Designation: D6467 – 13

Standard Test Method for Torsional Ring Shear Test to Determine Drained Residual Shear Strength of Cohesive Soils[1]

This standard is issued under the fixed designation D6467; 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 provides a procedure for performing a torsional ring shear test under a drained condition to determine the residual shear strength of cohesive soils. An intact specimen can be used for testing. However, obtaining a natural slip surface specimen, determining the direction of field shearing, and trimming and aligning the usually non-horizontal shear surface in the ring shear apparatus is difficult. As a result, this test method focuses on the use of a reconstituted specimen to measure the residual strength. This test method is performed by deforming a presheared, reconstituted specimen at a controlled displacement rate until the constant drained shear resistance is offered on a single shear plane determined by the configuration of the apparatus. An unlimited amount of continuous shear displacement can be achieved to obtain a residual strength condition. Generally, three or more normal stresses are applied to a test specimen to determine the drained residual failure envelope. A separate test specimen may be used for each normal stress.

1.2 A shear stress-displacement relationship may be obtained from this test method. However, a shear stress-strain relationship or any associated quantity, such as modulus, cannot be determined from this test method because soil extrusion and volume change prevents defining the height needed in the shear strain calculations. As a result, shear strain cannot be calculated but shear displacement can be calculated.

1.3 The selection of normal stresses and determination of the shear strength envelope for design analyses and the criteria to interpret and evaluate the test results are the responsibility of the engineer or office requesting the test.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.5 All measured and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D422 Test Method for Particle-Size Analysis of Soils
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D2435 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)
D3080 Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

[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.

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[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.

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

3.2.1 *consolidated*—soil specimen condition after primary consolidation under a specific normal stress.

3.2.2 *presheared*—soil specimen condition after shearing to at least one revolution of the ring in the direction of shear to create a failure surface prior to drained shearing.

3.2.3 *residual shear force*—the shear force is the average force being applied to the specimen when the shear resistance neither increases nor decreases with continued shear displacement.

3.2.4 *residual shear strength*—the minimum constant resistance of soil to shear along a fully developed failure surface and equals the residual shear force divided by the cross-sectional area of the specimen.

3.2.5 *drained residual strength state*—the state at which a soil exhibits residual shear strength and shear stress – shear displacement relationship becomes almost horizontal.

4. Summary of Test Method

4.1 This test method consists of placing the specimen in the annular specimen container, applying a predetermined normal stress through the top loading platen, providing for wetting and draining of the specimen (optional); consolidating the specimen under the normal stress; decreasing the normal stress to yield an overconsolidated specimen; preshearing the specimen by rotating the specimen container against the top loading platen for one revolution; applying a constant rate of shear deformation rotation; and measuring the torque/shearing force and rotation displacement until a constant value of shearing resistance is reached.

5. Significance and Use

5.1 The ring shear test is suited to the relatively rapid determination of drained residual shear strength because of the short drainage path through the thin specimen, and the capability of testing one specimen under different normal stresses to quickly obtain a shear strength envelope.

5.2 The test results are primarily applicable to assess the shear strength in slopes that contain a preexisting shear surface, such as old landslides, soliflucted slopes, and sheared bedding planes, joints, or faults.

5.3 The apparatus allows a reconstituted specimen to be overconsolidated and presheared prior to drained shearing. This simulates the field conditions that lead to a preexisting shear surface along which the drained residual strength can be mobilized.

5.4 The ring shear device keeps the cross-sectional area of the shear surface constant during shear and shears the specimen continuously in one rotational direction for any magnitude of displacement. This allows clay particles to become oriented parallel to the direction of shear and a residual strength condition to develop.

