Designation: D 3080 – 03

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

This standard is issued under the fixed designation D 3080; 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 a soil material in direct shear. The test is performed by deforming a specimen at a controlled strain rate on or near a single shear plane determined by the configuration of the apparatus. Generally, three or more specimens are tested, each under a different normal load, to determine the effects upon shear resistance and displacement, and strength properties such as Mohr strength envelopes.

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

1.3 The determination of strength envelopes and the development of criteria to interpret and evaluate test results are left to the engineer or office requesting the test.

1.4 The results of the test may be affected by the presence of soil or rock particles, or both, (see Section 7).

1.5 Test conditions including normal stress and moisture environment are selected which represent the field conditions being investigated. The rate of shearing should be slow enough to ensure drained conditions.

1.6 There may be instances when the gap between the plates should be increased to accommodate sand sizes greater than the specified gap. Presently there is insufficient information available for specifying gap dimension based on particle size distribution.

1.7 The values stated in inch-pound units are to be regarded as the standard. Within this test method the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of each other.

1.8 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026.

1.8.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 422 Method for Particle-Size Analysis of Soils[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft)[2]

D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56 000 ft-lbf/ft)[2]

D 1587 Practice for Thin-Walled Geotechnical Tube Sampling of Soils[2]

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock[2]

D 2435 Test Method for One Dimensional Consolidation Properties of Soils[2]

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[2]

D 4753 Specifications for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil Rock and

[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 Structural Properties of Soils.

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[2] *Annual Book of ASTM Standards,* Vol 04.08.

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

Construction Materials Testing[2]

D 6026 Practice for Using Significant Digits in Geotechnical Data[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D 653.

3.2 *Description of Terms Specific to This Standard:*

3.2.1 *Relative Lateral Displacement*—The horizontal displacement of the top and bottom shear box halves.

3.2.2 *Failure*—The stress condition at failure for a test specimen. Failure is often taken to correspond to the maximum shear stress attained, or the shear stress at 15 to 20 percent relative lateral displacement. Depending on soil behavior and field application, other suitable criteria may be defined.

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 frames that hold the test specimen, and displacing one frame horizontally with respect to the other at a constant rate of shearing deformation and measuring the shearing force and horizontal displacements as the specimen is sheared (Fig. 1).

5. Significance and Use

5.1 The direct shear test is suited to the relatively rapid determination of consolidated drained strength properties because the drainage paths through the test specimen are short, thereby allowing excess pore pressure to be dissipated more rapidly than with other drained stress tests. The test can be made on all soil materials and undisturbed, remolded or compacted materials. There is however, a limitation on maximum particle size (see 7.2).

5.2 The test results are applicable to assessing strength in a field situation where complete consolidation has occurred under the existing normal stresses. Failure is reached slowly under drained conditions so that excess pore pressures are dissipated. The results from several tests may be used to express the relationship between consolidation stress and drained shear strength.

5.3 During the direct shear test, there is rotation of principal stresses, which may or may not model field conditions. Moreover, failure may not occur on the weak plane since failure is forced to occur on or near a horizontal plane at 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 Shear stresses and displacements are nonuniformly distributed within the specimen, and an appropriate height is not defined for calculating shear strains or any associated engineering quantity. The slow rate of displacement provides for dissipation of excess pore pressures, but it also permits plastic flow of soft cohesive soils. Care should be taken to ensure that the testing conditions represent those conditions being investigated.

5.5 The range in normal stresses, rate of shearing, and general test conditions should be selected to approximate the specific soil conditions being investigated.

NOTE 1—Notwithstanding the statement on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing the test and the suitability of the equipment and facilities used. Agencies which meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means of evaluating some of these 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 thickness 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 the specimen in water. The device shall be capable of applying a shear force to 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 their 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, etc. Dissimilar metals, which may cause galvanic action, are 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 vertically by a horizontal plane into two halves of equal thickness which are fitted together with alignment screws. The shear box is also fitted with gap screws, which control the space (gap) between the top and bottom halves of the shear box.

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 horizontal 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

[3] *Annual Book of ASTM Standards,* Vol 04.09.

