required by the instruments. A tank capable of storing the required volume of gas and associated pressure regulator(s) required to deliver the gas at the specified pressure.

NOTE 3—Other inert gas may be substituted for helium; refer to manufacturer's suggestions. Helium is often used because it obeys the ideal gas law and is able to penetrate small soil pores. Ordinary air may produce acceptable results for non-reactive test specimens in some instruments, however, that practice should be discouraged because of the uncertainty introduced into the test results.

6.4 *Drying Oven*—Thermostatically-controlled oven, capable of maintaining a uniform temperature of 110 ± 5°C (230 ± 9°F) throughout the drying chamber.

6.5 *Desiccator*—A desiccating cabinet or jar with air-tight seal containing silica gel or an anhydrous calcium sulfate desiccant. The desiccator needs to be capable of providing isolation for the test specimen after drying while cooling to ambient temperature to limit adsorption of moisture or other vapors. The desiccator does not necessarily need to have features such as inert gas purge or ESD protection, though if these are present with the selected desiccator no harm to the test specimen should occur while under storage.

6.6 *Anhydrous Calcium Sulfate*—Desiccant used to reduce adsorption of moisture onto dried test specimen while cooling to ambient temperature. Note that this is a desiccant and will adsorb water from skin, eyes, and lungs, possibly causing irritation of contacted surfaces. Therefore, follow recommendations given in Safety Data Sheet (SDS) obtained from the supplier.

NOTE 4—Indicating desiccant changes color when it is no longer able to absorb moisture. However, indicating desiccant is more expensive than the non-indicating variety. To save cost, indicating desiccant can be mixed in with the non-indicating type. A ratio of one part indicating desiccant to approximately four parts non-indicating has proven to be acceptable in many applications.

[3] Carroll, D., Clay Minerals: A Guide to Their X-Ray Identification, *Geological Society of America Special Paper 126*, 1970.