Designation: D3080/D3080M – 23

Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions[1]

This standard is issued under the fixed designation D3080/D3080M; 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 covers the determination of the consolidated drained shear strength of one specimen of a soil material under direct shear boundary conditions. The specimen is deformed at a controlled rate on or near a single shear plane determined by the configuration of the apparatus.

1.2 Shear stresses and displacements are nonuniformly distributed within the specimen. An appropriate height of the failure zone cannot be defined for calculation of shear strains. Therefore, stress-strain relationships or any associated quantity such as the shear modulus, cannot be determined from this test.

1.3 The results of the test are affected by the presence of coarse-grained soil or rock particles, or both, which may make the testing data invalid in some cases. Check requirements of maximum soil particle size in 6.2.1 and 6.2.2.

1.4 Test conditions, including normal stress, access to water during consolidation and shearing, and specimens conditions should be selected to represent the field conditions being investigated and are left to the engineer or office requesting the test. The rate of shearing must be slow enough to ensure drained conditions.

1.5 Generally, three or more tests are performed on specimens from one soil sample, each under a different normal load, to determine the effects upon shear resistance and displacement. The development of criteria to interpret and evaluate test results is left to the engineer or office requesting the test. Interpretation of multiple tests requires engineering judgment and is beyond the scope of this test method. This test method pertains to the requirements for a single test.

1.6 This test method limits the maximum particle size of the test specimen based on the size of the shear box. Likewise, the gap size during shear is specified. It is acceptable for the testing requester to require a certain gap size between the upper and lower shear box halves to accommodate certain sand size particles. Presently there is insufficient information available for specifying the gap dimension based on particle size distribution.

1.7 *Units*—The values stated in either inch-pound units or SI units [given 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 nonconformance with the standard.

1.7.1 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 a slug. The slug unit is not given, unless dynamic (F = ma) calculations are involved.

1.7.2 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This practice implicitly combines two separate systems of units; the absolute and the gravitational systems. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit of mass. However, the use of balances and scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.

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 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 of significant digits in the specified limit.

1.8.2 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

[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 Nov. 1, 2023. Published December 2023. Originally approved in 1972. Last previous edition approved in 2011 as D3080/D3080M–11. DOI: 10.1520/D3080_D3080M-23.

*A Summary of Changes section appears at the end of this standard of these test methods to consider significant digits used in analysis methods for engineering design.

1.9 *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.*

1.10 *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

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

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

D2435/D2435M Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)

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]

D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

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

D6027/D6027M Practice for Calibrating Linear Displacement Transducers for Geotechnical Purposes

D6913/D6913M Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms used in this test method, refer to Terminology D653.

3.2 *Description of Terms Specific to This Standard:*

3.2.1 *fabricated slurry specimen*—laboratory reconstituted specimen formed by consolidating a slurry to a specified water content.

3.2.2 *failure criterion*—(Generically defined in Terminology D653.) For this standard, *failure criterion* is often taken as the maximum shear stress attained, or in the absence of a peak condition, the shear stress at 10 percent relative lateral displacement. Depending on soil behavior and field application, other suitable criteria may be defined at the direction of the requesting agency.

3.2.3 *nominal normal stress—in the direct shear test*, the applied normal (vertical) force divided by the area of the shear box.

3.2.3.1 *Discussion*—The contact area of the specimen on the imposed shear plane decreases during shear and hence the true normal stress is unknown.

3.2.4 *nominal shear stress—in the direct shear test*, the applied shear force divided by the area of the shear box.

3.2.4.1 *Discussion*—The contact area of the specimen on the imposed shear plane decreases during shear and hence the true shear stress is unknown.

3.2.5 *percent relative lateral displacement*—The ratio, in percent, of the relative lateral displacement to the diameter or lateral dimension of the specimen in the direction of shear.

3.2.6 *pre-shear—in strength testing*, the stage of a test after the specimen has stabilized under the consolidation loading condition and just prior to starting the shearing phase.

3.2.7 *relative lateral displacement*—the displacement between the top and bottom shear box halves.

4. Summary of Test Method

4.1 This test method consists of placing the test specimen in the direct shear device, applying a predetermined normal stress, providing for wetting or draining of the test specimen, or both, consolidating the specimen under the normal stress, unlocking the shear box halves that hold the test specimen, and shearing the specimen by displacing one shear box half laterally with respect to the other at a constant rate of shearing deformation while measuring the shearing force, relative lateral displacement, and normal displacement (Fig. 1). The shearing rate must be slow enough to allow nearly complete dissipation of excess pore pressure.

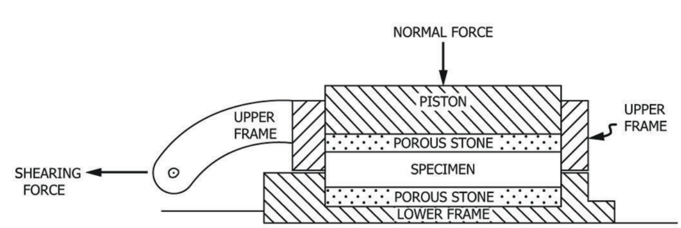

FIG. 1 Test Specimen in Single Shear Apparatus

[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.