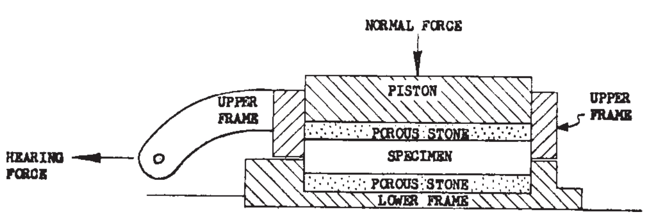

FIG. 1 Test Specimens in (*a*) Single and (*b*) Double Shear

depends on the soil being tested. The permeability of the insert should be substantially greater than that of the soil, but should be textured fine enough to prevent excessive intrusion of the soil into the pores of the insert. The diameter or width of the top porous insert or plate shall be 0.01 to 0.02 in. (0.2 to 0.5 mm) less than that of the inside of the ring. If the insert functions to transfer the horizontal stress to the soil, it must be sufficiently coarse to develop interlock. Sandblasting or tooling the insert may help, but the surface of the insert should not be so irregular as to cause substantial stress concentrations in the soil.

NOTE 2—Exact criteria for insert texture and permeability have not been established. For normal soil testing, medium grade inserts with a permeability of about 0.5 to 1.0×10^3 ft/yr (5.0×10^{-4} to 1.0×10^{-3} cm/s) are appropriate for testing silts and clays, and coarse grade inserts with a permeability of about 0.5 to 1.0×10^5 ft/yr (0.05 to 0.10 cm/s) are appropriate for sands. It is important that the permeability of the porous insert is not reduced by the collection of soil particles in the pores of the insert; hence frequent checking and cleaning (by flushing and boiling, or by ultrasonic cleaning) are required to ensure the necessary permeability.

6.4 *Loading Devices*:

6.4.1 *Device for Applying and Measuring the Normal Force*—The normal force is applied by a lever loading yoke which is activated by dead weights (masses) or by a pneumatic loading device. The device shall be capable of maintaining the normal force to within ±1 percent of the specified force quickly without exceeding it.

6.4.2 *Device for Shearing the Specimen*—The device shall be capable of shearing the specimen at a uniform rate of displacement, with less than ±5 percent deviation, and should permit adjustment of the rate of displacement from 0.0001 to 0.04 in./min (.0025 to 1.0 mm/min). The rate to be applied depends upon the consolidation characteristics of the soils (see 9.12.1). The rate is usually maintained with an electric motor and gear box arrangement and the shear force is determined by a load indicating device such as a proving ring or load cell.

6.4.3 The weight of the top shear box shall be less than 1 percent of the applied normal force: this will most likely require that the top shear box be supported by counter force and might require modifications to the equipment.

NOTE 3—Shearing the test specimen at a rate greater than specified may produce partially drained shear results that will differ from the drained strength of the material.

6.5 *Shear Force Measurement Device*—A proving ring or load cell accurate to 0.5 lbf (2.5 *N*), or 1 percent of the shear force at failure, whichever is greater.

6.6 *Shear Box Bowl*—A metallic box which supports the shear box and provides either a reaction against which one half of the shear box is restrained, or a solid base with provisions for aligning one half of the shear box, which is free to move coincident with applied shear force in a horizontal plane.

6.7 *Controlled High Humidity Room*, if required, for preparing specimens, such that water content gain or loss during specimen preparation is minimized.

6.8 *Trimmer or Cutting Ring*, for trimming oversized samples to the inside dimensions of the shear box with a minimum of disturbance. An exterior jig may be needed to maintain the shear box alignment.

6.9 *Balances*—a balance or scale conforming to the requirements of Specification D 4753 readable (with no estimate) to 0.1% or better.

6.10 *Deformation Indicators*—Either dial gages or displacement transformers capable of measuring the change in thickness of the specimen, with a sensitivity of at least 0.0001 in. (0.0025 mm) and to measure horizontal displacement with sensitivity of at least 0.001 in. (0.025 mm).

6.11 *Apparatus for Determination of Water Content*, as specified in Test Method D 2216.

6.12 *Equipment for Remolding or Compacting Specimens*, if applicable.

