



Designation: D6528 – 17

Standard Test Method for Consolidated Undrained Direct Simple Shear Testing of Fine Grain Soils¹

This standard is issued under the fixed designation D6528; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This test method defines equipment specifications and testing procedures for the measurement of constant volume strength and stress-strain characteristics of cohesive soils after one-dimensional consolidation using a constant rate of simple shear deformation mode of loading. The constant volume condition is equivalent to the undrained condition for saturated specimens.

1.2 This test method is written specifically for devices that test rectangular parallelepiped or cylindrical specimens. Other more general devices, such as the torsional shear hollow cylinder, may be used to perform consolidated constant volume simple shear tests but are beyond the scope of this test method.

1.3 This test method is applicable to testing intact, laboratory reconstituted, and compacted soils, however, it does not include specific guidance for reconstituting or compacting test specimens.

1.4 It shall be the responsibility of the agency requesting this test to specify the magnitude of the vertical consolidation stress prior to constant volume shear and, when appropriate, the maximum vertical consolidation stress, which will result in an overconsolidated specimen.

1.5 *Units*—The values stated in SI units are to be regarded as the standard. No other units of measurement are included in this standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this test method.

1.5.1 In the engineering profession it is customary practice to use, interchangeably, units representing both mass and force, unless dynamic calculations ($F=Ma$) are involved. This implicitly combines two separate systems of units, that is, the absolute system and the gravimetric system. It is scientifically undesirable to combine two separate systems within a single standard. This test method has been written using SI units; however, inch-pound conversions are given in the gravimetric

system, where the pound (lbf) represents a unit of force (weight). The use of balances or scales recording pounds of mass (lbm), or the recording of density in lb/ft^3 should not be regarded as nonconformance with this test method.

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

1.6.1 The procedures used to specify how data are collected/recorded or calculated in this test standard are regarded as the industry standard. In addition, they are representative of the significant digits that should generally 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; it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this test standard to consider significant digits used in analysis methods for engineering design.

1.6.2 Measurements made to more significant digits or better sensitivity than specified in this standard shall not be regarded a nonconformance with this standard.

1.7 *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.*

1.8 *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

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

- D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
- D1587 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 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)
- D3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4220 Practices for Preserving and Transporting Soil Samples
- D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- D4452 Practice for X-Ray Radiography of Soil Samples
- D6026 Practice for Using Significant Digits in Geotechnical Data
- D6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- D7928 Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

one cycle of secondary compression or one day longer than the end of excess pore water pressure dissipation.

4.3 The specimen is sheared by displacing one platen tangentially relative to the other at a constant rate of displacement and measuring the resulting shear force. The platens are constrained against rotation and vertical movement throughout shear.

4.4 The specimen volume is held constant during shear to simulate undrained conditions. Constant volume is achieved by changing the vertical load applied to the specimen to maintain constant specimen height. Since the pore pressure is zero through shear, the change in vertical stress is equal to the change in effective stress and assumed to be equal to the change in pore water pressure that would occur in a sealed specimen confined by a constant vertical total stress.

NOTE 1—The quality of the result produced by this test standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities. Agencies that meet the criteria of Practice D3740 generally are considered capable of competent and objective testing/sampling/inspection/etc. Users of this test standard 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.

5. Significance and Use

5.1 The shear strength of a specimen depends on the method of shearing, soil type, vertical consolidation stress, time of consolidation, rate of strain, and prior stress history of the soil.

5.2 In this test, the shear strength is measured under constant volume conditions that are equivalent to undrained conditions for a saturated specimen; hence, the test is applicable to field conditions wherein soils have fully consolidated under one set of stresses, and then are subjected to changes in stress without time for further drainage to take place.

5.3 The constant volume (undrained) strength is a function of stress conditions. In this test method, the strength is measured under plane strain conditions and the principle stresses continuously rotate due to the application of shear stress. This simple shear stress condition occurs in many field situations including zones below a long embankment and around axially loaded piles.

5.4 The state of stress within the simple shear specimen is not sufficiently defined nor uniform enough to allow rigorous interpretation of the results. Expressing the data in terms of the shear stress and vertical effective stress on the horizontal plane is useful for engineering purposes, but should not be confused with the effective stress parameters derived from other shear tests having better defined states of stress.

