Designation: D7608 – 10

Standard Test Method for Torsional Ring Shear Test to Determine Drained Fully Softened Shear Strength and Nonlinear Strength Envelope of Cohesive Soils (Using Normally Consolidated Specimen) for Slopes with No Preexisting Shear Surfaces[1]

This standard is issued under the fixed designation D7608; 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 fully softened shear strength and nonlinear strength envelope of cohesive soils. The fully softened strength is used to evaluate the stability of slopes that do not have a preexisting shear surface. In addition, the fully softened shear strength corresponds to the peak shear strength of a normally consolidated specimen. This test method focuses on the use of a reconstituted specimen to measure the fully softened strength. This test method is performed by shearing a normally consolidated, reconstituted specimen at a controlled displacement rate until the peak shear resistance has been obtained. Generally, the drained fully softened failure envelope is determined at three or more effective normal stresses. A separate test specimen must be used for each normal stress to measure the fully softened strength otherwise a post-peak or even residual strength will be measured if the same specimen is used because of the existence of a shear surface.

1.2 The ring shear apparatus allows a reconstituted specimen to be normally consolidated at the desired normal stress prior to drained shearing. This simulates the field conditions under which the fully softened strength develops in overconsolidated clays, claystones, mudstones, and shales.

1.3 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 possible 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.

1.4 The selection of normal stresses and final 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.

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

1.6 *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)
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
D6467 Test Method for Torsional Ring Shear Test to Determine Drained Residual Shear Strength of Cohesive Soils

[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.

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *fully softened shear force*—the shear force being applied to the specimen when the shear resistance begins to decrease with continued shear displacement.

3.2.3 *fully softened shear strength*—the maximum shear resistance of normally consolidated and not presheared soil to shear and equals the fully softened shear force divided by the cross-sectional area of the specimen. The fully softened shear strength should be used in an effective stress stability analysis of slopes in overconsolidated clays with no pre-existing shear surface. The shear strength can be represented by a failure envelope and the strength parameters of c' and Φ'.

4. Summary of Test Method

4.1 This test method consists of placing the reconstituted specimen (slurry or paste) 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; applying a constant rate of shear deformation; and measuring the shearing force and displacement until a maximum shear resistance is reached.

5. Significance and Use

5.1 The ring shear apparatus maintains 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 and along entire cross-sectional area.

5.2 The ring shear apparatus allows a reconstituted specimen to be consolidated at the desired normal stress prior to drained shearing. This simulates the field conditions under which the fully softened strength develops in overconsolidated clays, claystones, mudstones, and shales because the fully softened strength corresponds to the peak shear strength of a normally consolidated clay.

5.3 The ring shear test is suited to the relatively rapid determination of drained fully softened shear strength because of the short drainage path through the thin specimen and failure occurring near the top porous stone.

5.4 The ring shear test minimizes the effect of initial disturbance that may result from adjusting/creating a gap before starting shearing, especially in the direct shear device.

5.5 The test results are primarily applicable to assess the shear strength of overconsolidated soils for drained analysis in slopes that do not have a pre-existing shear surface, sheared bedding planes, joints, or faults.

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 inserts. The shear device shall provide a means 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 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 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 insert 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, or exposing the shear plane by separating the top and bottom portions of the specimen container. 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 Inserts*—two bronze or stainless steel porous inserts 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,