



Standard Test Method for Density of Soil in Place by the Sleeve Method¹

This standard is issued under the fixed designation D 4564; 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 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 $\frac{3}{4}$ 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 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/ft³ should not be regarded as nonconformance with this test method.

1.5 *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:

D 653 Terminology Relating to Soil, Rock, and Contained Fluids²

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures²

D 4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table²

D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density²

D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil, Rock, and Construction Material Testing²

E 11 Specification for Wire-Cloth Sieves for Testing Purposes³

3. Terminology

3.1 Definitions—Except as listed below, all definitions are in accordance with Terminology D 653.

3.1.1 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve.

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 working a metal sleeve into the soil to be tested, removing the soil

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² Annual Book of ASTM Standards, Vol 04.08.

³ Annual Book of ASTM Standards, Vol 14.02.

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 roadfills, 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.

6. Apparatus

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

6.2 *Balances*—For determining the moisture content, a balance or scale having a minimum capacity of about 1000 g and meeting the requirements of Specification D 4753 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 D 4753.

6.3 *Drying Equipment*—An oven, in accordance with Method D 2216, for drying moisture content samples, and assorted dishes and pans.

6.4 *Miscellaneous Equipment*—A shovel, for preparing test surface; nails and hammer for securing sleeve baseplate; 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 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 baseplate 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.

7.4 The sleeve(s) should be checked periodically for wear (see 8.2.3). If the cutting edge has become dull or damaged, it may be repaired if the angle and length of the bevel is maintained.

8. Calibration

8.1 Determine the calibration equation in accordance with Annex A1.

8.2 Calibration of the Sleeve:

8.2.1 Using either a vernier caliper or inside micrometer caliper, determine the inside diameter of the sleeve just above the beveled edge in three locations spaced equally around the circumference of the sleeve. If any two measurements differ by 0.10 in. (2.5 mm), the sleeve is out of round and should not be used. Repeat this procedure after every 100 tests.

8.2.2 If more than one sleeve is to be used to determine the calibration equation or for measuring the in-place density, the diameter measurements for the sleeves shall not differ more than 0.05 in. (1.3 mm). There should be some control over the amount of the bevel on sleeves that are going to be used interchangeably.

8.2.3 If from wear, a diameter measurement shows a 0.05-in. (1.3-mm) difference from the initial measurement, the sleeve(s) should either not be used or a new calibration equation should be determined. New sleeves shall have diameter measurements within 0.05 in. of the sleeves used to determine the calibration equation.

8.2.4 Each sleeve shall be permanently identified with some type of marking on the sleeve.

9. Procedure

9.1 Prepare a smooth, level working area (Note 3). Place the baseplate on the designated area, making sure there are no air gaps underneath, and nail into place.

NOTE 3—The working area may need to be at a sufficient depth below the surface of the soil to avoid material possibly disturbed by surface traffic.

9.1.1 Take care throughout the test procedure not to apply pressure on the soil surface adjacent to the baseplate which could possibly disturb the in-place condition of the soil. Construction or other activity should be stopped in the vicinity of the test to avoid disturbance of the soil by either pressure or vibration.

