Designation: D1586/D1586M – 18

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D1586/D1586M; 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 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler with a 140 lb [63.5 kg] hammer dropped 30 in. [750 mm] to obtain a soil sample for identification purposes, and measure the resistance of the soil to penetration of the standard 2 in. [50 mm] diameter sampler. The SPT "*N*" value is the number of hammer blows required to drive the sampler over the depth interval of 0.5 to 1.5 ft [0.15 to 0.45 m] of a 1.5 ft [0.45 m] drive interval.

1.2 Test Method D4633 is generally necessary to measure the drill rod energy of a given drop hammer system and using the measured drill rod energy, *N* values can be corrected to a standard energy level. Practice D6066 uses Test Methods D1586 and D4633 and has additional requirements for hammers, hammer energy, and drilling methods to determine energy corrected penetration resistance of loose sands for liquefaction evaluation.

1.3 Practice D3550/D3550M is a similar procedure using a larger diameter split barrel sampler driven with a hammer system that may allow for a different hammer mass. The penetration resistance values from Practice D3550/D3550M do not comply with this standard.

1.4 Test results and identification information are used in subsurface exploration for a wide range of applications such as geotechnical, geologic, geoenvironmental, or geohydrological explorations. When detailed lithology is required for geohydrological investigations, use of continuous sampling methods (D6282/D6282M, D6151/D6151M, D6914/D6914M) are recommended when the incremental SPT *N* value is not needed for design purposes (see 4.1.1).

1.5 Penetration resistance testing is typically performed at 5 ft [1.5 m] depth intervals or when a significant change of materials is observed during drilling, unless otherwise specified.

1.6 This test method is limited to use in nonlithified soils and soils whose maximum particle size is approximately less than one-half of the sampler diameter.

1.7 This test method involves use of rotary drilling equipment (Guide D5783, Practice D6151/D6151M). Other drilling and sampling procedures (Guides D6286 and D6169/D6169M) are available and may be more appropriate. Considerations for hand driving or shallow sampling without boreholes are not addressed. Subsurface investigations should be recorded in accordance with Practice D5434. Samples should be preserved and transported in accordance with Practice D4220/D4220M using Group B. Soil samples should be identified by group name and symbol in accordance with Practice D2488.

1.8 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.

1.8.1 The procedures used to specify how data are collected/recorded and calculated in the 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 data.

1.9 *Units*—The values stated in either inch-pound or SI units [presented in brackets] are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Reporting of test results in units other than inch-pound shall not be regarded as

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

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

nonconformance with this practice. SI equivalent units shown herein are in general conformance with existing international standards.

1.10 Penetration resistance measurements often will involve safety planning, administration, and documentation. This test method does not purport to address all aspects of exploration and site safety.

1.11 Performance of the test usually involves use of a drill rig; therefore, safety requirements as outlined in applicable safety standards (for example, OSHA regulations,[2] NDA Drilling Safety Guide,[3] drilling safety manuals, and other applicable local agency regulations) must be observed.

1.12 *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.*

1.13 *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:*[4]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
D1452/D1452M Practice for Soil Exploration and Sampling by Auger Borings
D1587/D1587M Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
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)
D2573/D2573M Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils
D3550/D3550M Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of 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/D4220M Practices for Preserving and Transporting Soil Samples
D4633 Test Method for Energy Measurement for Dynamic Penetrometers
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5092 Practice for Design and Installation of Groundwater Monitoring Wells
D5299 Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock
D5778 Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils
D5782 Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5784/D5784M Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices
D5872/D5872M Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water Quality Monitoring Devices
D6026 Practice for Using Significant Digits in Geotechnical Data
D6066 Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential
D6151/D6151M Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
D6169/D6169M Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations
D6282/D6282M Guide for Direct Push Soil Sampling for Environmental Site Characterizations
D6286 Guide for Selection of Drilling Methods for Environmental Site Characterization
D6913/D6913M Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
D6914/D6914M Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices

3. Terminology

3.1 *Definitions:*

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *anvil, n—in drilling*, that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2.2 *cathead, n—in drilling*, the rotating drum or windlass in the rope-cathead lift system around which the operator

[2] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, http://www.osha.gov.

[3] Available from the National Drilling Association, 3511 Center Rd., Suite 8, Brunswick, OH 44212, http://www.nda4u.com.

[4] 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.

wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.2.3 *drill rods, n—in drilling*, rods used to transmit downward force and torque to the drill bit while drilling a borehole and also connect sampler to the hammer system for testing.

3.2.4 *hammer, n—in drilling*, that portion of the hammer drop system consisting of the 140 ± 2 lbm [63.5 ± 0.5 kg] impact mass which is successively lifted and dropped to provide the impact energy to drill rods that accomplishes the sampling and penetration.

3.2.5 *hammer drop system, n—in drilling*, the equipment that includes the 140 lbm [63.5 kg] hammer, lifting and dropping assembly, and guide tube (if used) which the operator or automatic system accomplishes the lifting and dropping of the hammer to produce the blow.

