Designation: D4219 – 08

Standard Test Method for Unconfined Compressive Strength Index of Chemical-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 strain-controlled application of test load.

1.2 *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.*

1.3 *This test method offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D422 Test Method for Particle-Size Analysis of Soils (Withdrawn 2016)[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2166 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 Design Strength Parameters

D6026 Practice for Using Significant Digits in Geotechnical Data

E4 Practices for Force Verification of Testing Machines

3. Terminology

3.1 For common definitions of terms used in this test method, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *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.

3.2.2 *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 Method D2166, 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

[1] This method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.15 on Stabilization With Admixtures.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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 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 E4.

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.

6.1.2.1 For true strain measurements, particularly on stiff specimens, 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/ft^2 (0.15 psi) (1 kPa) for specimens with an unconfined compressive strength of less than 1 ton/ft^2 (15 psi) (100 kPa), and for stronger samples, the devices shall be capable of measuring unit load to the nearest 0.05 ton/ft^2 (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 D422. 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 D4320. 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.

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.

10.2 Report significant digits in a manner consistent with D6026.