Designation: D4219 – 22

Standard Test Method for Short-Term Unconfined Compressive Strength Index of Chemically Grouted Soils[1]

This standard is issued under the fixed designation D4219; 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 short-term unconfined compressive strength index of chemically grouted soils, using displacement-controlled application of test load.

1.2 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard.

1.2.1 It is common practice in the engineering/construction profession to concurrently use pounds to represent both a unit of mass (lbm) and of force (lbf). This practice implicitly combines two separate systems of units; the absolute and the gravitational systems. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. As stated, this standard includes the gravitational system of inch-pound units and does not use/present the slug unit of mass. However, the use of balances and scales recording pounds of mass (lbm) or recording density in lbm/ft^3 shall not be regarded as nonconformance with this standard.

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this test method.

1.3.1 For purposes of comparing a measured or calculated value(s) with specified limits, the measured or calculated value(s) shall be rounded to the nearest decimal of significant digits in the specified limit.

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

1.4 *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.*

1.5 *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

D2166/D2166M Test Method for Unconfined Compressive Strength of Cohesive Soil

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4320 Practice for Laboratory Preparation of Chemically Grouted Soil Specimens for Obtaining Engineering Parameters

D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

D6913/D6913M Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

3. Terminology

3.1 *Definitions:*

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

[1] This method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.16 on Grouting.

Current edition approved Oct. 1, 2022. Published October 2022. Originally approved in 1983. Last previous edition approved in 2008 as D4219 – 08, which was withdrawn January 2017 and reinstated in October 2022. DOI: 10.1520/D4219-22.

[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**

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *short-term unconfined compressive strength index, n*—the ratio of the load at which an unconfined cylindrical specimen of soil fails in a simple compressive test to the specimen initial area before testing.

4. Summary of Test Method

4.1 A cylindrical specimen of chemically grouted soil is subjected to a constant rate of compressive deformation until it fails. The ratio of the peak load at failure, or at 20 % strain, whichever occurs first, divided by the specimen area before testing is defined as the short-term unconfined compressive strength index.

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 Method D2166/D2166M, 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.

NOTE 1—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/etc. Users of this 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.

6. Apparatus

6.1 *Compression Device*—The compression testing device shall be any compression device with sufficient load and capacity, and displacement rate control to provide the rate of axial deformation prescribed in 8.4.

6.1.1 *Bearing Surfaces*—The compression device shall be equipped with two steel bearing blocks with an area at least as large as the specimen and 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 0.010 mm (0.0004 in.) when the blocks are new, and shall be maintained within a permissible variation of 0.02 mm (0.001 in.). 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.

6.2 *Deformation Indicator*—The deformation indicator shall be readable to 0.2 mm (0.01 in.), or better, and have a travel range of at least 20 % of the length of the test specimen.

6.2.1 For true strain measurements, particularly on stiff specimens, the deformation 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.

6.2.2 If true strain measurements are not required, platen movement may be used for strain control using either the deformation indicator or a displacement indicator internal to the compression device.

6.3 *Axial Load-Measuring Device*—The axial load-measuring devices shall be capable of measuring unit loadthe axial load to an accuracy of within 1 % of the axial load at failure.

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

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. Specimen diameter shall be greater than 10 times the maximum particle size, and not less than 35 mm (1.4 in.). For procedures relating to particle-size analysis, see Test Method D6913/D6913M. Test specimens shall be right circular cylinders. (When new test data are only for comparison with existing data from non-standard samples, specimen dimensions conforming to those previously used are acceptable.)

7.2 *Specimen Fabrication Preferable,* specimens are made by pumping catalyzed grout solution through the soil matrix utilizing procedures in Test Method D4320. Specimens may also be made by pouring the soil matrix into a catalyzed grout solution, or by adding catalyzed 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 water content 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) can be minimized by the use of capping materials.

8. Procedure

8.1 Measure the specimen length and diameter to the nearest 0.2 mm (0.01 in.) at three or more different locations and calculate an average value for each.

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 a constant rate of deformation without shock to produce an approximate constant rate of axial strain not exceeding 1 % per minute. In no case shall failure occur in less than 2 minutes. Continue increasing the deformations until the load indicator shows the load decreasing steadily and the specimen displays a well-defined failure pattern, or until 20 % strain is reached, whichever occurs first.

NOTE 4—Stiffer materials usually fail at smaller strains, and therefore, slower strain rates should be used.

8.5 Record the maximum load carried by the specimen to the nearest 5 N (1 lbf), or 1 % of the peak load, whichever is smaller.

9. Calculation

9.1 Calculate the short-term unconfined compressive strength index of the specimen by dividing the maximum load carried by the specimen during the test by the initial cross-sectional area of the specimen. Since this is an index measurement for comparing different grouting options, there is no need to do area correction calculations to determine the specimen area at failure.

NOTE 5—Accounting for area correction will not be regarded as nonconformance with this standard, but should be clearly stated and performed for all tests that will be compared as part of a testing program.

10. Report

10.1 The methodology used to specify how data are recorded on the test data sheet(s)/form(s), as given below, is covered in 1.3 and in Practice D6026.

10.2 Record as a minimum the following general information:

10.2.1 Specimen identification and classification,
10.2.2 Chemical grout composition and gel time,
10.2.3 Method of specimen preparation,
10.2.4 Details of curing conditions and age at time of test,
10.2.5 Other physical data that may be pertinent,
10.2.6 Identification of individual performing the test method,
10.2.7 Date test is performed.

10.3 Record as a minimum the following test data:

10.3.1 Specimen physical dimensions prior to testing,
10.3.2 Strain rate used during shearing, and
10.3.3 Short-term unconfined compressive strength index.

11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of this test method.

11.1.1 Subcommittee D18.16 is seeking any data from the users of this test method that might be used to make a limited statement on precision.

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

12. Keywords

12.1 chemical grout; chemically grouted soil; grouting; short-term unconfined compressive strength index; specimen fabrication; strength

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (2008) that may impact the use of this standard. (October 1, 2022)

(1) Title change: Added Short-Term and changed Chemical to Chemically.
(2) Section 1 was modified to match current standard requirements and caveats.
(3) Subsection 2.1: List of ASTM standards were updated to reflect current status.
(4) Subsection 3.1: "Definitions" were added.
(5) Throughout the standard: Unconfined compressive strength was changed to short-term unconfined compressive strength index to reflect what is being measured in this test.
(6) Main units were changed to SI.
(7) The apparatus, procedures, and reporting sections were updated.
(8) In Calculations, a statement on why no area correction is needed for this testing was added.
(9) Added Note 5.
(10) These changes address the comments made in previous ballots: D15_15(16-02) and D18(16-03)