6.13 Miscellaneous Equipment, including timing device with a second hand, distilled or demineralized water, spatulas, knives, straightedge, wire saws, etc., used in preparing the specimen.

7. Test Specimen

7.1 The sample used for specimen preparation should be sufficiently large so that a minimum of three similar specimens can be prepared. Prepare the specimens in a controlled temperature and humidity environment to minimize moisture loss or gain.

7.1.1 Extreme care shall be taken in preparing undisturbed specimens of sensitive soils to prevent disturbance to the natural soil structure. Determine the initial mass of the wet specimen for use in calculating the initial water content and unit weight of the specimen.

7.2 The minimum specimen diameter for circular specimens, or width for square specimens, shall be 2.0 in. (50 mm), or not less than 10 times the maximum particle size diameter, whichever is larger, and conform to the width to thickness ratio specified in 7.4.

7.3 The minimum initial specimen thickness shall be 0.5 in. (12 mm), but not less than six times the maximum particle diameter.

7.4 The minimum specimen diameter to thickness or width to thickness ratio shall be 2:1.

NOTE 4—If large soil particles are found in the soil after testing, a particle size analysis should be performed in accordance with Method D 422 to confirm the visual observations, and the result should be provided with the test report.

7.5 *Specimen Preparation*:

7.5.1 *Undisturbed Specimens*—Prepare undisturbed specimens from large undisturbed samples or from samples secured in accordance with Practice D 1587, or other undisturbed tube sampling procedures. Undisturbed samples shall be preserved and transported as outlined for Group C or D samples in Practice D 4220. Handle specimens carefully to minimize disturbance, changes in cross section, or loss of water content. If compression or any type of noticeable disturbance would be caused by the extrusion device, split the sample tube lengthwise or cut it off in small sections to facilitate removal of the specimen with minimum disturbance. Prepare trimmed specimens, whenever possible, in an environment which will minimize the gain or loss of specimen moisture.

NOTE 5—A controlled high-humidity room is desirable for this purpose.

7.5.2 *Compacted Specimens*—Specimens shall be prepared using the compaction method, water content, and unit weight prescribed by the individual assigning the test. Assemble and secure the shear box. Place a moist porous insert in the bottom of the shear box. Specimens may be molded by either kneading or tamping each layer until the accumulative mass of the soil placed in the shear box is compacted to a known volume, or by adjusting the number of layers, the number of tamps per layer, and the force per tamp. The top of each layer shall be scarified prior to the addition of material for the next layer. The compacted layer boundaries shall be positioned so they are not coincident with the shear plane defined by the shear box halves, unless this is the stated purpose for a particular test. The tamper used to compact the material shall have an area in contact with the soil equal to or less than ½ the area of the mold. Determine the mass of wet soil required for a single compacted lift and place it in the shear box. Compact the soil until the desired unit weight is obtained. Continue placing and compacting soil until the entire specimen is compacted.

NOTE 6—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 during consolidation. However, the upper ring in some shear devices requires friction to support the ring after the shear plates have been gapped. A light coating of grease applied between the halves of the shear box may be used to reduce friction between the halves of the shear box during shear. TFE-fluorocarbon coating may also be used on these surfaces instead of grease to reduce friction.

NOTE 7—The required thickness of the compacted lift may be determined by directly measuring the thickness of the lift, or from the marks on the tamping rod which correspond to the thickness of the lift being placed.

NOTE 8—The decision to dampen the porous inserts by inundating the shear box before applying the normal force depends on the problem under study. For undisturbed samples obtained below the water table, the porous inserts are usually dampened. For swelling soils, the sequence of consolidation, wetting, and shearing should model field conditions. Determine the compacted mass of the specimen from either the measured mass placed and compacted in the mold, or the difference between the mass of the shear box and compacted specimen and the tare mass of the shear box.

7.6 Material required for the specimen shall be batched by thoroughly mixing soil with sufficient water to produce the desired water content. Allow the specimen to stand prior to compaction in accordance with the following guide:

Classification D 2487	Minimum Standing Time, h
SW, SP	No Requirement
M	3
SC, ML, CL	18
MH, CH	36

7.7 Compacted specimens may also be prepared by compacting soil using the procedures and equipment used to determine moisture-density relationships of soils (Test Methods D 698 or D 1557), and trimming the direct shear test specimen from the larger test specimen as though it were an undisturbed specimen.