NOTE 1—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 testing. Users of this test method are cautioned that compliance with Practice D3740 does not ensure reliable testing. Reliable testing depends on several factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Shear Device,* to hold the specimen securely between two porous discs. The shear device provides a mean for applying a normal stress to the faces of the specimen, for measuring changes in thickness of the specimen, for permitting drainage of water through the porous discs at the top and bottom boundaries of the specimen, and for submerging the specimen in water. The device is capable of applying a torque to the specimen along a shear plane parallel to the faces of the specimen. A number of different ring shear devices are commercially available, in practice, or are being developed so a general description of a ring shear device is presented without schematic diagrams. The location of the shear plane depends on the configuration of the apparatus. As a result, the shear plane may be located near a soil/porous disc interface or at the mid-height of the specimen if an upper ring can be separated from a bottom ring as is done in a direct shear box. The device shall have low friction along the inner and outer walls of the specimen container developed during shearing. Friction may be reduced by having the shear plane occur at the top of the specimen container, modifying the specimen container walls with low-friction material. 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 a material such as stainless steel, bronze, or coated aluminum that is not subject to corrosion by moisture or substances within the soil. Dissimilar metals, which may cause galvanic action, are not permitted.

6.2 *Specimen Container,* a device containing an annular cavity for the soil specimen with an inside diameter not less than 50 mm (2 in.) and an inside to outside diameter ratio not less than 0.6. The container has provisions for drainage through the top and bottom. The initial specimen depth, before consolidation and preshearing, is not less than 5 mm (0.2 in.). The maximum particle size is limited to 10 % of the initial specimen height as stated in the test specimen description.

6.3 *Torque Arm/Loading Platen Assembly,* may have different bearing stops for the proving rings, load cells, or force or torque transducers to provide different options for the torque measurement.

6.4 *Porous Discs,* two bronze or stainless steel porous discs mounted on the top loading platen and the bottom of the specimen container cavity to allow drainage from the soil specimen along the top and bottom boundaries. The inserts aid in transfer of shear stress to the top and bottom boundaries of the specimen. The inserts must be sufficiently serrated to develop a strong interlock with the soil specimen. The permeability of the inserts 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. The outer and inner diameters of the inserts shall be 0.1 mm (0.004 in.) less, and greater than those of the specimen annular cavity, respectively. The serration should have a depth of between 10 and 15 % of the initial specimen height. The porous discs shall be clean and free from cracks, chips, and nonuniformities. New porous discs should be boiled for at least 10 minutes and left in the water to cool to ambient temperature before use. Immediately after each use, clean the porous discs with a nonabrasive brush and boil to remove clay particles that may reduce their permeability.

NOTE 2—Exact criteria for porous disc texture and permeability have not been established. The grade of the porous disc shall be fine enough to prevent intrusion of soil into the pores. For normal soil testing, medium-grade inserts with a permeability of about 5.0×10^{-4} to 1.0×10^{-3} cm/s (0.5 to 1.0×10^{3} ft/year) are appropriate for testing silts and clays. It is important that the permeability of the porous disc 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) is required to ensure that the permeability is not reduced.

6.5 *Loading Devices:*

6.5.1 *Device for Applying and Measuring the Normal Force*—Normal force is usually applied by a lever-loading yoke that is activated by dead weights (masses) or by any automatic loading mechanism. The device shall be capable of rapidly applying and maintaining the normal force to within ±1 % of the specified force.

6.5.2 *Device for Shearing the Specimen*—This device shall be capable of shearing the specimen at a uniform rate of rotation, with less than ±5 % deviation. The rate to be applied depends upon the consolidation characteristics of the soil (see 9.5.1). The rate is usually maintained with an electric motor and gear box arrangement.

6.6 *Shear Force Measurement Device,* two proving rings, load cells, in combination with a lever arm or a torque transducers accurate to measure a force of 0.2 N (0.05 lbf).

6.7 *Water Bath,* container for the shear device and water needed to inundate the specimen.

6.8 *Controlled High-Humidity Enviroment*—For preparing the specimen, such that the water content gain or loss during specimen rehydration is minimized.

