



Designation: D2166 – 06

Standard Test Method for Unconfined Compressive Strength of Cohesive Soil¹

This standard is issued under the fixed designation D2166; 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 unconfined compressive strength of cohesive soil in the intact, remolded, or reconstituted condition, using strain-controlled application of the axial load.

1.2 This test method provides an approximate value of the strength of cohesive soils in terms of total stresses.

1.3 This test method is applicable only to cohesive materials which will not expel or bleed water (water expelled from the soil due to deformation or compaction) during the loading portion of the test and which will retain intrinsic strength after removal of confining pressures, such as clays or cemented soils. Dry and crumbly soils, fissured or varved materials, silts, peats, and sands cannot be tested with this method to obtain valid unconfined compression strength values.

NOTE 1—The determination of the unconsolidated, undrained strength of cohesive soils with lateral confinement is covered by Test Method D2850.

1.4 This test method is not a substitute for Test Method D2850.

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

1.5.1 The procedures used to specify how data are collected/recorded and calculated in this test method 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; and it is common practice to increase or reduce significant digits of reported data to commensurate with these considerations. It is beyond the scope of this test method to consider significant digits used in analysis methods for engineering design.

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.05 on Strength and Compressibility of Soils.

Current edition approved July 15, 2006. Published January 2007. Originally approved in 1963. Last previous edition approved in 2000 as D2166 – 00^{e1}. DOI: 10.1520/D2166-06.

1.6 The values stated in SI units are to be regarded as the standard. The values stated in inch-pound units are approximate.

1.7 *This standard does not purport to address all of the safety problems, 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

- D653 Terminology Relating to Soil, Rock, and Contained Fluids
- D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
- D1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
- D2850 Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive 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
- D6026 Practice for Using Significant Digits in Geotechnical Data
- D6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

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. Terminology

3.1 *Definitions*—Refer to Terminology **D653** for standard definitions of terms.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *unconfined compressive strength (q_u)*—the compressive stress at which an unconfined cylindrical specimen of soil will fail in a simple compression test. In this test method, unconfined compressive strength is taken as the maximum load attained per unit area or the load per unit area at 15 % axial strain, whichever is secured first during the performance of a test.

3.2.2 *shear strength (s_u)*—for unconfined compressive strength test specimens, the shear strength is calculated to be $\frac{1}{2}$ of the compressive stress at failure, as defined in **3.2.1**.

4. Significance and Use

4.1 The primary purpose of the unconfined compression test is to quickly obtain a measure of compressive strength for those soils that possess sufficient cohesion to permit testing in the unconfined state.

4.2 Samples of soils having slickensided or fissured structure, samples of some types of loess, very soft clays, dry and crumbly soils and varved materials, or samples containing significant portions of silt or sand, or both (all of which usually exhibit cohesive properties), frequently display higher shear strengths when tested in accordance with Test Method **D2850**. Also, unsaturated soils will usually exhibit different shear strengths when tested in accordance with Test Method **D2850**.

4.3 If tests on the same sample in both its intact and remolded states are performed, the sensitivity of the material can be determined. This method of determining sensitivity is suitable only for soils that can retain a stable specimen shape in the remolded state.

NOTE 2—For soils that will not retain a stable shape, a vane shear test or Test Method **D2850** can be used to determine sensitivity.

NOTE 3—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing/sampling/inspection. Users of this standard are cautioned that compliance with Practice **D3740** does not in itself ensure reliable results. Reliable results depend on many factors; Practice **D3740** provides a means of evaluating some of those factors.

5. Apparatus

5.1 *Compression Device*, The compression device may be a platform weighing scale equipped with a screw-jack-activated load yoke, a hydraulic loading device, or any other compression device with sufficient capacity and control to provide the rate of loading prescribed in **7.1**. For soil with an unconfined compressive strength of less than 100 kPa (1.0 ton/ft²) the compression device shall be capable of measuring the compressive stress to within 1 kPa (0.01 ton/ft²). For soil with an unconfined compressive strength of 100 kPa (1.0 ton/ft²) or greater, the compression device shall be capable of measuring the compressive stress to the nearest 5 kPa (0.05 ton/ft²).

5.2 *Sample Extruder*, capable of extruding the soil core from the sampling tube at a uniform rate in the same direction of

travel in which the sample entered the tube, and with negligible disturbance of the sample. Conditions at the time of sample removal may dictate the direction of removal, but the principal concern is to reduce the potential for additional disturbance beyond that incurred during initial sampling.

5.3 *Deformation Indicator*, The deformation indicator shall be a dial indicator graduated to 0.03 mm (0.001 in.) or better and having a travel range of at least 20 % of the length of the test specimen, or some other measuring device, such as an electronic deformation measuring device, meeting these requirements.

5.4 *Dial Comparator*, or other suitable device, for measuring the physical dimensions of the specimen to within 0.1 % of the measured dimension.

NOTE 4—Vernier calipers are not recommended for soft specimens, which will deform as the calipers are applied on the specimen.

5.5 *Timer*, A timing device indicating the elapsed testing time to the nearest second shall be used for establishing the rate of strain application prescribed in **7.1**.

5.6 *Balance*, The balance used to weigh specimens shall determine the mass of the specimen to within 0.1 % of its total mass.

5.7 *Equipment*, as specified in Test Method **D2216**.

5.8 *Miscellaneous Apparatus*, including specimen trimming and carving tools, remolding apparatus, water content cans, and data sheets, as required.

6. Preparation of Test Specimens

6.1 *Specimen Size*—Specimens shall have a minimum diameter of 30 mm (1.3 in.) and the largest particle contained within the test specimen shall be smaller than one tenth of the specimen diameter. For specimens having a diameter of 72 mm (2.8 in.) or larger, the largest particle size shall be smaller than one sixth of the specimen diameter. If, after completion of a test on an intact specimen, it is found, based on visual observation, that larger particles than permitted are present, indicate this information in the remarks section of the report of test data (**Note 5**). The height-to-diameter ratio shall be between 2 and 2.5. Determine the average height and diameter of the test specimen using the apparatus specified in **5.4**. Take a minimum of three height measurements (120° apart), and at least three diameter measurements at the quarter points of the height.

NOTE 5—If large soil particles are found in the specimen after testing, a particle-size analysis performed in accordance with Test Method **D6913** may be performed to confirm the visual observation and the results provided with the test report.

6.2 *Intact Specimens*—Prepare intact specimens from large samples or from samples secured in accordance with Practice **D1587** and preserved and transported in accordance with the practices for Group C samples in Practices **D4220**. Tube specimens may be tested without trimming except for the squaring of ends, if conditions of the sample justify this procedure. Handle specimens carefully to reduce the potential for additional disturbance, changes in cross section, or loss of water content. If compression or any