8. Calibration

8.1 The calibration is to determine the deformation of the apparatus when subject to the consolidation load, so that for each normal consolidation load the apparatus deflection may be subtracted from the observed deformations. Therefore, only deformation due to sample consolidation will be reported for complete tests. Calibration for the equipment load-deformation characteristics need to be performed on the apparatus when first placed in service, or when apparatus parts are changed.

8.2 Assemble the direct-shear device with a metal calibration disk or plate of a thickness approximately equal to the desired test specimen and up to 1/4 in. (5 mm) smaller in diameter or width of the shear box.

8.3 Position the normal displacement indicator. Adjust this indicator so that it can be used to measure either consolidation or swell from the calibration disk or plate reading. Record the zero or "no load" reading.

8.4 Apply increments of normal force up to the equipment limitations, and record the normal displacement indicator reading and normal force. Remove the applied normal force in reverse sequence of the applied force, and record the normal displacement indicator readings and normal force. Average the values and plot the load deformation of the apparatus as a function of normal load. Retain the results for future reference in determining the thickness of the test specimen and compression within the test apparatus itself.

8.5 Remove the calibration disk or plate.

NOTE 9—Other methods of proven accuracy for calibrating the apparatus are acceptable.

9. Procedures

9.1 Assemble the shear box.

9.1.1 *Undisturbed Specimen*—Place moist porous inserts over the exposed ends of the specimen in the shear box; place the shear box containing the undisturbed specimen and porous inserts into the shear box bowl and attach the shear box.

NOTE 10—For some apparatus, the top half of the shear box is held in place by a notched rod which fits into a receptacle in the top half of the shear box. The bottom half of the shear box is held in place in the shear box bowl retaining bolts. For some apparatus, the top half of the shear box is held in placed by an anchor plate.

9.1.2 *Compacted Specimen*—Place the shear box containing the compacted specimen and porous inserts into the shear box bowl and attach the shear box.

9.2 Connect and adjust the shear force loading system so that no force is imposed on the load measuring device.

9.3 Properly position and adjust the horizontal displacement measurement device used to measure shear displacement. Obtain an initial reading or set the measurement device to indicate zero displacement.

9.4 Place a moist porous insert and load transfer plate on the top of the specimen in the shear box.

9.5 Place the normal force loading yoke into position and adjust it so the loading bar is horizontal. For dead load lever loading systems, level the lever. For pneumatic loading systems, adjust the yoke until it sits snugly against the recess in the load transfer plate, or place a ball bearing on the load transfer plate and adjust the yoke until the contact is snug.

9.6 Apply a small normal load to the specimen. Verify that all components of the loading system are seated and aligned. The top porous insert and load transfer plate must be aligned so that the movement of the load transfer plate into the shear box is not inhibited. Record the applied vertical load and horizontal load on the system.

NOTE 11—The normal stress applied to the specimen should be approximately 1 lbf/in.^{2} (7 kPa).

9.7 Attach and adjust the vertical displacement measurement device. Obtain initial reading for the vertical measurement device and a reading for the horizontal displacement measurement device.

9.8 If required, fill the shear box with water, and keep it full for the duration of the test.

9.9 Calculate and record the normal force required to achieve the desired normal stress or increment thereof. Apply the desired normal stress by adding the appropriate mass to the lever arm hanger, or by increasing the pneumatic pressure.

NOTE 12—The normal force used for the specimen will depend upon the data required. Application of the normal force in one increment may be appropriate for relatively firm soils. For relatively soft soils, application of the normal force in several increments may be necessary to prevent damage to the specimen.

9.10 Apply the desired normal load or increments thereof to the specimen and begin recording the normal deformation readings against elapsed time. For all load increments, verify completion of primary consolidation before proceeding (see Test Method D 2435). Plot the normal displacement versus either log of time or square root of time (in min).

9.11 After primary consolidation is completed, remove the alignment screws or pins from the shear box. Open the gap between the shear box halves to approximately 0.025 in. (0.64 mm) using the gap screws. Back out the gap screws.