6.9 *Deformation Indicators*—Dial gage, or other suitable device, capable of measuring the change in thickness of the specimen, with a sensitivity of 0.0025 mm (0.0001 in.). Etched scale on circumference of the ring base to measure the degrees traveled, and thus the shear displacement, or other methods capable of obtaining a sensitivity of 2°.

6.10 *Equipment for Determination of Water Content,* in accordance in Test Method D2216.

6.11 *Miscellaneous Equipment,* including timing device with a second hand, site-specific, test water (distilled or demineralized), mortar, pestle, spatulas, razor blades, straightedge, and so forth.

7. Test Specimen

7.1 The sample used for specimen preparation is to be sufficiently large so that a ring shear specimen and specimens for index property tests can be prepared.

7.2 If an intact specimen is desired, the sample obtained from the shear surface should be trimmed to produce an annular specimen. Trimming of specimen can be accomplished using an annular trimming ring to facilitate trimming and insertion of the specimen into the annular specimen container. A field shear surface may consist of small seams of clayey material surrounded by material with a coarser gradation. If so, only the clayey shear zone material should be tested and not the coarser surrounding material to simulate field shearing conditions. The intact specimen should be trimmed by ensuring minimization of moisture loss or gain.

7.3 Reconstituted silt and clay specimens may be prepared by crushing an air-dried representative sample and passing it through the U.S. Standards No. 200 sieve.

7.4 Reconstituted specimens of heavily overconsolidated clays, mudstones, claystones, and shales may be prepared by ball-milling an air-dried representative sample and passing it through the U.S. Standard No. 200 sieve. The ball-milling facilitates disaggregation of the clay particles and reduces the shear displacement required to achieve a residual strength condition. If ball-milling is not used, greater shear displacement will be required to disaggregate the clay particles and achieve a residual strength condition in the apparatus. The additional shear displacement can be large and create testing problems such as significant soil extrusion and wall friction.

7.5 Another technique for obtaining a reconstituted specimen is pushing a representative sample, at the as-received water content, through the U.S. Standard No. 200 sieve. Soil with more than 10 % organic content is to be reconstituted without drying.

7.6 After processing, the reconstituted sample should be mixed with site specific water/fluid or distilled water until a water content near the liquid limit is obtained. Using this water content minimizes the amount of air trapped during placement of the soil paste into the annular cavity of specimen container. A water content between the liquid and plastic limits can be used if air is not likely to be trapped in the annular cavity. The soil paste should then be allowed to rehydrate for 24 h preferably in a humidity control environment before transferring it to a specimen container.

7.7 Care is to be taken during crushing and mixing operations to avoid introducing impurities into the sample.

7.8 A spatula is used to place the soil paste into the annular specimen cavity. The top of the specimen is planed flush with the top of the specimen container.

7.9 The liquid limit, plastic limit, and clay-size fraction of the specimens are measured using the ball-milled or sieved soil samples that are used to create the test specimen.

8. Calibration

8.1 The calibration is to determine the deformation of the apparatus, exclusive from the specimen, when subjected to the consolidation load. The apparatus deformation at each consolidation load should be subtracted from the observed deformations during a test. Therefore, only deformation caused by specimen consolidation will be reported for complete tests.

8.2 Assemble the ring-shear device with the porous discs and a metal calibration disk or plate of a thickness approximately equal to the desired test specimen and slightly smaller in width. The metal calibration disk shall have parallel end surfaces finished to a high degree of precision, and be clean without any grit. Similarly, the sample holder shall be clean without any grit. Record the zero or "no load" reading.

8.3 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. Plot the load-deformation relationship 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.

8.4 Remove the calibration disk or plate.

8.5 Calibration for the equipment load-deformation characteristics needs to be performed on the apparatus when first placed in service, or when apparatus parts are changed.

NOTE 3—Other methods of proven accuracy for calibrating the apparatus are acceptable.

9. Procedure

9.1 Assemble the specimen container.

9.2 *Preconsolidation:*

9.2.1 Place and secure the specimen container containing the specimen into the empty water bath that is attached to the apparatus. Place the top platen with the moist porous disc over the top of the specimen.

