
Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils

AASHTO Designation: T 206-22

Technically Revised: 2022

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

ASTM Designation: D1586/D1586M-18



**American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, D.C. 20004**

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1. SCOPE

- 1.1. This test method describes the procedure, generally known as the standard penetration test (SPT), for driving a split-barrel sampler to obtain a representative soil sample for identification purposes, and measure the resistance of the soil to penetration of the standard sampler.
- 1.2. ASTM D4633 is 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.
- 1.3. 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 is recommended.
- 1.4. Penetration resistance testing is typically performed at 1.5 m (5 ft) depth intervals or when a significant change of materials is observed during drilling, unless otherwise specified.
- 1.5. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns 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.*
- 1.6. The values stated in SI units are to be regarded as the standard.
Note 1—ASTM D6066 can be used when testing loose sands below the water table for liquefaction studies or when a higher level of care is required when drilling these soils. This practice provides information on drilling methods, equipment variables, energy corrections, and blow-count normalization.
- 1.7. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- R 13, Conducting Geotechnical Subsurface Investigations
- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories

2.2. *ASTM Standards:*

- D4633, Standard Test Method for Energy Measurement for Dynamic Penetrometers
- D6066, Standard Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential (withdrawn 2020; no replacement)

3. TERMINOLOGY

3.1. *Description of Terms Specific to This Standard:*

- 3.1.1. *anvil*—that portion of the drive-weight assembly that the hammer strikes and through which the hammer energy passes into the drill rods.
- 3.1.2. *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.
- 3.1.3. *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole, and also connect the sampler to the hammer system for testing.
- 3.1.4. *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.
- 3.1.5. *hammer*—that portion of the drive-weight assembly consisting of the 63.5 ± 1 kg (140 ± 2 lb) impact weight that is successively lifted and dropped to provide the impact energy to drill rods that accomplishes the sampling and penetration.
- 3.1.6. *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.
- 3.1.7. *hammer fall guide*—that part of the hammer drop system used to guide the fall of the hammer.
- 3.1.8. *N-value*—the blow count representation of the penetration resistance of the soil. The *N-value*, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 150 to 450 mm (6 to 18 in.) (see Section 7.3).
- 3.1.9. ΔN —the number of blows obtained from each of the 150-mm (6-in.) intervals of sampler penetration (see Section 7.3).
- 3.1.10. *number of rope turns*—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 degrees (see Figure 1).

