
Standard Method of Test for Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO Designation: T 296-22

Technically Revised: 2022

Technical Subcommittee: 1a, Soil and Unbound Recycled Materials



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This test method covers the determination of unconsolidated strength and stress–strain relationships for a cylindrical specimen of either an undisturbed or remolded cohesive soil sheared undrained in compression at a constant rate of axial deformation (strain controlled). T 208 is a related test method to this standard, although not as controlled.
- 1.2. The test method provides for the calculation of total stresses on, and axial compression of, the test specimen by measurement of axial load and axial deformation.
- 1.3. The test provides data useful in determining strength and deformation properties of cohesive soils such as Mohr strength envelopes and Young’s modulus.
- 1.4. The determination of strength envelopes and the development of relationships to aid in interpreting and evaluating test results are left to the engineer or office requesting the test.
- 1.5. The values stated in SI units are to be regarded as standard.
- 1.6. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns 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.*
- 1.7. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - M 339M/M 339, Thermometers Used in the Testing of Construction Materials

- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- T 89, Determining the Liquid Limit of Soils
- T 90, Determining the Plastic Limit and Plasticity Index of Soils
- T 100, Specific Gravity of Soils
- T 207, Thin-Walled Tube Sampling of Soils
- T 208, Unconfined Compressive Strength of Cohesive Soil

2.2. *ASTM Standards:*

- D422, Standard Test Method for Particle-Size Analysis of Soils (withdrawn 2016; no replacement)
- D653, Standard Terminology Relating to Soil, Rock, and Contained Fluids
- D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D4220/D4220M, Standard Practices for Preserving and Transporting Soil Samples
- E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standard:*

- IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerance

3. TERMINOLOGY

3.1. *Definitions*—The definitions of terms used in this test method shall be in accordance with ASTM D653 or D2487.

3.2. *Description of Terms Specific to This Standard:*

3.2.1. *failure*—the stress condition at failure for a test specimen. Failure is often taken to correspond to the maximum principal stress difference (maximum deviator stress) attained or the principal stress difference (deviator stress) at 15 percent axial strain, whichever is obtained first during the performance of a test. Depending on soil behavior and field application, other suitable failure criteria may be defined, such as the principal stress difference (deviator stress) at a selected axial strain other than 15 percent.

3.2.2. *principal stress difference (deviator stress)*—the difference in magnitude between the major principal stress and minor principal stress; in a triaxial compression test, the stress due to the axial load that is applied in excess of the confining pressure.

3.2.3. *total stress, σ* —the total force per unit area acting within a soil mass. It is the sum of neutral and effective stresses ($\sigma' + \mu$).

4. SIGNIFICANCE AND USE

- 4.1. The strength in this test is measured under undrained conditions and is applicable to field conditions where soils are subjected to a change in stress without time for consolidation to take place (unconsolidated condition), and the field stress conditions are similar to those in the tests.
- 4.2. The shear strength determined from the test expressed in terms of total stresses or effective stresses is commonly used in embankment stability analyses, earth pressure calculations, and foundation design.

5. APPARATUS

- 5.1. The requirements for equipment needed to perform satisfactory tests are given in the following sections.
- 5.2. *Axial Loading Device*—The axial compression device may be a screw jack driven by an electric motor through a geared transmission, a hydraulic or pneumatic loading device, or any other compression device with sufficient capacity and control to provide the rate of axial strain (loading) described in Section 8.1.4. The rate of advance of the loading device should not deviate by more than ± 1 percent from the selected value. Vibration due to the operation of the loading device shall be sufficiently small to not cause dimensional changes in the specimen or to produce changes in pore-water pressure when the drainage valves are closed.
Note 1—A loading device may be judged to produce sufficiently small vibrations if there are no visible ripples in a glass of water placed on the loading platform when the device is operating.
- 5.3. *Axial Load-Measuring Device*—The axial load-measuring device may be a load ring, electronic load cell, hydraulic load cell, or any other load-measuring device capable of the accuracy prescribed in this paragraph and may be a part of the axial loading device. The axial load-measuring device shall be capable of measuring the axial load to an accuracy of within ± 1 percent of the axial load at failure. If the load-measuring device is located inside the triaxial compression chamber, it shall be insensitive to horizontal forces and to the magnitude of the chamber pressure.
- 5.4. *Triaxial Compression Chamber*—The triaxial chamber must be able to withstand a chamber pressure equal to the sum of the effective confining pressure and back pressure. It shall consist of a top plate and a baseplate separated by a cylinder. The cylinder may be constructed of any material capable of withstanding the applied pressures. It is desirable to use a transparent material or have a cylinder provided with viewing ports so the behavior of the specimen may be observed. The top plate shall have a vent valve such that air can be forced out of the chamber as it is filled. The baseplate shall have an inlet through which pressure liquid is supplied to the chamber.
Note 2—Although the confining fluid for this test is typically a liquid, compressed air or other gases may be successfully used. Use of air or other gases is a safety concern, however, about which the user must be aware and take reasonable safeguards.
- 5.5. *Axial Load Piston*—The piston passing through the top of the chamber and its seal must be designed so the variation in axial load due to friction does not exceed 0.1 percent of the axial load at failure and so there is negligible lateral bending of the piston during loading.
Note 3—The use of two linear ball bushings to guide the piston is recommended to minimize friction and maintain alignment.
Note 4—A minimum piston diameter of one sixth of the specimen diameter has been used successfully in many laboratories to minimize lateral bending.
- 5.6. *Chamber Pressure Control Device*—The chamber pressure control device shall be capable of applying and controlling pressure to within 2 kPa (± 0.25 psi) for chamber pressures less than