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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Methods for One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures[1]

This standard is issued under the fixed designation D 3877; 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 These test methods provide procedures for conducting expansion, shrinkage, and uplift pressure tests on compacted soil-lime mixtures and can be used to determine the lime content required to achieve desired control of volume changes caused by increases or decreases of moisture.

1.2 The tests can be used to determine *(1)* the magnitude of volume changes under varying load conditions, *(2)* the rate of volume change, and *(3)* the magnitude of pressure change as moisture changes of the soil-lime mixture take place. The permeability of soil-lime mixture can also, if desired, be determined at the various load conditions.

NOTE 1—Changes in field conditions can have major effects on the expansion and shrinkage characteristics of expansive soils. Therefore, to the greatest extent possible, initial and anticipated future field conditions should be duplicated, particularly with respect to moisture and density.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 51 Terminology Relating to Lime and Limestone (as used by the industry)[2]

D 427 Test Method for Shrinkage Factors of Soils[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]

D 698 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 2.49-kg (5.5 lb) Rammer and 305-mm (12-in.) Drop[3]

D 854 Test Method for Specific Gravity of Soils[3]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[3]

D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock[3]

D 2435 Test Method for One-Dimensional Consolidation Properties of Soils[3]

D 3551 Method for Laboratory Preparation of Soil-Lime Mixtures Using a Mechanical Mixer[3]

D 4943 Test Method for Shrinkage Factors of Soils by the Wax Method[4]

3. Terminology

3.1 Refer to Terminology C 51 for terms relating to lime.

3.2 Refer to Terminology D 653 for terms relating to soil.

4. Significance and Use

4.1 From these tests the relative expansive potential of soil-lime mixtures containing varying amounts of lime can be evaluated. From such an evaluation, the amount of lime required to reduce expansion to acceptable levels can be determined. The data can then be used for the design and specification requirements for structural fill and subgrade fill where expansive soils are encountered and it is desired to give a certain degree of expansion-shrinkage control to structure foundations and road subgrades. The tests will also show if the specific soils are amenable to lime stabilization.

5. Apparatus

5.1 The apparatus shall comply with the requirements of Test Method D 2435, except that the minimum specimen thickness shall be 19.0 mm (0.75 in.). The apparatus shall be capable of exerting a pressure on the specimen of at least 200 % of the maximum anticipated design load and at least the maximum uplift pressure.

5.2 *Micrometer Dial Gage*, mounted on the apparatus as shown in Fig. 1. Other equivalent arrangements may be used for mounting the gage. The sensitivity of the dial gage shall be ±0.0025 mm (±0.0001 in.).

5.3 *Ring Gage*, machined to the same height as the specimen ring to an accuracy of ±0.02 mm (±0.001 in.) and that can be fitted into the consolidometer.

5.4 *Consolidometer*, equipped with a lower drain cock and

[1] These test methods are under the jurisdiction of ASTM Committee D-18 on Soil and Rock and are the direct responsibility of Subcommittee D18.15 on Stabilization by Admixtures.

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[2] *Annual Book of ASTM Standards*, Vol 04.01.

[3] *Annual Book of ASTM Standards*, Vol 04.08.