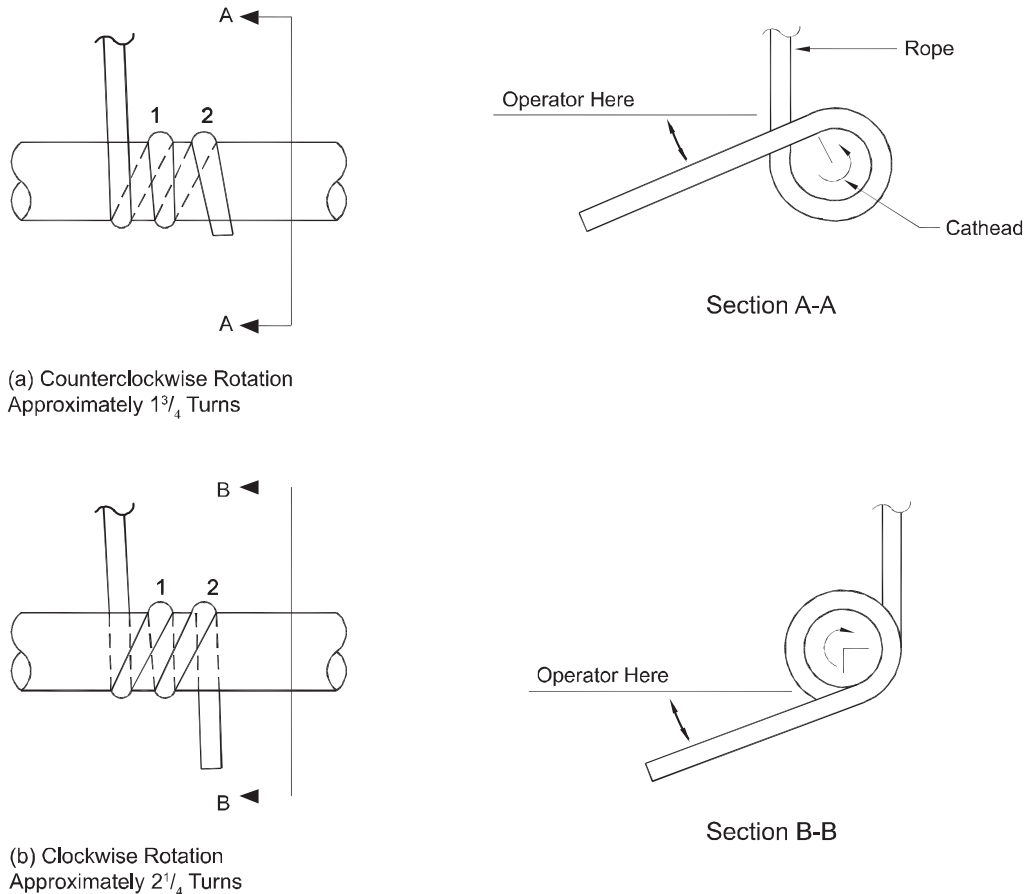


Figure 1—Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead

- 3.1.11. *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.
- 3.1.12. *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. SIGNIFICANCE AND USE

- 4.1. This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample. This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations, which relate SPT blow count, or *N*-value, and the engineering behavior of earthworks and foundations, are available.
- 4.1.1. Incremental SPT sampling is not a preferred method of soil sampling for environmental or geohydrological exploration unless SPT *N*-values are needed for design purposes. Continuous sampling methods such as direct push soil sampling, or continuous coring using hollow-stem augers or sonic drills provide the best continuous record of lithology. Continuous sampling can be performed with SPT samplers, but it is slow compared to other methods, and *N*-values may be unreliable. Sampling for detailed lithology can be reduced by using screening tests such as cone penetrometers, dynamic cone penetrometer, or geophysics.

- 4.2. *SPT N-values* are affected by many variables in the design and execution of the test. Investigations of energy transmission in SPT testing showed that differing drop hammer systems provide different energies to the sampler at depth. There are so many different hammer designs that it is important to obtain the energy transfer ratio (ETR) for the hammer system being used according to ASTM D4633. ETR of various hammer systems has shown to vary between 45 to 95 percent of maximum potential energy (PE). Since the *N*-value is inversely proportional to the energy delivered, resulting *N*-values from different systems are far from standard. It is now common practice to correct *N*-values to an energy level of 60 percent of total PE, or N_{60} , values as presented here and in ASTM D6066. In this standard, it is not required to report ETR or N_{60} but strongly advised to note and report if available. If the ETR of the hammer–anvil–rod system is known, the hammer PE can still vary after calibration; thus it is essential that hammer drop heights or rates, or both, be monitored to confirm consistent performance. Report any occurrence of hammer drop heights that do not meet the required value of 750 mm (30 in.) during testing. Using previous ETR data for a hammer system does not assure that it will perform the same on the current project. If onsite ETR is not obtained, be sure to check hammer drop height or rates, or both, to assure the hammer is operating the same as when previously checked.
- 4.3. *Test Depth Increments*—Test intervals and locations are normally stipulated by the project engineer or geologist. Typical practice is to test at 1.5-m (5-ft) intervals or less in homogeneous strata. If a different soil type in the substratum is encountered, then a test is conducted as soon as the change is noted. It is recommended to clean out the borehole a minimum cleanout interval of at least 0.25 m (1 ft) past the termination point of the previous test depth between tests to assure test isolation and to check drill hole condition for the next test. Therefore, the closest spacing for typical practice of SPT is 0.75 m (2.5 ft). The cleanout between test intervals can be adjusted by the user depending on borehole conditions and design data needs such as hard soils or thin strata. The practice of performing continuous SPT for *N*-value determination is not recommended but can be done with careful cleanout before testing. In that case, the borehole also must be cleaned out between tests. At continuous spacing, with no additional cleanout depth, *N*-values may be adversely affected by disturbance of previous sample driving, especially in softer soils, but the effect is not known. Some practitioners like to overdrive the sampler an additional 0.15 m (0.5 ft) to gain an additional soil sample for a total drive interval of 0.6 m (2.0 ft). This is acceptable if the *N*-value remains the sum of the 0.15 to 0.3 m (0.5 to 1.0 ft) intervals of the drive interval and reasonable cleanout is performed between tests.

5. APPARATUS

- 5.1. *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. A suitable borehole is one in which the drilling indicates stable conditions at the base of boring. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions:
- 5.1.1. *Drag, Chopping, and Fishtail Bits*, less than 162 mm (6.5 in.) and greater than 56 mm (2.2 in.) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbing the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.
- 5.1.2. *Roller-Cone Bits*, less than 162 mm (6.5 in.) and greater than 56 mm (2.2 in.) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected. Use side discharge or baffled bottom discharge bits to avoid jetting fluid disturbance in the base of the boring. The tricone roller bit baffles produce some downward discharge. If the deposit is fine grained, it is preferred to use a fishtail or drag bit with baffled discharge points to advance the boring.