Designation: D4648/D4648M – 24

Standard Test Methods for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Soil[1]

This standard is issued under the fixed designation D4648/D4648M; 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 These test methods cover the miniature vane test in saturated fine-grained, cohesive clay and silt soils for the estimation of undrained shear strength. Knowledge of the nature of the soil in which each vane test is to be made is necessary for assessment of the applicability and interpretation of the test results. These test methods are not applicable to sandy soils or non-plastic silts, which may allow drainage during the test. These test methods are intended for soils which have an undrained shear strength less than 1.0 tsf [100 kPa].

NOTE 1—Vane failure conditions in higher strength clay and predominately silty soils may deviate from the assumed cylindrical failure surface, thereby causing error in the measured strength.

1.2 These test methods include the use of both conventional calibrated torque spring units (Method A) and electrical torque transducer units (Method B) with a motorized miniature vane shear device.

1.3 Laboratory vane is an ideal tool to investigate strength anisotropy in the vertical and horizontal directions, if suitable samples (specimens) are available.

1.4 The values stated in either inch-pound units 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 nonconformance with this standard.

1.4.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs. The rationalized slug unit is not given, unless dynamic (F = ma) calculations are involved.

1.5 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.

1.6 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1587/D1587M Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes (Withdrawn 2024)[3]

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

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

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 (Withdrawn 2023)[3]

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.05 on Strength and Compressibility of Soils.

Current edition approved Jan. 15, 2024. Published February 2024. Originally approved in 1987. Last previous edition approved in 2016 as D4648/D4648M – 16. DOI: 10.1520/D4648_D4648M-24.

[2] 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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

D6519/D6519M Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler
D8121/D8121M Test Method for Approximating the Shear Strength of Cohesive Soils by the Handheld Vane Shear Device

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 *torque spring, n*—an elastic spring that can be calibrated to provide a measure of torque that is proportional to the rotation (about a central longitudinal axis) of one end of the spring relative to a fixed condition at the opposite end of the spring.

4. Summary of Test Method

4.1 The miniature vane shear test consists of inserting a four-bladed vane in the end of an intact specimen from a tube sample or remolded specimen and rotating it at a constant rate to determine the torque required to cause a cylindrical surface to be sheared by the vane. This torque is then converted to a unit shearing resistance of the cylindrical surface area. The torque is measured by a calibrated torque spring or torque transducer that is attached directly to the vane.

5. Significance and Use

5.1 The miniature vane shear test may be used to obtain estimates of the undrained shear strength of fine-grained soils. The test provides a rapid determination of the undrained shear strength on undisturbed, or remolded or reconstituted soils.

NOTE 2—Notwithstanding the statements on precision and bias contained in this test method: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D3740 does not in itself ensure reliable testing. Reliable testing depends on several factors; Practice D3740 provides a means for evaluating some of those factors.

6. Interferences

6.1 *Vane Disturbance*—The remolded zone around a vane blade resulting from insertion is generally assumed to be small and have little or no effect on the stress-strain properties of the sediment being tested. In reality, the volume of soil disturbed by the insertion of the vane blade into the assumed cylindrical volume of soil being tested may be significant. The vane shall displace no more than 15% of the soil being tested as defined by the maximum vane area ratio presented in Fig. 1.

7. Apparatus

7.1 *Vane Blade*—The vane assembly shall consist of four rectangular bladed vanes, as illustrated in Fig. 2. It is recommended that the height of the vane be twice the diameter (2:1), although vanes with a height equal to the diameter (1:1) also may be used (see Note 3). Vane blade diameter (*D*) may vary from 0.50 to 1.0 in. [12.7 to 25.4 mm].

7.2 *Vane Device*—The vane device should be motorized and, in the case of a torque spring device, shall rotate the torque spring at a constant rate of 60 to 90°/min [1.0 to 1.6 rad/min]. A vane device which applies the torque directly through a stiff shaft using an electrical transducer to measure torque shall rotate the vane at a constant rate that ranges from 20 to 30°/min [0.35 to 0.52 rad/min]. The vane/spring rotation device shall have an indicator or recording system that displays/records deflection (torque) of the calibrated spring or electrical transducer and, where possible, vane blade rotation.

7.3 *Torque Measuring Device*—The torque measuring device shall be a conventional torque spring, electrical torque transducer, or any other measuring device capable of the accuracy prescribed herein and may be part of the vane device. The torque measuring device shall be capable of measuring the torque to at least three significant digits. Undrained shear strength estimated by a hand-held vane (Test Methods D8121/D8121M) is often used to assist in selection of the appropriate spring or torque transducer range and accuracy.

NOTE 3—Since many clays are anisotropic with respect to strength, the relative importance of horizontal, as distinct from vertical, shearing surfaces can influence the test results. For this reason it is important that the recommended ratio of height to diameter be respected unless the intent is to vary the ratio in order to determine the horizontal and vertical strengths separately. For more detailed discussion on effects of height to diameter ratio as well as vane shape, refer to Refs. **(1)** and **(2)**.[4]

8. Preparation and Testing of Specimens

8.1 *Specimen Size*—Specimens should have a diameter sufficient to allow clearance of at least two blade diameters between all points on the circumference of the shearing surface and the outer edge of the sample.

8.2 *Intact Vane Strength*—Prepare intact specimens from intact samples secured in accordance with Practice D1587/D1587M or D6519/D6519M, and handle and transport in accordance with the practices for Group C and D Samples in Practices D4220/D4220M. Tests may be run in the sampling tube, eliminating the need for extrusion. Handle specimens carefully to prevent disturbance or loss of water (moisture) content. Trim flat the end of the sample where the vane will be inserted. The specimen surface shall be perpendicular to the wall of the tube and parallel to the leading, horizontal edge of the vane.

8.3 *Remolded Vane Strength*—Conduct remolded miniature vane strength tests on failed specimens similar to remolded field vane tests (Test Method D2573/D2573M) by rotating the

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.