9.2.2 Place a small seating load so that the normal stress applied to the specimen including the seating load and the top platen is approximately 3.0 kPa (0.4 psi).

9.2.3 Attach and adjust the vertical displacement measurement device and obtain the initial time and vertical displacement reading.

9.2.4 Fill the water bath with test water, and keep it full for the duration of the consolidation phase.

9.2.5 Consolidate the specimen to the highest desired normal stress for the shear strength envelope using a load increment ratio of unity. For each load increment, verify completion of primary consolidation using Test Method D2435 before proceeding.

9.2.6 When data for the maximum consolidation increment yields a well defined normal deformation versus log time relationship which extends into secondary compression, the relationship should be interpreted as in Test Method D2435 and the time to failure should be computed using the following equation:

$$t_f = 50 \ t_{50} \quad (1)$$

where:

t_f = total estimated elapsed time to failure, min, and
t_{50} = time required for the specimen to achieve 50 % consolidation under the maximum normal stress increment, min.

9.2.7 When data for the maximum consolidation increment do not satisfy the requirements of 9.2.5 but yield a well defined normal deformation versus root time relationship, the relationship should be interpreted as in Test Method D2435 and the time to failure should be computed using the following equation:

$$t_f = 11.6 \ t_{90} \quad (2)$$

where:

t_{90} = time required for the specimen to achieve 90 % consolidation under the maximum normal stress (increment), min.

9.3 *Wall Friction Reduction*—Wall friction may be significant during the shearing process causing an overestimate of the residual shear strength, therefore, reduction in wall friction is necessary. If the specimen container consists of a single piece of metal, the amount of wall friction depends on the magnitude of top platen settlement into the specimen container, type of soil, and material lining of the specimen container walls. In this type of specimen container, the thickness of soil trapped between the inner and outer walls of the specimen container and the upper porous disc should be minimized. If the specimen container can be separated into two pieces, the opening between the upper and lower halves should be wide enough to prevent particles from being trapped in the opening and that shearing occurs at this opening. Other techniques also can be used to reduce wall friction.

9.4 *Preshearing*—Create a shear surface using the following steps:

9.4.1 Unload the specimen to the lowest desired normal stress.

9.4.2 Swing the two proving rings or load cell assemblies toward the torque arm so that the two bearing adjustment rods create a right angle with the bearing stops on the torque arm. Secure the proving ring or load cell assemblies into place using clamps. A torque transducer assembly may not require this step.

9.4.3 Shear the specimen slowly by selecting the shear displacement rate less than 25 degrees/min. Specimen should be sheared by rotating the ring shear base to one complete revolution. Slow rate of shear displacement is selected to minimize soil extrusion.

9.4.4 Swing the proving ring or load cell rods away from the torque arm. A torque transducer assembly may not require this step.

9.4.5 Ensure dissipation of any excess pore water pressure induced during preshearing by allowing sufficient time to the specimen after preshearing until vertical displacement becomes almost negligible.

9.5 *Shearing:*

9.5.1 Select the appropriate displacement rate to minimize shear-induced pore water pressure. The following equation is used as a guide to estimate an appropriate rate of shear:

$$d_r = d_f / t_f \quad (3)$$

where:

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

NOTE 4—Rapid shearing of the test specimen may produce partially drained shear results that differ from the drained strength of the material. As a guide, a rotation rate of 0.03 degree/min is usually required for a clay of high plasticity with an initial specimen height of 5 mm (0.2 in.). This slow rotation rate can be used for other soils if better information to estimate shear rate is unavailable. Rotation rate is converted to displacement rate by considering the rotation along mean diameter of sample or the conversion factor provided in the manual.

NOTE 5—The magnitude of the estimated displacement at failure is dependent on many factors including the type of soil. As a guide, use d_f = 5 mm (0.2 in.) for a clay of high plasticity (CH) or a silt of high plasticity (MH), and use d_f = 2.5 mm (0.1 in.) for silt of low plasticity (ML), clay of low plasticity (CL), silty sand (SM), or clayey sand (SC).

