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Standard Test Method for Vertical Strip Drains Using a Large-Scale Consolidation Test[1]

This standard is issued under the fixed designation D7498/D7498M; 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 is a performance test which measures the effectiveness of vertical strip drains on the time rates of consolidation of compressible soils from construction project sites.

1.1.1 It is expected that the design agency will be responsible for performing this test. It is not intended to be a manufacturer-performed test.

1.2 This test method is applicable to all vertical strip drains.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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]

D4354 Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing

D4439 Terminology for Geosynthetics

3. Terminology

3.1 *Definitions*—For definitions related to geosynthetics, see Terminology D4439.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *vertical strip drains, n*—a geocomposite consisting of a geotextile cover and drainage core installed vertically into soil to provide drainage for accelerated consolidation of soils.

4. Summary of Test Method

4.1 This test method describes procedures for determining the effectiveness of vertical strip drains used under specified soil conditions to enhance the time rate of consolidation of compressible soils.

4.2 A specimen of the vertical strip drain is inserted in the test chamber and compressible soil from the project site is remolded around the vertical strip drain, such that the drain is in a similar position as it would be on the project site.

4.3 The top of the soil is sealed with a wax seal, such that drainage only occurs through the vertical strip drain. The vertical strip drain protrudes up through the seal.

4.4 A sand drainage blanket is placed on top of the wax seal, such that the vertical strip drain drains into the sand blanket.

4.5 A rubber cup seal provides the means of applying incremental loads in a similar manner to a standard soils consolidation test.

4.6 A similar setup is used, only with a 50 mm [2 in.] sand drain in place of the vertical strip drain.

4.7 The coefficients of consolidation are determined from the test results for both the vertical strip drain and the sand drain. Time rates of consolidation are then compared.

4.8 Persons performing this test shall have knowledge in the consolidation testing of soils.

5. Significance and Use

5.1 As this is a time-intensive test, it should not be considered as an acceptance test for commercial shipments of prefabricated vertical strip drains.

5.2 Prior to the development of vertical strip drains, when it was desired to increase the rate of consolidation of a compressible soil on a construction project, large-diameter sand drains

[1] This test method is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.03 on Permeability and Filtration.

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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.

were installed. Vertical strip drains can be installed in areas where it is desired to increase the rate of soils consolidation in place of these large-diameter sand drains.

5.3 This test method can be used to compare the performance of vertical strip drains to that of sand drains.

6. Apparatus

6.1 The apparatus for this test method is a specialty piece of equipment that must be capable of safely handling loads up to 206.8 kPa [30 psi] using compressed air.

6.1.1 As this is a time-intensive test, it is recommended to have three test apparatus setups. This will allow simultaneous testing of three vertical strip drain specimens.

6.1.2 *Test Chamber*—A 254.0 mm [10 in.] diameter by 558.6 mm [22 in.] high by 12.7 mm [0.5 in.] wall thickness PVC pipe (Fig. 1).

6.1.2.1 *Drainage Ports*—Six 3.18 mm [0.125 in.] drainage ports are located 152.4 mm [6 in.] from the top, and equally spaced around the perimeter of the cylinder.

6.1.2.2 On the outside of the cylinder, at 180° to one another, two 19.05 mm [0.75 in.] thick acrylic hooks are located 25.4 mm [1 in.] from the bottom of the test chamber for the purpose of fastening the test chamber to the base plate.