[4] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

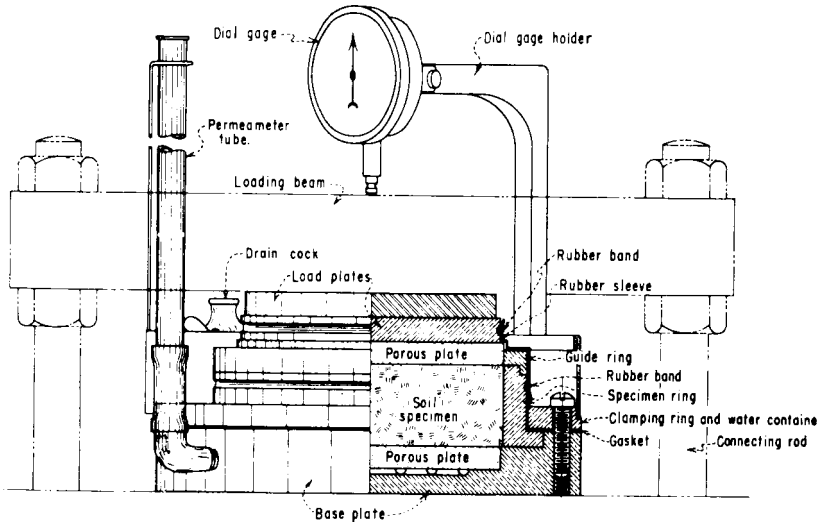

FIG. 1 Fixed-Ring Consolidometer

permeameter tube standpipe for removing any entrapped air below the specimen and for adding water to the specimen, respectively, as shown on Fig. 1.

5.5 *Extension Collar*, for compacting specimens, about 100 mm (4 in.) in depth and of the same diameter as the specimen ring.

NOTE 2—Specimens may be compacted in a mold larger than the specimen ring and the specimens trimmed to fit the specimen ring.

5.6 *Compaction Hammer*, of the type required for Test Methods D 698, Method A, or similar.

5.7 *Glass Plates*, two, to cover each consolidometer ring.

6. Sampling

6.1 Samples of natural soils for these tests may be obtained in accordance with Practice D 1452 or from other approved methods. The soil samples should not be oven dried prior to test specimen preparation.

7. Procedure

7.1 Assemble the consolidometer base, specimen ring, porous plates, and load plate with the ring gage in the empty specimen container with the same arrangement of parts to be used for testing the specimen.

7.2 Place the assembly in the loading apparatus in the same position it will occupy during the test.

7.3 Apply a load equal to a unit pressure of 2.4 kPa (50 lbf/ft^2) on the load plate.

7.4 Record the initial dial gage reading, r_1. Mark the parts of the apparatus so that they can be reassembled in the same matched position during the test on the soil-lime specimen.

7.5 Prepare a minimum of 1 kg (2 lb) of the soil-lime mixture with the desired lime and water contents in accordance with Method D 3551. The mixture shall have no particles larger than 4.75 mm (3⁄16 in., No. 4 sieve size).

7.6 Weigh the consolidometer ring.

7.7 With the extension collar in place on the assembled consolidometer ring, compact the specimen in the consolidometer ring to the desired wet unit weight by means of a suitable compaction hammer. The specimen should have a thickness of about 6 mm (¼ in.) greater than the depth of the ring gage.

7.8 Remove the extension collar and trim the excess material from the top of the specimen with a suitable straightedge or other tool.

7.9 Place a moisture sample of the trimmed material in an airtight container for later moisture content determinations in accordance with Test Method D 2216.

7.10 Immediately after trimming the compacted specimen, weigh the specimen and ring and cover the exposed surfaces of the specimen with glass plates held in place by clamps, until the specimen is placed in the loading device.

7.11 Compute the initial wet density of the specimen using the calculated volume of the consolidometer ring and the net weight of the specimen. The computed wet density shall be within 16.02 kg/m^3 (1 lb/ft^3) and 1 % water content of that required.

7.12 If the desired density is not obtained, discard the specimen. Repeat the compaction process, adjusting the compactive effort to achieve the desired unit weight.

7.13 Any curing for the soil-lime specimen shall be done at this time. Conduct all curing in suitable sealed containers to prevent moisture evaporation and carbonation of the lime.

7.14 At the end of the curing period, place the specimen with its confining consolidometer ring in the loading apparatus in accordance with Test Method D 2435, making certain that the parts are matched in the same matched position as that used for the initial calibration (4:1).

7.15 Apply a seating load equal to a pressure of 2.4 kPa (50 lbf/ft^2).

7.16 Record the dial gage reading, r_2. Use the difference of r_1 to r_2 to determine the exact height of the specimen.

8. Expansion Tests

8.1 The expansive characteristics of an expansive soil with or without lime treatment vary according to the applied stress paths.

8.2 At least two duplicate specimens are required for a complete test.

8.3 Using the procedures described in this method and in Test Method D 2435, determine the data for two series of tests: *(1)* loaded and expanded, whereby the unsoaked specimen is