NOTE 6—The preceding equation is being used to estimate the displacement rate for shearing an intact soil specimen in which the shear displacement required to reach the drained peak strength, or structure failure, can be easily defined. However, the equation can also be used as a guide for shearing a presheared specimen. Failure would be taken to correspond to the shear stress attained for the presheared specimen.

9.5.2 Set the shere displacement rate.

9.5.3 Activate the shear stress measurement system by repeating 9.4.2.

NOTE 7—The proving ring, load cell, or force transducer rods should be at a right angle to the torque arm. A small set square is useful in establishing right angles.

9.5.4 Record the initial time; vertical and shear displacements; and proving ring, load cell, force, or torque transducer readings.

9.5.5 Start the apparatus and initiate shear.

9.5.6 Obtain data readings of time, vertical and shear displacement, and shear force at desired intervals of displacement.

9.5.7 After the soil is in a well-defined residual strength state, stop the apparatus. The residual strength state is achieved when the shear stress – shear displacement relationship becomes almost horizontal, which usually requires a shear displacement of 10 mm (0.4 in.) for a presheared specimen. The residual strength state can be verified using the plotting technique in accordance with 10.2.1.

9.5.8 Deactivate shear stress measurement system.

9.5.9 Apply the next higher normal stress using a load increment ratio (LIR) of one-half or unity to minimize soil extrusion. LIR is defined as the change in pressure divided by the precondition pressure. Allow the specimen to dissipate excess pore water pressure induced by the increased normal stress by monitoring vertical displacement or volume change. Repeat the shearing process.

9.5.10 Continue this procedure until all of the specified normal stresses have been applied and all data have been recorded. Alternatively, a new specimen may be introduced for each desired normal stress.

9.5.11 Remove the normal force and swing the proving ring or load cell assemblies away from the torque arm. A torque transducer assembly may not require this step.

9.5.12 Separate the top platen from the specimen container with a sliding motion along the failure plane. Do not pull the top platen perpendicular to the failure surface, since it would damage the specimen. Photograph, sketch, or describe in writing the failure surface.

10. Calculation

10.1 Calculate the following:

10.1.1 Calculate average shear stress that resists slippage between the two surfaces of the failure plane as follows:

$$\tau = \frac{3(F_1 + F_2)L}{4\pi(R_2^3 - R_1^3)} \tag{4}$$

where:

τ = shear stress, MPa (lbf/in.^{2}),
F_1, F_2 = load on the proving rings, load cells, or force transducer, N (lbf),
R_1, R_2 = inner and outer specimen radii, mm (in.), and
L = torque arm length, mm (in.).

10.1.2 Calculate normal stress acting on the failure plane as follows:

$$\sigma' n = \frac{P}{\pi(R_2^2 - R_1^2)} \tag{5}$$

where:

$\sigma' n$ = normal stress, MPa (lbf/in.^{2}), and
P = normal vertical force acting on the specimen, N (lbf).

10.1.3 *Displacement Rate*—Calculate the actual average displacement rate by dividing the average shear displacement by the elapsed time, or report the rate used for the test:

$$d_r = d_h / t_e \tag{6}$$

where:

d_r = shear displacement rate, mm/min (in./min),
d_h = shear displacement, mm (in.) = degrees traveled $\left(\frac{\pi}{180°}\right)\left(\frac{R_1 + R_2}{2}\right)$, and
t_e = elapsed time of test, min.

10.2 *Shear Stress – Displacement and Shear Stress – Normal Stress Graphs:*

10.2.1 For each normal stress, prepare a graph of shear stress versus shear displacement. From these graphs, select the value of residual shear strength for each normal stress by determining the minimum shear stress value. The minimum shear stress occurs at the horizontal portion of the shear stress-shear displacement relationship.