6.1.3 *Base Plate:*

6.1.3.1 A 361.95 mm [14.25 in.] diameter PVC flat plate, 38.1 mm [1.5 in.] thick.

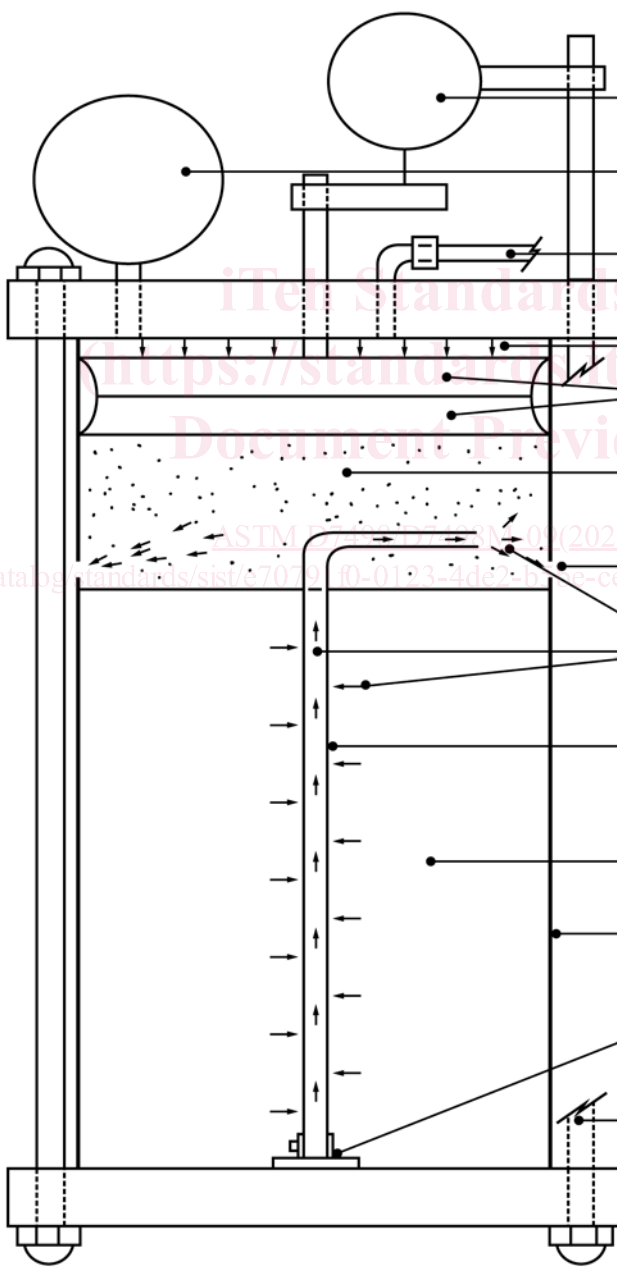

FIG. 1 Large-Scale Consolidator

6.1.3.2 The base plate has a 12.7 mm [0.5 in.] wide by 6.35 mm [0.25 in.] deep concentric groove, having an inside diameter of 254.0 mm [10 in.], located on the top side of the base plate.

6.1.3.3 A 3.17 mm [0.125 in.] by 228.6 mm [9 in.] diameter rubber O-ring is stretched and placed in this groove.

6.1.3.4 The test chamber is seated into the groove on top of the O-ring.

6.1.4 *Tension Rods:*

6.1.4.1 Equally spaced around the base plate, 158.75 mm [6.25 in.] from the center of the plate, are six 0.952 mm [0.375 in.] diameter by 76.2 mm [30 in.] long threaded tension rods.

6.1.4.2 Each tension rod is attached to the base plate by two hex nuts, one above the plate and one beneath.

6.1.4.3 On two 180° opposing tension rods place a wing nut that is used to secure the test chamber to the base plate via the hooks referred to in 6.1.2.2.

6.1.5 *Double Cup Seal Assembly:*

6.1.5.1 This is used to evenly distribute the consolidation load over the soil in the test chamber. It consists of the following parts:

6.1.5.2 Two 254.00 mm [10 in.] diameter by 4.76 mm [0.3125 in.] thick rubber cup seals that are placed back to back. They are sandwiched between two 241.3 mm [9.5 in.] diameter by 12.7 mm [0.5 in.] flat PVC plates.

6.1.5.3 A 12.7 mm [0.5 in.] diameter by 228.6 mm [9 in.] long center rod centrally located on the cup seal assembly. It is attached to the assembly by a ball-and-socket device.