3.2.6 *hammer fall guide, n—in drilling*, that part of the hammer drop system used to guide the fall of the hammer.

3.2.7 *number of rope turns, n—in drilling*, the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.2.8 *sampling rods, n—in drilling*, rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.2.9 *standard penetration test (SPT), n—in drilling*, a test process in the bottom of a borehole in which a split-barrel sampler (see 5.3) with an outside diameter of 2 in. [50 mm] is driven a prescribed distance of 1.0 ft [0.3 m] after a seating interval of 0.5 ft [0.15 m] using a 140 lbm [63.5 kg] hammer falling 30 in. [750 mm] for each hammer blow to compute the *N*-value.

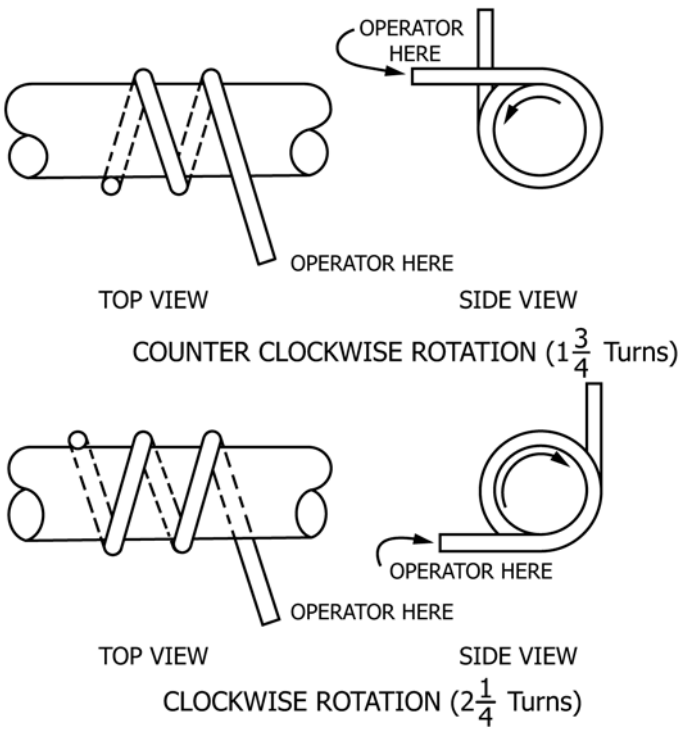

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

3.2.10 *test interval, n—in drilling*, the depth interval for the SPT test consists of an 0.5 ft [0.15 m] seating interval followed by the 1.0 ft [0.3 m] test interval.

3.3 *Definitions from D6066 Pertinent to This Standard:*

3.3.1 *cleanout depth, n*—depth that the bottom of the cleanout tool (end of drill bit or cutter teeth) reaches before termination of cleanout procedures.

3.3.2 *cleanout interval, n*—interval between successive penetration resistance tests from which material must be removed using conventional drilling methods.

3.3.2.1 *Discussion*—During the clean-out process, the previous penetration test interval (1.5 ft [450 mm]) is drilled through and an additional distance is cleaned past the end depth of the previous test to assure minimal disturbance of the next test interval. The term cleanout interval in this practice refers to the additional distance past the previous test termination depth.

3.4 *Symbols Specific to This Standard:*

3.4.1 *N-value, n*—reported in blows per foot, equals the sum of the number of blows (*N*) required to drive the sampler over the depth interval of 0.5 to 1.5 ft [0.15 to 0.45 m] below the base of the boring (see 8.3).

3.4.2 N_{60}, *n*—standard penetration resistance adjusted to a 60 % drill rod energy transfer ratio (Test Method D4633, Practice D6066).

3.5 *Symbols Specifc to This Standard and Pertinent to This Standard from Test Method D4633:*

3.5.1 *EFV, n*—the energy transmitted to the drill rod from the hammer during the impact event.

3.5.2 *ETR, n*—ratio (*EFV / PE*) of the measured energy transferred to the drill rods to the theoretical potential energy (PE).

4. Significance and Use

4.1 This test is the most frequently used subsurface exploration drilling test performed worldwide. Numerous international and national standards are available for the SPT which are in general conformance with this standard.[5] The test provides samples for identification purposes and provides a measure of penetration resistance which can be used for geotechnical design purposes. Many local and widely published international correlations which relate blow count, or *N*-value, to the engineering properties of soils are available for geotechnical engineering purposes.

4.1.1 Incremental SPT sampling is not a preferred method of soil sampling for environmental or geohydrological exploration unless the SPT *N*-value is needed for design purposes. Continuous sampling methods such as Direct Push Soil Sampling (Guide D6282/D6282M), or continuous coring using Hollow-Stem Augers (Practice D6151/D6151M) or Sonic

[5] "Geotechnical Investigation and testing – Field testing- Part 3: Standard Penetration Test (ISO 22476-3:2004)," EN ISO 22476-3, European Standard, European Committee for Standardization, Brussels Belgium.