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StandardTest Method for Density and Unit Weight of Soil in Place by the Sleeve Method[1]

This standard is issued under the fixed designation D4564; 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.

ε^1 NOTE—A typo in A1.5.1 was corrected editorially in May 2011.

1. Scope*

1.1 This test method covers the determination of the density of soil in place by the sleeve method.

1.2 The sleeve method of determining the density of soil in place is used for cohesionless, granular soils for which other methods of determining the density (sand cone, test pit, and the like) may not be practical. Typically, the sleeve method is applicable for soils that are predominantly fine gravel size, with a maximum of 5 % fines, and a maximum particle size of ¾ in. (19.0 mm).

NOTE 1—There have been other methods developed for testing cohesionless soils. Compared to other methods, this procedure is convenient for field construction control testing because smaller and lighter equipment is used and the test can be performed in a smaller area.

1.3 A calibration equation is necessary in the application of this test method to obtain a reliable value of the in-place density of the soil (see Annex A1). The calibration equation is used to calculate the density of the soil in place from the mass of dry soil per inch of test hole measured by the sleeve method.

1.3.1 The calibration equation is predetermined for a particular soil type that is to be tested. When the soil changes significantly in either gradation or particle angularity, the calibration equation may have to be adjusted or redefined before the sleeve method can be used.

1.3.2 There may be certain soils meeting the general description in 1.2 for which a calibration equation may not be appropriate due to unsatisfactory correlation of the data. The sleeve method would not be applicable for these soils.

1.3.3 There may be certain soils meeting the description in 1.2 for which the calibration equation may be applicable only for a certain range of densities. The sleeve method will give reliable values of the density in place only within that range of densities.

1.4 This test method uses inch-pound units with SI rationalized units; that is, a combined standard.

1.4.1 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4.2 The converted inch-pound units used the gravitational system of units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs. The converted slug unit is not given, unless dynamic (F = ma) calculations are involved.

1.4.3 It is common practice in the engineering profession to concurrently use pounds to represent both a unit of mass (lbm) and a unit of force (lbf). This implicitly combines two separate systems of units; that is, the absolute system and the gravitational system. It is scientifically undesirable to combine the use of two separate sets of inch-pound units within a single standard. This standard has been written using the gravitational system of units when dealing with the inch-pound system. In this system the pound (lbf) represents a unit of force (weight). However, the use of balances or scales recording pounds of mass (lbm), or the recording of density in lbm/ft^3 should not be regarded as nonconformance with this test method.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026 unless superseded by this standard.

1.5.1 The procedures used to specify how data are collected, recorded or calculated in this 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 or reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analytical methods for engineering design.

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.08 on Special and Construction Control Tests.

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

1.6 *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:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

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

D4253 Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

D4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

D4643 Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating

D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing

D4959 Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating

D6026 Practice for Using Significant Digits in Geotechnical Data

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration equation*—relationship between the density of a soil in place and the mass of dry soil per inch of test hole, using the sleeve method. A linear relationship between the two values is assumed.

4. Summary of Test Method

4.1 In this test method, the density is determined by inserting a metal sleeve into the soil to be tested, removing the soil within the sleeve, and determining the dry mass of soil removed per linear inch of the depth of the excavation within the sleeve. The mass per inch is related to the dry density of the in-place material using a calibration equation that has been predetermined for the particular soil being tested.

5. Significance and Use

5.1 This test method is used to determine the density of cohesionless soil used in the construction of earth embankments and road fills, or of cohesionless soils used for structure backfill, bedding and backfill for pipe, or filters. This test method is used as the basis for acceptance of soils compacted to a specified density or to a specified relative density.

5.2 This test method may be useful in determining the density of cohesionless soils in a confined or limited space since this test method requires less working area than other methods.

5.3 A predetermined calibration equation is necessary to use this procedure (see Annex A1). It is assumed there is a linear relationship between the density in place and the mass of dry soil per inch of test hole measured by the sleeve method. This may not be true for certain soils or the linear relationship may exist only for a particular range of densities.

5.4 The quality of the results 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. 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 *Sleeve Apparatus*—The sleeve apparatus shall consist of a sleeve base plate, sleeve, measurement plate, and driver. The apparatus shall conform to the requirements shown in Fig. 1.

6.2 *Balances*—For determining the water content, a balance or scale having a minimum capacity of about 1000 g and meeting the requirements of Specification D4753 for a balance for 0.1-g readability. For the in-place density determination and development of the calibration equation, the balances or scales used must conform to the requirements and principles of Specification D4753.

6.3 *Drying Equipment*—An oven, in accordance with Method D2216, for drying water content samples, and assorted dishes and pans.

6.4 *Miscellaneous Equipment*—A shovel, for preparing test surface; nails and hammer for securing sleeve base plate; scoops and spoons for digging test hole; buckets with lids or other suitable containers for retaining the density sample without moisture loss; a trisquare or machinist's square for measuring the depth of the density hole; and a vernier caliper or inside micrometer caliper to measure the diameter of the sleeve.