6.1.5.4 A removable PVC platform that is attached to the center rod after the test chamber is completely assembled. This is used to seat the deflection dial or transducer on.

6.1.6 *Top Plate:*

6.1.6.1 An identical plate to the base plate, including the groove for test chamber seating, and holes for tension rods to go through.

6.1.6.2 A 3.17 mm [0.125 in.] by 228.6 mm [9 in.] diameter rubber O-ring is stretched and placed in the groove.

6.1.6.3 A threaded 6.35 mm [0.25 in.] diameter hole going completely through the top plate into which a brass fitting is mounted. The air supply line is attached to this fitting. The consolidation loads are applied through this air line.

6.1.6.4 The double cup seal assembly is mounted through a hole in the center of the top plate. The cup seals are placed such that they will be inside the test chamber.

6.1.6.5 A pressure gauge for reading the applied air pressure is mounted to the top plate such that it reads the pressure inside the test chamber.

6.1.7 A deflection dial or electronic displacement transducer graduated in 0.0254 mm [0.001 in.] divisions.

6.1.7.1 The deflection measuring device is attached to the top plate by mounting it on a rod mounted to the outer edge of the top plate.

6.1.8 *Vertical Strip Drain Mount*—A flat PVC plate cut to fit the inside of the test chamber.

NOTE 1—See Figs. 1 and 2 for schematic diagrams of the test apparatus.

7. Materials

7.1 *Project Soil*—A quantity of in-situ compressible soil large enough to perform the number of required tests shall be obtained from the project site. This does not have to be undisturbed soil.

NOTE 2—The quantity of soil needed shall be figured based on filling the test chamber to a height of 381 mm [15 in.] at the desired density.

7.2 *Silicone Spray*—The spray is used to lubricate the inside surface of the test chamber to minimize friction between the soil and the chamber surface.

8. Hazards

8.1 There are no known hazards with the materials or in performing the test.

9. Sampling, Laboratory Samples, and Test Specimens

9.1 *Lot Sample*—As a lot sample for acceptance testing, take the number of units as directed in Table 3 in Practice D4354. Consider rolls of the vertical strip drain to be the primary sampling units.

9.2 *Laboratory Sample*—Take for the laboratory sample a sample 1829 mm [72 in.] in length from each of the lot samples. Before taking the laboratory sample, remove the outer layer of drain from the sample roll to avoid testing any damaged material.

9.3 *Test Specimens*—From each laboratory sample cut three test specimens, each 508.0 mm [20 in.] long, making sure each end of the specimen is cut square.

9.3.1 At one end of each test specimen cut three notches 6.35 mm [0.25 in.] by 12.7 mm [0.5 in.] long. Each notch should line up with the mounting bolts in the specimen mount. See Fig. 1.

9.3.2 Place a 25.4 mm [1 in.] wide piece of masking tape around each test specimen, covering the area from 374.6 mm to 400.0 mm [14.75 to 15.74 in.] of the length of each specimen.

10. Test Setup

10.1 Compute the total wet mass of soil to be used in each chamber by multiplying the desired wet density by the volume the soil will occupy. This is the initial mass of soil.

10.2 Taking a small portion of the wet soil from 10.1, determine and record the initial moisture content of the soil to be placed in the test chamber using Eq 1:

$$w_i = [(W_T - W_S)/W] \times 100\,\% \quad (1)$$

where:

w_i = initial moisture content (%),
W_T = total wet mass of soil (g), and
W_S = dry mass of soil (g).

10.3 Secure the test chamber to the bottom base, making sure that the O-ring seal is in place in the base plate.

10.4 Draw a line around the inside of the test chamber 381.0 mm [15 in.] up from the top surface of the base plate. This is the height to which the soil will be placed, and is the initial height of soil in the test chamber.