5.5 The values of the secant shear modulus can be used to estimate the initial settlements of embankments built on saturated cohesive soils due to undrained shear deformations.

5.6 The data and the rate of consolidation from the consolidation portion of this test are comparable to results obtained using Test Methods D2435 provided that the more rigorous consolidation procedure of Test Methods D2435 is followed.

3. Terminology

3.1 Definitions:

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

3.2 *shear modulus, n* —a measure of a material's resistance to shear stress, equal to the ratio of the increment in the shear stress to the resultant increment in angle of deformation expressed in radians; also known as the modulus of rigidity.

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *active height control, n* —a method of keeping the height of the specimen constant during the shearing process in which the displacement control mechanism is physically adjusted in response to the vertical displacement measurement.

3.3.2 *passive height control, n* —a method of keeping the height of the specimen constant during the shearing process in which the specimen and force measuring device are clamped by a mechanism that is much stiffer than the specimen.

4. Summary of Test Method

4.1 In this test method a specimen of cohesive soil is constrained vertically between two parallel, rigid platens and laterally, such that the cross sectional area remains constant.

4.2 The specimen is loaded vertically and allowed to consolidate one-dimensionally. Each vertical load increment is maintained until excess pore water pressures are essentially dissipated as interpreted from the vertical displacement rate. The maximum vertical load is maintained until completion of

5.6.1 When using wire reinforced membranes the vertical displacements measured from Test Methods D2435 are somewhat smaller than for the direct simple shear test because the direct simple shear (DSS) specimen's lateral confinement is less rigid.

5.6.2 The estimated preconsolidation pressure is comparable provided the specimen is loaded sufficiently into the normally consolidated range.

6. Apparatus

6.1 Fig. 1 presents a schematic diagram of the necessary components for the apparatus.

6.2 *Vertical Loading Device*—A suitable device for applying vertical force to the specimen that must be capable of maintaining constant force during the consolidation phase of a test, permit quick application of force for consolidation increments, and allow continuous adjustment of force when using active height control or be rigidly locked in place when using passive height control.

6.3 *Shear Loading Device*—A suitable device for applying shear force to the specimen with sufficient capacity and control to deform the specimen at the required displacement rate. Displacement should be smooth and continuous. At a minimum, the displacement rate should be within $\pm 15\%$ of the average calculated rate (12.3.7) from 50% of the peak shear force to the end of the test. Vibration due to operation of this device should be sufficiently small so as not to cause visible ripples in a glass of water placed on the loading platform.

6.4 *Force Transducer*—Two suitable transducers: one for measuring vertical force and one for measuring shear force. Each transducer shall have the necessary capacity, be accurate to $\pm 1\%$ of the applied maximum force for a given test and have a readability of at least 4 significant digits of the applied maximum force for a given test. The transducers shall be insensitive to eccentric loading or installed in a fashion to eliminate eccentric loading. The compressibility of the shear measuring transducer shall not cause the deviation in shear displacement rate to exceed $\pm 15\%$ of the average rate. When

using passive height control, the compressibility of the vertical transducer plus compressibility of slide table must satisfy the deflection requirement of 6.9.

6.5 *Vertical Loading Ram*—A suitable device that must hold one platen parallel to the other while allowing vertical displacement of the specimen. If the piston resists the shear force, it must do so with negligible rotation of the platen.

6.6 *Shear Slide Table*—A suitable device that must hold the platens parallel to each other and allow shear displacement of the specimen. When using passive height control device the slide table's compressibility plus the compressibility of vertical transducer must satisfy the deflection requirement of 6.9. The slide table shall allow a sufficient displacement to provide a minimum of 30% shear strain.

6.7 *Lateral Confinement Device*—The specimen shall be constrained laterally such that the cross-sectional area at any location does not change by more than 0.1% during shear. In addition, the confinement must allow uniform shear deformation. Circular specimens are generally confined by a wire reinforced membrane or stacked rigid rings. Square specimens generally are confined by stacked hollow plates or hinged solid plates. The thickness of the individual stacked rings or plates must be less than $\frac{1}{10}$ of the specimen thickness in order to allow relatively uniform shear deformation. When the confining device is within a water bath, it shall be constructed of corrosion resistant material.

