



Designation: D 4219 – 93a

Standard Test Method for Unconfined Compressive Strength Index of Chemical- Grouted Soils¹

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1. Scope

1.1 This test method covers the determination of the short-term unconfined compressive strength index of chemically grouted soils, using strain-controlled application of test load.

1.2 The values stated in inch-pound units are to be regarded as standard.

1.3 *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:

D 422 Method for Particle-Size Analysis of Soils²

D 2166 Test Methods for Unconfined Compressive Strength of Cohesive Soil²

D 3740 Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction²

D 4320 Test Method for Laboratory Preparation of Chemically Grouted Soil Specimens for Obtaining Design Strength Parameters²

E 4 Practices for Load Verification of Testing Machines³

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *chemical grout*—any grouting material characterized by being a pure solution; for example, no particles in suspension.

3.1.2 *curing conditions*—the environment, particularly temperature and humidity, and state of confinement at which a specimen is stored during the time interval between fabrication and testing.

3.1.3 *unconfined compressive strength*—the load per unit area at which an unconfined cylindrical specimen of soil will

fail in a simple compressive test. Failure is defined as the maximum load attained per unit area, or the load per unit area at 20 % strain, whichever occurs first.

4. Summary of Test Method

4.1 A cylindrical specimen of chemically grouted soil is subjected to a (approximate) constant rate of compressive strain until it fails.

5. Significance and Use

5.1 The purpose of this test method is to obtain values for comparison with other test values to verify uniformity of materials or the effects of controllable variables, in grout-soil compositions.

5.2 This test method is similar, in principle, to Test Methods D 2166, but is not intended for determination of strength parameters to be used in design. Such values are more properly obtained from long-term triaxial tests.

6. Apparatus

6.1 *Compression Device*—The compression testing machine may be of any type having sufficient capacity and control to provide the rate of loading prescribed in 8.4. It shall conform to the requirements of Section 15 of Practices E 4.

6.1.1 *Bearing Surfaces*—The testing machine shall be equipped with two steel bearing blocks having a Rockwell hardness of not less than 55 HRC. One of the blocks shall be spherically seated and normally will bear on the upper surface of the specimen. The other bearing block may be either a plain rigid block or spherically seated block on which the specimen will rest. The bearing faces shall not depart from a plane by more than 0.0004 in. (0.010 mm) when the blocks are new, and shall be maintained within a permissible variation of 0.001 in. (0.02 mm). The center of the sphere for the spherically seated block shall coincide with the center of the bearing face of the specimen. The movable portion of the bearing block shall be held closely in the spherical seat, but the design shall be such that the bearing face can be rotated and tilted through small angles in any direction.

6.1.2 *Deformation Indicator*, shall be a dial indicator graduated to 0.001 in. (0.02 mm) and having a travel range of at least 20 % of the length of the test specimen.

NOTE 1—For true strain measurements, particularly on stiff specimens,

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² *Annual Book of ASTM Standards*, Vol 04.08.

³ *Annual Book of ASTM Standards*, Vol 03.01.



the dial indicator attachment must be made so that average axial strain is measured. This eliminates the possibility of negative readings due to tilting of the load platens.

6.1.3 *Dynamometer*—The load-measuring devices shall be capable of measuring unit load to within 0.01 ton/ft² (0.15 psi) (1 kPa) for specimens with an unconfined compressive strength of less than 1 ton/ft² (15 psi) (100 kPa), and for stronger samples, the devices shall be capable of measuring unit load to the nearest 0.05 ton/ft² (0.75 psi) (5 kPa).

7. Preparation of Test Specimens

7.1 *Specimen Size*—The test specimens shall have a length-to-diameter ratio between 2 and 3, preferably 2.5. Sample diameter shall be greater than 10 times the maximum specimen particle size, and not less than 1.4 in. (35 mm). For procedures relating to particle-size analysis, see Method D 422. Test specimens shall be right circular cylinders. (When new test data are only for comparison with existing data from non-standard samples, sample dimensions conforming to those previously used are acceptable.)

7.2 *Specimen Fabrication*—Laboratory specimens shall preferably be made by pumping catalysed grout solution through the soil matrix utilizing procedures in Test Method D 4320. Specimens may also be made by pouring the soil matrix into a catalysed grout solution, or by adding catalysed grout to a container of soil matrix. If the latter two procedures do not produce uniform samples at the desired density, the pumping method must be used. (When new test data are only for comparison with existing data from non-standard preparation methods, the methods previously used are acceptable.)

7.3 *Curing Conditions*—Specimens should be cured under moisture conditions approaching those in situ. When in-situ conditions are not known, specimens should be cured in the containers in which they were made, stored under conditions which prevent moisture loss or volume change of the specimen. Permissible exceptions are for tests run to evaluate wet-dry and freeze-thaw cycles.

NOTE 2—Strength increases with time for many grout formulations.

7.4 *End Conditions*—The ends of specimens to be tested shall be smooth, perpendicular to the longitudinal axis, and of the same diameter as the specimen. Capping materials such as plaster of paris or neat cement, which do not change the grout characteristics at the contact zone, may be used to improve end conditions.

NOTE 3—Tensile failure (vertical cracking through the specimen ends) should be avoided by the use of capping materials.

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8. Procedure

8.1 Measure the specimen length and diameter to the nearest 0.01 in. (0.2 mm) at several places to obtain average values.

8.2 Check the ability of the spherical seat to rotate freely in its socket(s) before each test.

8.3 Clean the bearing faces of the upper and lower bearing blocks and of the test specimen and place the test specimen on the lower bearing block. Carefully align the axis of the specimen with the center of thrust of the spherically seated block(s). Adjust the movable portion of the spherically seated block so that uniform seating is obtained.

8.4 Apply the load continuously and without shock to produce an approximate constant rate of load or deformation. In no case shall failure occur in less than 2 min, nor shall maximum strain rate exceed 1 %/min.

NOTE 4—Stiffer materials require slower strain rates.

9. Calculation

9.1 Calculate the unconfined compressive strength of the specimen by dividing the maximum load carried by the specimen during the test by the initial cross-sectional area. The area may alternatively be calculated from dimensions obtained by direct measurement when the diameter can be measured.

10. Report

10.1 The following data shall be included in the report:

10.1.1 Specimen identification, classification, and other physical data that may be pertinent,

10.1.2 Specimen physical dimensions prior to testing,

10.1.3 Chemical grout composition and gel time,

10.1.4 Method of specimen preparation,

10.1.5 Details of curing conditions and age at time of test, and

10.1.6 Unconfined compressive strength.

11. Precision and Bias

11.1 *Precision*—Data are being evaluated to determine the precision of this test method. In addition, Subcommittee D18.16 is seeking pertinent data from users of this test method.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

12.1 chemical grout; chemical grouted soil; grouting; specimen fabrication; strength; unconfined compressive