



Designation: D8153 – 22

Standard Test Method for Determination of Soil Water Contents Using a Dielectric Permittivity Probe¹

This standard is issued under the fixed designation D8153; 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 describes the procedures for measuring the water mass per unit volume of soil and soil-aggregate by use of an in situ permittivity probe. Measurements are taken at a depth beneath the surface of the soil determined by the design of the probe.

1.1.1 For limitations see Section 6 on Interferences.

1.2 The permittivity probe is inserted into a hole drilled or punched into the soil being measured. As its name indicates, the probe measures the dielectric permittivity of the soil into which it is placed. Two electrodes, connected to an oscillating circuit, are mounted a predetermined distance apart. These electrodes act as the plates of a capacitor, with the soil between the plates forming the capacitor dielectric.

1.2.1 The probe circuit creates an oscillating electric field in the soil. Changes in the dielectric permittivity of the soil are indicated by changes in the circuit's operating frequency. Since water has a much higher dielectric constant (80) than the surrounding soil (typically around 4), the water content can be related by a mathematical function to the change in dielectric permittivity, and, consequently, the changes in the circuit's operating frequency.

1.2.2 The construction, deployment, and operating principle of the device described in this test method differ from other methods that measure the dielectric constant, bulk electrical conductivity, complex impedance, or electromagnetic impedance (see Test Methods **D6780/D6780M**, **D7698**, and **D7830/D7830M**) of the soil and relate the results to water mass per unit volume and/or water content.

1.2.3 The water content of the soil measured by the permittivity probe is the volumetric water content, expressed as the ratio of the volume of water to the total volume occupied by the soil. This quantity is often converted, and displayed, by the probe in units of mass of water per volume of soil, or water mass per unit volume. This conversion is performed by

multiplying the water content (in volume of water per volume of soil) by the density of water.

1.3 Water content most prevalent in engineering and construction activities is known as the gravimetric water content, ω , and is the ratio of the mass of the water in pore spaces to the total mass of solids, expressed as a percentage. To determine this quantity, the bulk density of the soil under measurement must also be determined.

1.4 *Units*—The values stated in SI units are to be regarded as the standard. Reporting the test results in units other than SI shall not be regarded as nonconformance with this standard.

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

1.5.1 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.

1.5.2 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 commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.6 *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.*

1.7 *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.*

¹ This test method is 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.

Current edition approved June 1, 2022. Published July 2022. DOI: 10.1520/D8153-22.