6.7.1 *Specimen Size Requirements:*

6.7.1.1 The minimum specimen diameter (or lateral dimension) shall be 45 mm.

6.7.1.2 The minimum specimen height shall be 12 mm.

6.7.1.3 The height to diameter, or minimum lateral dimension, ratio shall not exceed 0.4.

6.7.1.4 The specimen height shall not be less than ten times the maximum particle diameter (see 9.4).

6.7.2 *Platens*—The top and bottom platens of the apparatus shall be constructed of corrosion resistant material and have a circular, rectangular or square cross-section to match the specimen. The platens shall be designed to securely hold the

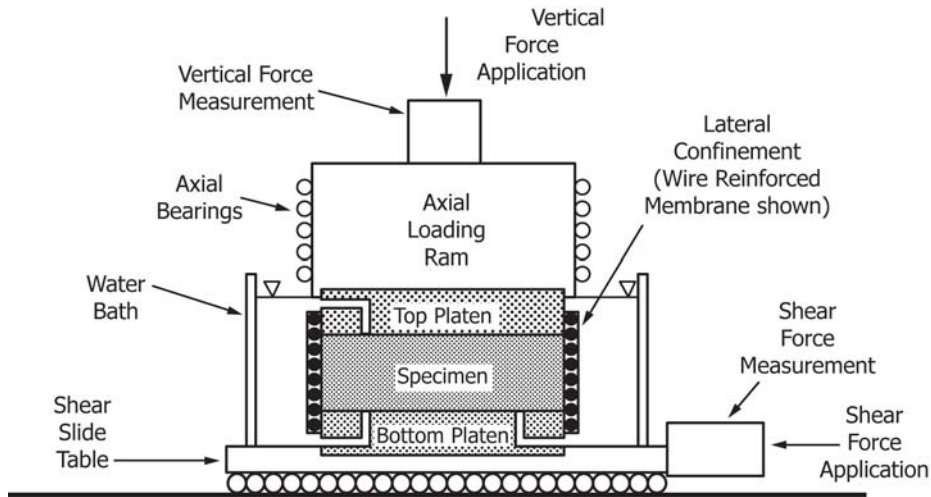


FIG. 1 Schematic Diagram of Direct Simple Shear Components

porous disks and provide drainage from the specimen to the water bath and transfer shear to the specimen without horizontal slippage.

6.7.3 Porous Disks—The porous disks shall be brass, silicon carbide, aluminum oxide, or similar rigid corrosion resistant material. The disks shall be flat, fine enough to prevent intrusion of the soil into the pores, and rough enough to transfer the shear stress. The disks must be at least ten times more permeable than the soil. Disks must cover at least 90 % of the specimen surface and when smaller than the specimen, must be recessed into the platen such that the surface in contact with the soil is flush with the platen.

NOTE 2—It is sometimes necessary to increase the surface roughness of the porous disks in order to prevent interface slippage. Short metallic pins cemented into the disks, knife edges and ridges have been used successfully but may introduce uncertainty in test results.

6.8 Displacement Indicators—Two suitable devices: one to measure the change in specimen height and one for measuring the shear deformation (vertical and lateral movement of top platen relative to bottom platen). These devices shall have a range of at least 50 % of the initial height of the specimen and shall have an accuracy of 0.25 %, or better of full range and a readability of at least 4 significant digits of the initial specimen height.

6.9 Volume Control Equipment—One of the two following methods may be used to achieve constant volume during shear. With either method, the specimen is free to drain and the measured change in vertical stress during shear is assumed to be equal to the pore pressure which would develop in a sealed specimen confined by a constant vertical total stress. In either case, the device shall not allow the specimen change in height to exceed 0.05 % including the equipment deformation determined in **10.1**.

6.9.1 Vertical Force Adjustment Device—Active height control requires a mechanism to continuously adjust the vertical force to prevent changes in the specimen height during shear.

NOTE 3—A variety of devices are used including manual adjustment of a worm gear, computer control of a worm gear, and computer control of a pneumatic cylinder.

6.9.2 Vertical Displacement Clamp—Passive height control requires a mechanism to lock the vertical loading ram in place during shear. The vertical force transducer must be moment insensitive and located between the specimen and the clamp or the specimen and the slide base.