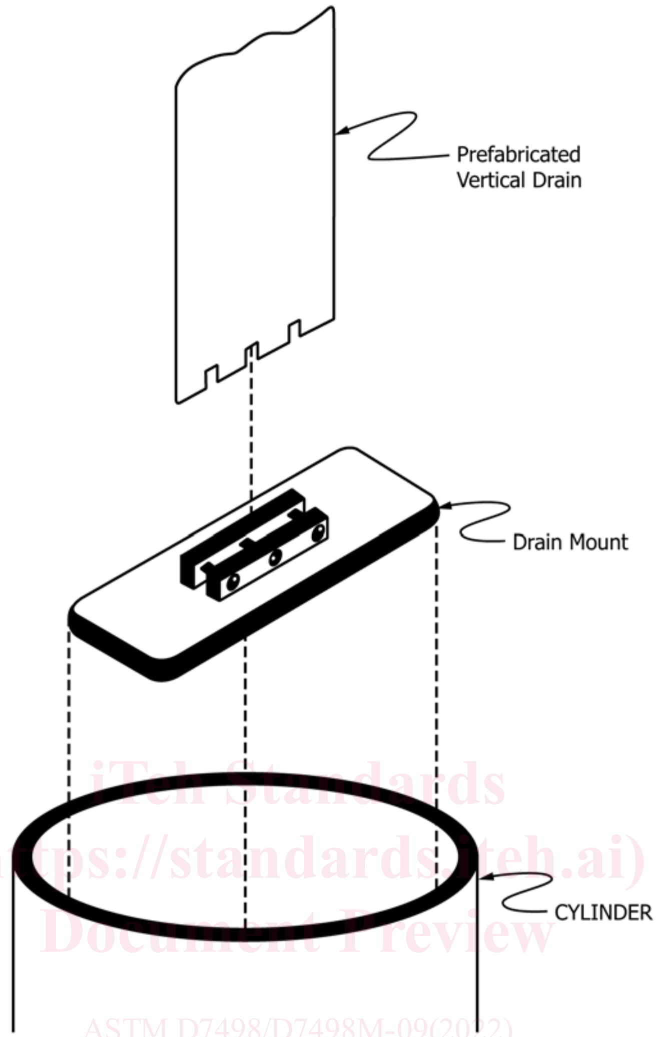

FIG. 2 Prefabricated Vertical Strip Drain Mount

10.5 Spray non-stick silicone spray around the inside surface of the test chamber. This will reduce sidewall fiction between the soil and the test chamber as consolidation takes place.

10.6 Assemble the test specimen to the specimen mounting plate by placing the three pre-cut notches over the assembly bolts and tightening these bolts. Place the assembly in the test chamber.

10.7 Weigh and record the test chamber, bottom base plate, prefabricated vertical strip drain and holder, and assembly rods weight.

10.7.1 Leaving the items in 10.6 on the scale, tare the scale out.

NOTE 3—If the scale can be locked, lock the platform in place after taring out. Then set the scale for the desired mass of soil to be added in the next step.

10.8 *Soil Placement*—Holding the prefabricated vertical strip drain in a vertical position, start placing the soil into the test chamber. Distribute evenly around the drain using hand pressure and kneading to eliminate voids and achieve a uniform density. Add soil in layers of equal thickness until the final placed layer reaches the line drawn in 10.4. Be sure to keep the test specimen in a vertical position as the chamber is filled with soil.

10.8.1 The moisture content, percent saturation, and placement density shall be as required by specifier.

10.8.2 Clean any excess soil from the walls of the test chamber and then unlock the scale and check to see that the desired mass of soil has been placed in the chamber.

10.9 Apply another coating of non-stick silicone spray to the inside exposed test chamber wall.

10.10 Place a 9.52 mm to 12.7 mm [0.375 to 0.5 in.] layer of molten wax on the entire top surface of the soil, allowing it to seal against the taped section of the test specimen. Make sure that wax does not splash on exposed portion of test specimen or the walls of the test chamber.

10.11 With a thin-bladed spatula carefully cut around the perimeter of the test chamber between the wax seal and the wall to break any bonding of the seal to the wall.

10.12 Place a uniform 25.4 mm [1 in.] layer of moist silica sand on top of the hardened wax seal. Fold the test specimen