Standard Method of Test for

In-Place Density and Moisture Content of Soil and Soil–Aggregate by Nuclear Methods (Shallow Depth)

AASHTO Designation: T 310-19

Technical Subcommittee: 1b, Geotechnical Exploration, Instrumentation, Stabilization, and Field Testing

Release: Group 3 (July)

AASHTO

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1. SCOPE

1.1. This test method describes the procedure for determining the in-place density and moisture of soil and soil–aggregate by use of nuclear gauge. The density of the material may be determined by either Direct Transmission, Backscatter, or Backscatter/Air-Gap Ratio Method. The moisture of the material is determined only from measurements taken at the surface of the soil (i.e., backscatter).

1.2. *Density*—The total or wet density of soil and soil-rock mixtures is determined by the attenuation of gamma radiation where the source or detector is placed at a known depth up to 300 mm (12 in.) while the detector(s) or source remains on the surface (Direct Transmission Method) or the source and detector(s) remain on the surface (Backscatter Method).

1.2.1. The density in mass per unit volume of the material under test is determined by comparing the detected rate of gamma radiation with previously established calibration data.

1.3. *Moisture*—The moisture content of the soil and soil-rock mixtures is determined by thermalization or slowing of fast neutrons where the neutron source and the thermal neutron detector both remain at the surface.

1.3.1. The water content in mass per unit volume of the material under test is determined by comparing the detection rate of thermalized or slow neutrons with previously established calibration data.

1.4. *SI Units*—The values stated in SI units are to be regarded as the standard. The inch-pound equivalents may be approximate. It is common practice in the engineering profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This implicitly combines two systems of units, that is, the absolute system and the gravitational system.

1.4.1. This standard has been written using the absolute system for water content (kilograms per cubic meter) in SI units. Conversion to the gravitational system of unit weight in lbf/ft^3 may be made. The recording of water content in pound-force per cubic foot should not be regarded as nonconformance with this standard, although the use is scientifically incorrect.

1.4.2. In the U.S. Customary units system, the pound (lbf) represents a unit of force (weight). However, the use of balances or scales recording pounds of mass (lbm) or recording of density (lbm/ft^3) should not be regarded as nonconformance with this standard.

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 and health practices and determine the applicability of regulatory limitations prior to use*. See Section 6, Hazards.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- T 99, Moisture–Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
- T 180, Moisture–Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
- T 191, Density of Soil In-Place by the Sand-Cone Method
- T 265, Laboratory Determination of Moisture Content of Soils
- T 272, One-Point Method for Determining Maximum Dry Density and Optimum Moisture

2.2. *ASTM Standards*:

- D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- D7013/D7013M, Standard Guide for Calibration Facility Setup for Nuclear Surface Gauges

3. SIGNIFICANCE

3.1. The test method described is useful as a rapid, nondestructive technique for the in-place determination of the wet density and water content of soil and soil–aggregate.

3.2. The test method is used for quality control and acceptance testing of compacted soil and rock for construction and for research and development. The nondestructive nature allows for repetitive measurements at a single test location and statistical analysis of the results.

3.3. *Density*—The fundamental assumptions inherent in the methods are that Compton scattering is the dominant interaction and that the material under test is homogeneous.

3.4. *Moisture*—The fundamental assumptions inherent in the test method are that the hydrogen present is in the form of water as defined by T 265 and that the material under test is homogeneous.

3.5. Test results may be affected by chemical composition, sample heterogeneity, and to a lesser degree, material density and the surface texture of the material being tested. The technique also exhibits spatial bias in that the gauge is more sensitive to water contained in the material in close proximity to the surface and less sensitive to water at deeper levels.

4. INTERFERENCES

4.1. *In-Place Density Interferences*:

4.1.1. The chemical composition of the sample may affect the measurement, and adjustments may be necessary.