6.10 Specimen Trimming Device (Optional)—A trimming turntable or a cylindrical cutting ring may be used for cutting the cylindrical specimens to the proper diameter. A wire saw and miter box or cutting shoe may be used for rectangular specimens. The top and bottom of the specimen may be rough trimmed with a wire saw. The flat surfaces must be finish trimmed with a sharpened straight edge and shall have a tolerance of ± 0.05 mm.

6.11 Specimen Setup Frame—A rigid frame to hold in alignment the bottom platen, the specimen in the trimming device, and expander containing the confinement device. The

frame must allow the trimmed specimen to be transferred from the trimming device to the confinement device with a minimum of disturbance.

6.12 Water Access System—A method to provide the specimen with free access to water at atmospheric pressure and prevent specimen drying due to evaporation. The entire specimen and confinement device may be submerged in a water bath or the end platens may be connected to a standpipe by flexible tubing. In either case, water must be available to both ends of the specimen by means of the porous disks.

6.13 Miscellaneous Equipment—Including timing device with one second readability, caliper, distilled or demineralized water, spatulas, knives, trimming blade and wire saws.

6.14 Balances, in accordance with Test Methods **D2216**.

6.15 Drying Oven, in accordance with Test Methods **D2216**.

6.16 Water Content Container, in accordance with Test Methods **D2216**.

6.17 Environment—Tests shall be performed in an environment where temperature fluctuations are less than $\pm 2^\circ\text{C}$ during shear, and there is no direct exposure to sunlight.

6.18 Trimming Environment—Trim the specimen in a glove box or room that has a high enough relative humidity to prevent changes in the water content of the soil.

6.19 Specimen Height Measurement Devices—A dial comparator or another suitable device shall be used to measure the height to four significant digits and shall be constructed so that its use will not indent or penetrate into the specimen.

7. Sampling

7.1 Intact Samples:

7.1.1 Intact samples having satisfactory quality for testing by this method may be obtained using procedures and apparatus described by Practices **D1587** and **D3550**. Specimens also may be trimmed from large intact block samples obtained and sealed in the field.

7.1.2 Intact samples to be tested by this method shall be preserved, handled and transported in accordance with the practices for Groups C and D samples in Practice **D4220**.

7.1.3 Intact samples shall be sealed and stored such that no moisture is lost or gained between sampling and testing. Storage time and temperature fluctuations should be reduced.

7.1.4 The quality of simple shear test results diminish greatly with sample disturbance. No sampling procedure can produce completely undisturbed samples; therefore, careful evaluation of the sample and selection of the highest quality material for testing is recommended for reliable testing.

NOTE 4—Evaluation for sample disturbance, stones or other inclusions, and selection of specimen location is greatly facilitated by x-ray radiography of the samples as described in Methods **D4452**.

7.2 Laboratory Reconstituted and Compacted Specimens:

7.2.1 Laboratory reconstituted and compacted specimens may be prepared from bulk homogeneous material.

7.2.2 Bulk material should be handled and transported in accordance with the practices for Group B samples of Practices **D4220**.

7.2.2.1 The material required for the specimen shall be batched by thoroughly mixing soil with sufficient water to produce the desired conditions. After batching, store the material in a covered container for at least 16 hours prior to specimen preparation.

8. Specimen Preparation

8.1 Reasonable precautions should be taken to reduce the potential for disturbance of the soil caused by vibration, distortion, and compression.

8.2 Test specimens and soil processing should be performed in an environment that prevents moisture change.

8.3 *Intact Specimens*—Trim the sample to the lateral dimension of the lateral confinement device to obtain the specimen.

8.3.1 Intact soil collected using sample tubes shall be at least 2.5 mm larger in each dimension than the specimen dimension except as specified in 8.3.2 and 8.3.3. Trim away the additional material using one of the following methods.

NOTE 5—The degree of sample disturbance is known to increase towards the perimeter of the tube sample, and therefore, it is better to use larger diameter samples where possible.

8.3.1.1 When using a trimming turntable and cylindrical specimens, make a complete perimeter cut, the width of the blade, to reduce the soil diameter to that of the confinement ring. Gradually advance the specimen into the ring by the width of the blade. Repeat until the specimen protrudes from the bottom of the ring.

8.3.1.2 When using a cutting shoe, trim the soil to a gentle taper in front of the cutting surface with a knife or spatula. After the taper is formed, advance the cutter a small distance to shave off the remaining soil and form the final diameter. Repeat the process until the specimen protrudes from the top of the cutter.