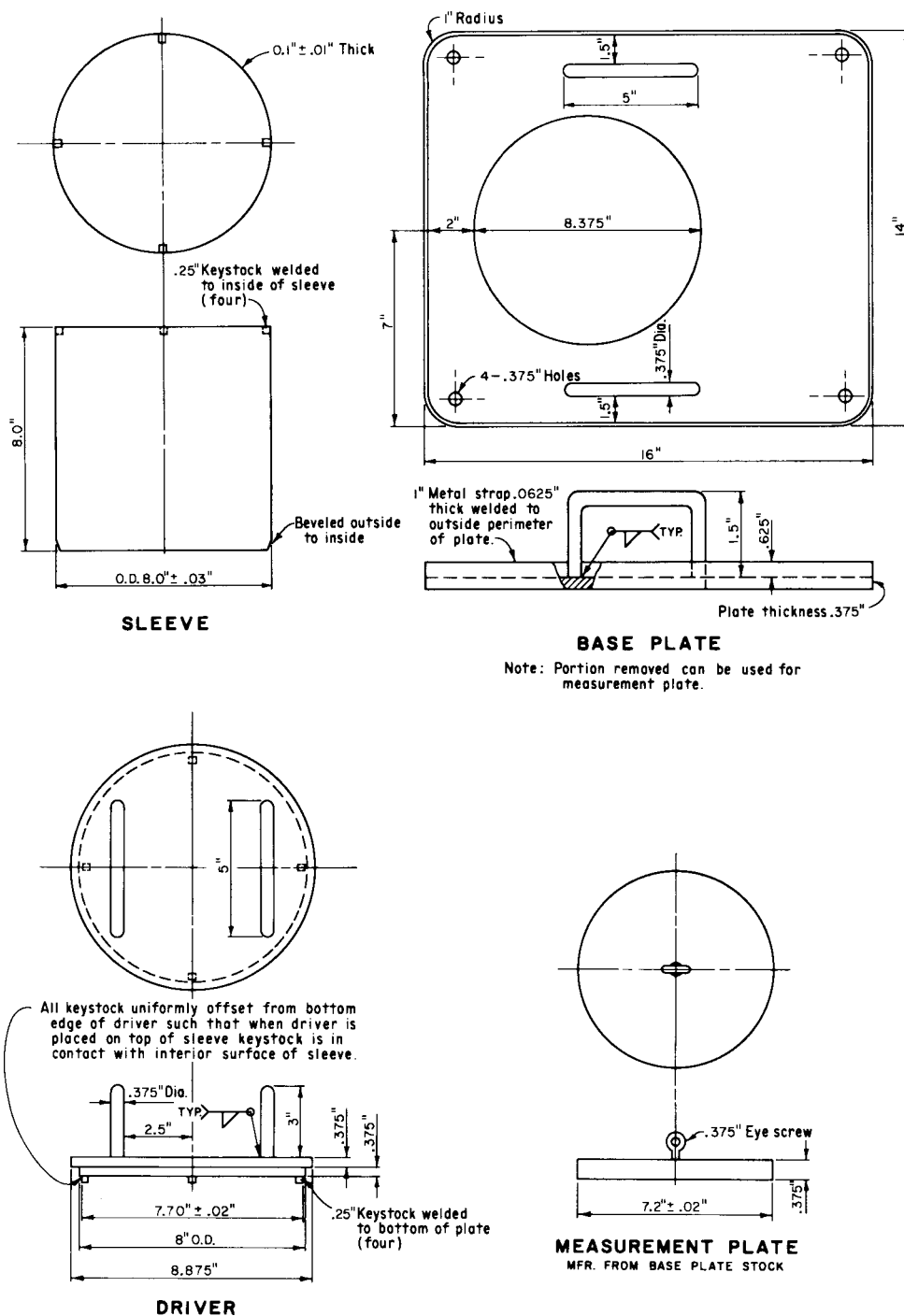


FIG. 1 Density Sleeve Apparatus

9.2 Place the beveled edge of the sleeve on the soil surface inside the hole in the baseplate. Place the driver on the sleeve. Slowly rotate the sleeve in a clockwise direction while pushing the sleeve into the soil in the exact penetration sequence determined in the calibration procedure (see Annex A1). The sleeve penetration into the soil should be perpendicular to the baseplate with as little variation as possible.

9.3 Remove the driver and extract material from inside the sleeve, being careful not to disturb soil below the leading edge of the sleeve. Place the extracted soil in a moisture-proof container, keeping the container closed as much as possible. A

mark placed on the inside of the sleeve, approximately 1 in. (25 mm) above the leading edge, can be a very useful reference. Continue rotating and advancing the sleeve and extracting material in the sequence determined in the calibration procedure until the driver rests evenly on the baseplate. Never extract material below the leading edge of the sleeve.

9.4 As the full depth of extraction of soil is approached, flatten the bottom of the hole as much as possible while extracting the soil.

9.5 Seal the container with the excavated soil to preserve the in-place moisture content.