



Designation: D2216 – 19

Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass¹

This standard is issued under the fixed designation D2216; 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 laboratory determination of the water (moisture) content by mass of soil, rock, and similar materials where the reduction in mass by drying is due to loss of water except as noted in 1.4, 1.5, and 1.8. For simplicity, the word “material” shall refer to soil, rock or aggregate whichever is most applicable.

1.2 Some disciplines, such as soil science, need to determine water content on the basis of volume. Such determinations are beyond the scope of this test method.

1.3 The water content of a material is the ratio of the mass of water contained in the pore spaces of soil or rock material, to the solid mass of particles, expressed as a percentage.

1.4 The term “solid material” as used in geotechnical engineering is typically assumed to mean naturally occurring mineral particles of soil and rock that are not readily soluble in water. Therefore, the water content of materials containing extraneous matter (such as cement etc.) may require special treatment or a qualified definition of water content. In addition, some organic materials may be decomposed by oven drying at the standard drying temperature for this method ($110 \pm 5^\circ\text{C}$). Materials containing gypsum (calcium sulfate dihydrate) or other compounds having significant amounts of hydrated water, may present a special problem as this material slowly dehydrates at the standard drying temperature ($110 \pm 5^\circ\text{C}$) and at very low relative humidity, forming a compound (such as calcium sulfate hemihydrate) that is not normally present in natural materials except in some desert soils. In order to reduce the degree of dehydration of gypsum in those materials containing gypsum or to reduce decomposition in highly/fibrous organic soils, it may be desirable to dry the materials at 60°C or in a desiccator at room temperature. When a drying temperature is used which is different from the standard drying

temperature as defined by this test method, the resulting water content may be different from the standard water content determined at the standard drying temperature of $110 \pm 5^\circ\text{C}$.

NOTE 1—Test Method D2974 provides an alternate procedure for determining water content of peat materials.

1.5 Materials containing water with substantial amounts of soluble solids (such as salt in the case of marine sediments) when tested by this method will give a mass of solids that includes the previously soluble dissolved solids. These materials require special treatment to remove or account for the presence of precipitated solids in the dry mass of the specimen, or a qualified definition of water content must be used. For example, see Test Method D4542 regarding information on marine sediments.

1.6 This test standard requires several hours for proper drying of the water content specimen. Test Methods D4643, D4944 and D4959 provide less time-consuming processes for determining water content. See Gilbert² for details on the background of Test Method D4643.

1.7 Two test methods are provided in this standard. The methods differ in the significant digits reported and the size of the specimen (mass) required. The method to be used may be specified by the requesting authority; otherwise Method A shall be performed.

1.7.1 *Method A*—The water content by mass is recorded to the nearest 1 %. For cases of dispute, Method A is the referee method.

1.7.2 *Method B*—The water content by mass is recorded to the nearest 0.1 %.

1.8 This standard requires the drying of material in an oven. If the material being dried is contaminated with certain chemicals that may react violently or emit hazardous gases when heated, health and safety hazards may exist. Therefore, this standard should not be used in determining the water content of contaminated soils unless adequate health and safety precautions are exercised.

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 Gilbert, P.A., “Computer Controlled Microwave Oven System for Rapid Water Content Determination,” Tech. Report GL-88–21, Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MS, November 1988.

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

1.9 *Units*—The values stated in SI units shall be regarded as standard except the Alternative Sieve Sizes listed in **Table 1** are used. No other units of measurement are included in this test method.

1.10 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.

1.10.1 This is especially important if the water content will be used to calculate other relationships such as moist mass to dry mass or vice versa, wet unit weight to dry unit weight or vice versa, and total density to dry density or vice versa. For example, if four significant digits are required in any of the above calculations, then the water content must be recorded to the nearest 0.1 %. This occurs since 1 plus the water content (not in percent) will have four significant digits regardless of what the value of the water content is; that is, 1 plus 0.1/100 = 1.001, a value with four significant digits. While, if three significant digits are acceptable, then the water content can be recorded to the nearest 1 %.

1.10.2 If water content data is to be used to calculate other relationships, such as moist or dry mass, wet or dry unit weight or total or dry density, then the specimen mass up to 200 g must be determined using a balance accurate to 0.01 g.

1.11 *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.*

1.12 *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:³

D653 Terminology Relating to Soil, Rock, and Contained Fluids

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.

D2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4220 Practices for Preserving and Transporting Soil Samples
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
D4643 Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D4944 Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester
D4959 Test Method for Determination of Water Content of Soil By Direct Heating
D5079 Practices for Preserving and Transporting Rock Core Samples (Withdrawn 2017)⁴
D6026 Practice for Using Significant Digits in Geotechnical Data
D7263 Test Methods for Laboratory Determination of Density (Unit Weight) of Soil Specimens

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 *constant dry mass (of a solid material)*—the state that a water content specimen has attained when further heating results in less than 1 % or 0.1 % additional loss in mass for Method A or B respectively. The time necessary to obtain constant dry mass will vary depending on numerous factors such as the type of material being tested, the size of the specimen and type of oven being used (forced draft or gravity

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

TABLE 1 Minimum Requirements for Mass of Test Specimens, and Balance Readability^A

Maximum Particle Size (100 % Passing)		Method A Water Content Recorded to ± 1 %		Method B Water Content Recorded to ± 0.1 %	
Sieve Size	Alternative Sieve Size	Minimum Specimen Mass	Balance Readability (g)	Minimum Specimen Mass (g)	Balance Readability (g)
75.0 mm	3 in.	5 kg	10	50 kg	10
37.5 mm	1-1/2 in.	1 kg	10	10 kg	10
19.0 mm	3/4 in.	250 g	0.1	2.5 kg	0.1
9.5 mm	3/8 in.	50 g	0.1	500 g	0.1
4.75 mm	No. 4			100 g	0.01
2.00 mm	No. 10			20 g	0.01

^ASee 1.10.2.