8.3.1.3 When using a miter box and parallelepiped specimens, trim each side of soft to medium stiff soil with a wire saw. Finish each surface with a sharpened straight edge. Stiff soil is best trimmed with a sharpened straight edge. The specimen shall have orthogonal surfaces.

8.3.2 Fibrous soils, such as peats, and those soils that are damaged easily by trimming, may be transferred directly from the sampling tube to the confinement device, provided that the device has the same dimensions as the sampling tube.

8.3.3 Specimens obtained using a ring-lined sampler may be used without prior trimming, provided they comply with the requirements of Practice D3550 and this test method.

8.4 *Laboratory Reconstituted and Compacted Specimens*—The method of preparation and specifications, such as water content, density, and compactive effort shall be stipulated by the agency requesting the test; however, the specimen must be fabricated using the guidelines specified in 8.4.1 – 8.4.3.

8.4.1 Compact batched material in layers using a pressing or kneading action into a preparation mold or directly into the cutting shoe. The top of each layer shall be scarified prior to addition of material for the next layer.

8.4.2 When soil is to be compacted directly into the cutting shoe, the specimen must be fabricated in at least three layers and the compacted material should be thicker than the final trimmed specimen.

8.4.3 When soil is compacted into an oversize preparation mold, compact using more than three layers and then trim the specimen using the intact preparation procedures.

8.5 Trim the top and bottom surfaces of the specimen to be flat and perpendicular to the specimen sides. This trimming may be accomplished using the rims of the cutting shoe or an additional alignment device. For soft to medium soils, a wire saw should be used to rough cut the surface. For stiff soils, and the final surfaces, a straightedge with a sharpened cutting surface should be used to make sure the surfaces are flat.

8.6 If a small rock particle is encountered in the surfaces being trimmed, it should be removed and the resulting void filled with soil from the trimmings.

8.7 Obtain two or three initial water content determinations of the soil in accordance with Test Methods D2216 from material trimmed adjacent to the test specimen if sufficient material is available or from the excess batched material.

8.8 Determine the initial moist mass of the specimen (M_{io}) to the nearest 0.01 g by direct measurement or when in the cutting shoe by measuring the mass of the shoe with specimen and subtracting the tare mass of the shoe.

8.9 Determine the initial height (H_o) of the specimen to the nearest 0.025 mm by taking the average of at least four evenly spaced measurements using a dial comparator or other suitable measuring device.

8.10 Use the specimen setup frame to insert the fully trimmed specimen into the confinement device.

8.11 Determine and record the diameter to the nearest 0.025 mm, such that the cross-sectional area (A) of the specimen may be calculated. The diameter and subsequent cross-section area, of the specimen may be taken as that of the confinement device or the cutting shoe.

8.12 When index properties are specified by the requesting agency, store the remaining trimmings taken from around the specimen and judged to be similar material in a sealed container for determination as described in Section 9.

9. Soil Index Property Determination

9.1 Determination of index properties is an important adjunct to, but not a requirement of, this test method. These determinations when specified by the requesting agency should be made on the most representative material possible. When testing uniform materials, the index tests may be performed on adjacent trimmings collected in 8.12. When samples are heterogeneous or trimmings are in short supply, index tests should be performed on material from the test specimen as obtained in 11.4.6.2, plus representative trimmings collected in 8.12. There will not be sufficient soil, however, from the test specimen to meet the minimum sample requirements of the following index tests.

9.2 *Specific Gravity*—The specific gravity (G_s) shall be determined in accordance with Test Methods D854 on material as specified in 9.1. The specific gravity determined from another sample judged to be similar to that of the test specimen

may be used for calculation in 12.1.5 whenever an approximate void ratio is acceptable.

9.3 *Atterberg Limits*—The liquid limit, plastic limit and plasticity index shall be determined in accordance with Test Methods D4318 using material from the sample as specified in 9.1. Determination of the Atterberg Limits are necessary for proper material classification and evaluation of test results. Atterberg Limits shall be determined on undried soil.

9.4 *Particle Size Distribution*—The particle size distribution shall be determined in accordance with the Test Method D6913 the minimum sample size requirement may not be met by the portion of the test specimen as obtained in 11.4.6.2. Particle size may be helpful when visual observation indicates that the specimen contains a substantial fraction of coarse grained material.