5. Significance and Use

5.1 The direct shear test is suited to the relatively rapid determination of the drained friction angle of soils under consolidated drained conditions because the drainage paths through the test specimen are short, allowing excess pore pressure to dissipate more rapidly than other drained strength tests. It is applicable for testing intact, or reconstituted specimens. There is, however, a limitation on the maximum particle size (see 6.2.1 and 6.2.2).

5.2 The testing protocols represent a field situation where complete consolidation has occurred under the existing normal stresses. Failure is reached slowly under drained conditions to allow excess pore pressure dissipation during shear. The shear rate must meet the requirements of 9.10. The results from several tests may be used to express the relationship between normal stress on the failure plane and drained shear strength.

NOTE 1—The equipment specified in this standard method is not appropriate for performing undrained shear tests. Using a fast displacement rate without proper control of the volume of the specimen will result in partial drainage and incorrect measurements of shear parameters.

5.3 During the direct shear test, there is rotation of principal stresses and failure may not occur on the weakest plane since failure is forced to occur on or near a plane through the middle of the specimen. The fixed location of the plane in the test can be an advantage in determining the shear resistance along recognizable weak planes within the soil material and for testing interfaces between dissimilar materials.

5.4 There are some limitations of the test, such as nonuniformity of shear stress on the failure plane and possibilities of nonuniformity of the failure plane due to nonuniformities within the soil and applied forces (moments caused by top half of shear box movement either up or down during shearing, and the like). Furthermore, when testing intact stiff clays, which are highly overconsolidated, there might be fissures or other discontinuities to cause excessive tilting, vertical movement (up or down) while shearing, and the like, and which, would nullify the use of the direct shear test.

5.5 The area of the shear surface decreases during the test. This area reduction creates uncertainty in the actual value of the shear and normal stress on the shear plane but should not affect the ratio of these stresses.

NOTE 2—The quality of the result produced by this standard 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/sampling/inspection/and the like. Users of this test method are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Shear Device*—A device to hold the specimen securely between two porous inserts in such a way that torque is not applied to the specimen. The shear device shall provide a means of applying a normal stress to the faces of the specimen, for measuring change in height of the specimen, for permitting drainage of water through the porous inserts at the top and bottom boundaries of the specimen, and for submerging the specimen in water. The device shall be capable of applying a shear force to fail the specimen along a predetermined shear plane (single shear) parallel to the faces of the specimen. The frames that hold the specimen shall be sufficiently rigid to prevent distortion during shearing. The various parts of the shear device shall be made of material not subject to corrosion by moisture or substances within the soil, for example, stainless steel, bronze, or aluminum, and the like. The use of dissimilar metals, which may cause galvanic action, is not permitted.

6.2 *Shear Box*—A shear box, either circular or square, made of stainless steel, bronze, or aluminum, with provisions for drainage through the top and bottom. The box is divided by a straight plane into two halves of equal thickness which are fitted together with alignment screws. The shear box is also fitted with gap screws, which create the space (gap) between the top and bottom halves of the shear box prior to shear. The two halves shall provide a bearing surface for the specimen along the shear plane during relative lateral displacement.

6.2.1 The minimum specimen diameter for circular specimens, or width for square specimens, shall be 2.0 in. [50 mm], or not less than ten (10) times the maximum particle size diameter, whichever is larger.

6.2.2 The minimum initial specimen height shall be 0.75 in. [20 mm], and not less than six (6) times the maximum particle diameter.

6.2.3 The minimum specimen diameter or width to height ratio shall be 2.0 or greater.

NOTE 3—A light coating of grease applied to the inside of the shear box may be used to reduce friction between the specimen and shear box. TFE-fluorocarbon coating may also be used on these surfaces instead of grease to reduce friction.

6.3 *Porous Inserts*—Porous inserts function to allow drainage from the soil specimen along the top and bottom boundaries. They also function to transfer shear stress from the insert to the top and bottom boundaries of the specimen. Porous inserts shall consist of silicon carbide, aluminum oxide, or metal which is not subject to corrosion by soil substances or soil moisture. The proper grade of insert depends on the soil being tested. The hydraulic conductivity of the porous insert shall be substantially greater than that of the soil, but shall be textured fine enough to prevent excessive intrusion of the soil into the pores of the insert; see Note 4. The diameter or width of the top porous insert or plate shall be 0.01 to 0.02 in. [0.25 to 0.5 mm] less than that of the inside of the shear box. The insert functions to transfer the shear stress to the soil and must be sufficiently coarse to develop interlock. Sandblasting or tooling the insert may help, but the surface of the insert shall not be so irregular as to cause substantial stress concentrations in the soil. Porous inserts shall be checked for clogging on a regular basis.

NOTE 4—Exact criteria for porous insert texture and hydraulic conductivity have not been established. The inserts have to be porous enough to allow drainage and make sure water can flow into the specimen to remove any capillary stresses within the test specimen. It is important that the hydraulic conductivity of the porous insert is not reduced by the collection of soil particles in the pores of the insert. Storing the porous inserts in a water filled container between uses will slow clogging. The inserts can be cleaned by flushing, boiling, or ultrasonic agitation.

6.4 *Loading Devices:*