10.2.2 Prepare a graph of normal stress versus shear stress using the same scale for each axis. Plot the values of residual shear strength determined in 10.2.1 and construct the shear strength envelope to define the residual shear strength of the soil as a function of normal stress. The shear strength envelope may be nonlinear, that is, stress dependent, and should pass through the origin.

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

11.1 The methodology used to specify how data are recorded on the test data sheets)/form(s), as given below, is covered in 1.5.

11.2 Record the following general information (data):

11.2.1 Sample/specimen identification information, such as Project No., Boring No., Sample No., Depth (units), Location, Type of Sample, for example, slip surface material.

11.2.2 Method of obtaining the sample.

11.2.3 Special selection and preparation process, such as removal of gravel or other materials, or identification of their presence, if intact or reconstituted specimen.

11.2.4 If the specimen is reconstituted or trimmed in a specialized manner, provide information on the method of reconstitution, etc.

11.2.5 Description of ring shear device used in this test method, including normal stress and shear stress application.

11.2.6 Description of ring shear monitoring equipment for shear stress, displacement, and normal stress used in this test method.

11.3 Record the following test specimen data:

11.3.1 Name of technician, date, time, and laboratory conditions (temperature, etc.).

11.3.2 The initial mass, length, diameter, area, and volume of the specimen, to either three or four significant digits.

11.3.3 Description of soil in the specimen, Classification D2487 for classification, Test Method D4318 for liquid and plastic limits, and Test Method D422 for grain size data.

11.3.4 Record specific gravity of soils as obtained using Test Method D854.

11.3.5 Initial water content of the prepared specimen as it is placed in the test apparatus using Test Method D2216 recorded to two or three significant digits.

11.3.6 Initial dry density or dry unit weight of the specimen at start of shear.

11.3.7 Initial percent saturation of the specimen and percent saturation at the end of the test.

11.3.8 Liquid limit, plastic limit, and clay-size fraction of the test specimen as obtained using Test Method D4318.

11.3.9 Whether or not the specimen is intact or reconstituted.

11.3.10 Whether or not the specimen was presheared and if so how the specimen was presheared and over what displacement.

11.3.11 Whether the same specimen or a new specimen was introduced for each normal stress.

11.4 Record the following test boundary conditions:

11.4.1 The magnitude of effective normal stress applied to the specimen to two or three significant digits.

11.4.2 Key specimen parameters prior to shearing, such as amount of settlement during consolidation, specimen thickness prior to shearing, amount of soil added to increase specimen thickness during or after consolidation, initial inner and outer radii of soil specimen.

11.5 Record the following shearing data:

11.5.1 The technique used to minimize wall friction between the top platen and specimen container walls.

11.5.2 The location of the failure surface.

11.5.3 Rate of shear displacement, and corresponding residual shear strength value and specimen thickness changes.

11.5.4 For each effective normal stress, a graph of shear stress versus shear displacement (see 10.2.1) and a graph of shear displacement versus vertical displacement.

11.5.5 A graph of effective normal stress versus shear stress showing the residual shear strength values and the constructed failure envelope (see 10.2.2).

12. Precision and Bias

12.1 *Precision*—The precision of Test Method D6467 is being determined and will be available on or before September 2012. It is not feasible to specify the precision of this test method at this time because no material having an acceptable reference value is available.

12.2 *Bias*—No information can be presented on the bias of Test Method D6467 because no material having an acceptable reference value is available.

13. Keywords

13.1 consolidated; drained test conditions; Mohr-Coulomb strength envelope; reconstituted specimens; residual shear strength; ring-shear test; torsional ring shear test

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D6467 – 06a) that may impact the use of this standard. (Approved May 1, 2013.)

(1) Replaced throughout the word 'undistrubed' with 'intact.'
(2) Added D3080 to Section 2 and added 9.2.6 and 9.2.7 to make it consistent with D3080.
(3) Added 3.2.5 and 11.3.1.
(4) Revised 6.8.
(5) Deleted 7.6 and Note 7, and renumbered subsequent areas accordingly.