10. Calibration

10.1 The measured vertical displacements during consolidation must be corrected for apparatus compressibility.

10.1.1 Assemble the apparatus with a copper or steel disk of approximately the same size as the specimen.

10.1.2 Measure the vertical displacement (D_c) to the nearest 0.001 mm as the vertical force (V_c) is increased from the seating value to its maximum value and then returned to the seating value.

10.1.3 Graph or tabulate these displacements as a function of force.

10.2 The measured shear force must be corrected for the resistance of the lateral confinement whenever this value exceeds 1 % of the measured failure value. The resistance of the lateral confinement can be measured as described below.

10.2.1 Assemble the apparatus with the confinement device and a sealed water bag or frictionless bearing in place of the specimen, such that the separation between the platens is equal to the typical specimen height. Clamp the lateral confinement to the top and bottom platens to prevent it from rotating during the calibration.

10.2.2 Apply the shear displacement (δ_c) and measure and record the shear force (S_c) as the top platen is displaced relative to the bottom platen.

10.2.3 Graph or tabulate these forces as a function of shear displacement.

10.3 Depending on the apparatus configuration, it may be necessary to correct the measured vertical and shear force for the friction in the loading ram and the slide table, respectively. These corrections are necessary whenever the friction exceeds 0.2 % of the maximum value for a given test. The friction can be measured as described in 10.3.1 – 10.3.6.

10.3.1 Assemble the apparatus without the confinement device.

10.3.2 Measure and record the vertical load to four significant digits while displacing the piston in the loading direction, and then again while displacing the piston in the unloading direction.

10.3.3 Compute and record the vertical force piston friction (V_{pf}) as one half the difference between these two values to four significant digits.

10.3.4 Measure and record the shear force to four significant digits while displacing the shear piston in the loading direction, and then again while displacing the piston in the unloading direction.

10.3.5 Compute and record the shear force piston friction (S_{pf}) as one half the difference between these two values to four significant digits.

NOTE 6—It is often convenient to include the shear piston friction in the calibration of the resistance of the lateral confinement device as measured in 10.2.

10.3.6 Measure and record the mass of the top platen (M_{tp}) to the nearest 0.01 g.

11. Procedure

11.1 *Assembling the Equipment:*

11.1.1 The apparatus must be assembled in such a manner as to prevent a change in water content of the specimen. Dry porous disks must be used with dry, expansive soils, and may be used for other types of soils. Damp disks may be used with soils having low swell potential. Saturated disks may only be used with saturated soils that have a low affinity for water.

11.1.2 Arrange the loading devices, such that no force is being applied. Measure and record the vertical force (V_o) and shear force (S_o) zero readings to four significant digits.

11.1.3 Place the specimen assembly in the loading device, clamp it in place and apply a small vertical seating stress of approximately 5 kPa.

NOTE 7—The most appropriate vertical seating stress depends on the stiffness of the soil. It should be as large as possible to eliminate seating displacement errors yet not so large as to cause consolidation.

11.1.4 Immediately adjust the vertical displacement indicator, then measure and record the zero reading (D_o) to the nearest 0.001 mm. If necessary, add additional vertical stress to prevent swelling of the specimen. Conversely, if the specimen begins to compress, reduce the seating stress.

11.1.5 Adjust the shear displacement indicator, then measure and record the zero reading (δ_o) to the nearest 0.01 mm.

11.1.6 Inundate the specimen with water. When using dry or partially saturated stones, it may be necessary to flush water through the bottom, and top stones separately to provide the specimen with adequate access to water. As inundation and specimen wetting occur, increase the vertical stress as required to prevent swelling. Measure and record the vertical load required to prevent swelling and the resulting displacement reading to the nearest 0.001 mm.

11.2 *Consolidating the Specimen:*

11.2.1 Apply increments of constant total vertical force to consolidate the specimen to the stress level specified by the requesting agency. The loading schedule shall comply with the guidelines specified in 11.2.1.1 – 11.2.2.4.

11.2.1.1 If detailed compression characteristics, including the preconsolidation pressure, are to be measured then the load schedule shall conform to Test Methods D2435.

11.2.1.2 The standard loading shall consist of a load increment ratio (LIR) of unity that is obtained by doubling the stress on the soil for each increment. A LIR as large as two may be used for stresses below the preconsolidation pressure.