9.12 Shear the specimen.

9.12.1 Select the appropriate displacement rate. Shear the specimen at a relatively slow rate so that no excess pore pressure would exist at failure. The following equation shall be used as a guide to determine the estimated minimum time required from the start of the test to failure:

$$t_f = 50t_{50}$$

where:

t_f = total estimated elapsed time to failure, min,
t_{50} = time required for the specimen to achieve 50 percent consolidation under the specified normal stress (or increments thereof), min.

NOTE 13—If the normal displacement versus square root of time used, t_{50} can be calculated from the time to complete 90 % consolidation using the following expression:

$$t_{50} = \frac{t_{90}}{4.28}$$

where:

t_{90} = time required for the specimen to achieve 90 percent consolidation under the specified normal stress (or increment thereof), min.
4.28 = constant, relates displacement and time factors at 50 and 90 percent consolidation.

NOTE 14—If the material exhibits a tendency to swell, the soil must be inundated with water and must be permitted to achieve equilibrium under an increment of normal stress large enough to counteract the swell tendency before the minimum time to failure can be determined. The time-consolidation curve for subsequent normal stress increments are then valid for use in determining t_f.

NOTE 15—Some soils, such as dense sands and over consolidated clays, may not exhibit well defined time-settlement curves. Consequently, the calculation of t_f may produce an inappropriate estimate of the time required to fail the specimen under drained conditions. For over consolidated clays which are tested under normal stresses less than the soil's pre-consolidation pressure, it is suggested that a time to failure be estimated using a value of t_{50} equivalent to one obtained from normal consolidation time-settlement behavior. For clean dense sands which drain quickly, a value of 10 min may be used for t_f. For dense sands with more than 5 % fines, a value of 60 min may be used for t_f. If an alternative value of t_f is selected, the rationale for the selection shall be explained with the test results.

9.13 Determine the appropriate displacement from the following equation:

$$d_r = d_f / t_f$$

where:

d_r = displacement rate (in./min, mm/min),
d_f = estimated horizontal displacement at failure (in., mm),
t_f = total estimate elapsed time to failure, min.

NOTE 16—The magnitude of the estimated displacement at failure is dependent on many factors including the type and the stress history of the soil. As a guide, use $d_f = 0.5$ in. (12 mm) if the material is normally or lightly over consolidated fine-grained soil, otherwise use $d_f = 0.2$ in. (5 mm).

9.13.1 *Select and Set the Displacement Rate*—For some types of apparatus, the displacement rate is achieved using combinations of gear wheels and gear lever positions. For other types the displacement rate is achieved by adjusting the motor speed.

9.13.2 Record the initial time, vertical and horizontal displacements, and normal and shear forces.

9.13.3 Start the apparatus and initiate shear.

9.13.4 Obtain data readings of time, vertical and horizontal displacement, and shear force at desired interval of displacement. Data readings should be taken at displacement intervals equal to 2 percent of the specimen diameter or width to accurately define a shear stress-displacement curve.

NOTE 17—Additional readings may be helpful in identifying the value of peak shear stress of over consolidated or brittle material.

NOTE 18—It may be necessary to stop the test and re-gap the shear box halves to maintain clearance between the shear box halves.

9.13.5 After reaching failure, stop the test apparatus. This displacement may range from 10 to 20 percent of the specimen's original diameter or length.

9.13.6 Remove the normal force from the specimen by removing the mass from the lever and hanger, or by releasing the pressure.

9.14 For cohesive test specimens, separate the shear box halves with a sliding motion along the failure plane. Do not pull the shear box halves apart perpendicularly to the failure surface, since it would damage the specimen. Photograph, sketch, or describe in writing the failure surface. This procedure is not applicable to cohesionless specimens.

9.15 Remove the specimen from the shear box and determine its water content according to Test Method D 2216.

9.16 *Calculate and Plot the Following*:

9.16.1 Nominal shear stress versus relative lateral displacement.

10. Calculation

10.1 Calculate the following:

10.1.1 Nominal shear stress, acting on the specimen is,

$$\tau = \frac{F}{A}$$

where:

τ = nominal shear stress (lbf/in.^{2}, kPa),
F = shear force (lbf, N),
A = initial area of the specimen (in.^{2}, mm^2).