7. Technical Considerations

7.1 Consistency in the gradation and particle angularity of the soil being tested is critical to the test. Redetermining the calibration equation may be required if changes in material gradation or particle angularity, or both, occur. The person performing the test must be aware of the characteristics of the soil used to determine the calibration equation and evaluate whether or not the soil being tested is significantly different.

7.2 The test is operator sensitive. If accurate test results are to be achieved, strict adherence to the procedures set forth in

[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.

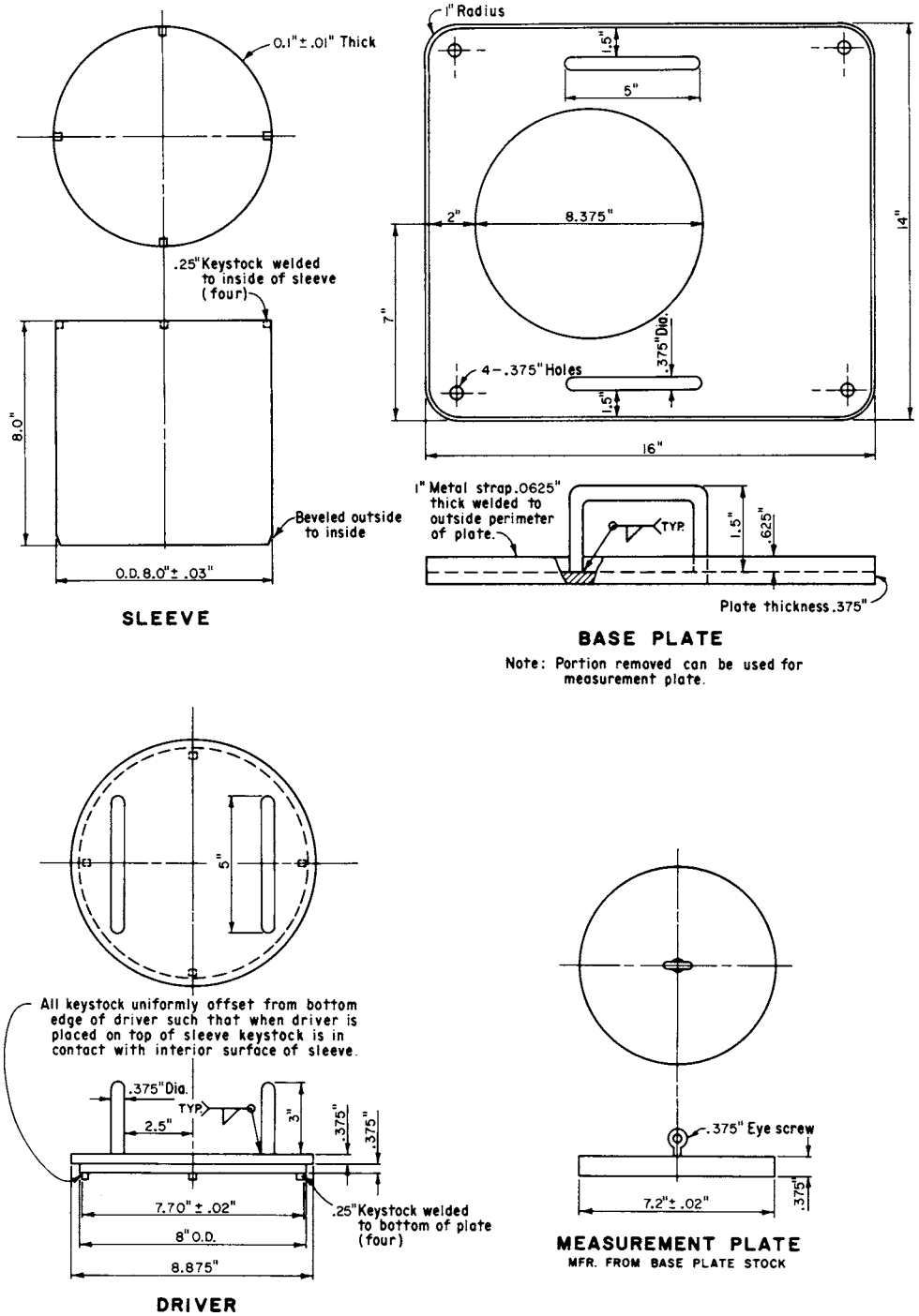

FIG. 1 Density Sleeve Apparatus

this test method is crucial. In particular, there must be adherence to the following techniques:

7.2.1 Rotate the sleeve into the soil in a clockwise direction only.

7.2.2 The sleeve advancement into the soil must follow the penetration sequence (one-half length of sleeve, three-fourths length of sleeve, etc.) determined in the calibration procedure.

7.2.3 The sleeve penetration into the soil should be perpendicular to the base plate with as little variation as possible.

7.2.4 Soil should never be excavated from below the leading edge of the sleeve.

NOTE 2—Since this test is sensitive to procedural techniques, operator experience in performing in-place density tests is desirable. Trial determinations should be performed before using the test procedure as a basis of acceptance for construction control.

7.3 Test results are not direct. A calibration equation must be applied to the mass of dry soil per inch of test hole to arrive at the in-place dry density.