10.1.2 Normal stress acting on the specimen is,

$$n = \frac{N}{A}$$

where:

n = normal stress (lbf/in.^{2}, kPa),
N = normal vertical force acting on the specimen (lbf, N).

NOTE 19—Factors which incorporate assumptions regarding the actual specimen surface area over which the shear and normal forces are measured can be applied to the calculated values of shear or normal stress, or both. If a correction(s) is made, the factor(s) and rationale for using the correction shall be explained with the test results.

10.1.3 *Displacement Rate*—Calculate the actual displacement rate by dividing the relative lateral displacement by the elapsed time, or report the rate used for the test.

$$d_r = d_h / t_e$$

where:

d_r = displacement rate (in.,min, mm,min),
d_h = relative lateral displacement (in.,mm),
t_e = elapsed time of test (min).

10.1.4 *Percent Relative Lateral Displacement*—Calculate the percent relative lateral displacement for each shear force reading.

$$d_p = d_i / d_h$$

where:

d_p = percent relative lateral displacement (%),
d_i = incremental displacement (in.,mm),

10.1.5 Compute the initial void ratio, dry unit weight and degree of saturation based on the specific gravity, initial water content, mass and volume of the total specimen. Specimen volume is determined by measurements of the shear box lengths or diameter and of the measured thickness of the specimen.

11. Report: Test Data Sheet(s)/Form(s)

11.1 The methodology used to specify how data are recorded on the data sheet(s)/form(s), as given below is covered in 1.8

11.2 Record as a minimum the following general information (data):

11.2.1 Sample identification, project and location.

11.2.2 Description of type of shear device used in test.

11.2.3 Description of appearance of the specimen, based on Practice D 2488 (Test Method D 2487 may be used as an alternative), Atterberg limits (Test Method D 4318), and grain size data (Method D 422), if obtained (see 7.4).

11.2.4 Description of soil structure, that is whether the specimen is undisturbed, remolded, compacted, or otherwise prepared.

11.2.5 Initial and final water content.

11.2.6 Dry mass and initial and final wet unit weight.

11.2.7 Initial and final dry unit weight.

11.2.8 Initial thickness and diameter (width for square shear boxes).

11.2.9 Normal stress, rate of deformation, shear displacement, and corresponding nominal shear stress values and specimen thickness changes.

11.2.10 Plot of log of time or square root of time versus deformation of those load increments where t_{50} was determined.

11.2.11 Plot of nominal shear stress versus percent relative lateral displacement.

11.2.12 Departure from the procedure outlines, such as special loading sequences or special wetting requirements.

12. Precision and Bias

12.1 *Precision*—Data are being evaluated to determine the precision of this test method. In addition, Subcommittee D18.05 is seeking pertinent data from users of the test method.

12.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

13. Keywords

13.1 compacted specimens; consolidated; direct-shear test; drained test conditions; Mohr strength envelope; shear strength; undisturbed

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (D 3080–98) that may impact the use of this standard.

(*1*) New Sections 1.8 and 1.8.1 were added to address significant digits.
(*2*) Previous section 1.7 was renumbered to 1.8.
(*3*) D854 was removed from Referenced Document section as the standard does not appear in the text.
(*4*) Practice D 6026 was added to the Referenced Document section.
(*5*) An editorial correction was made to 6.4.3.
(*6*) Permissive language was eliminated in sections 6.4.3, 7.1.1, and 7.5.2 ("should" was changed to "shall").
(*7*) Wording in section 6.9 was changed concerning balances.
(*8*) An editorial correction (grammatical) was made to section 9.14 — "described" was changed to "describe".
(*9*) Add calculation equation for percent relative lateral displacement in section 10.1.4, and renumbered following section.
(*10*) Note 13 was moved to the Scope section and subsequent sections were renumbered.
(*11*) Requirements for the calibration disk or plate was changed in Section 8.2.
(*12*) Section 11 was reformatted.
(*13*) A note was moved to the Scope section as 1.6.
(*14*) A grammatical correction was made to section 10.1.5.