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Standard Test Method for Density of Soil in Place by the Sleeve Method[1]

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 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 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 *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 Fluids[2]

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[2]

D 4253 Test Methods for Maximum Index Density of Soils Using a Vibratory Table[2]

D 4254 Test Methods for Minimum Index Density of Soils and Calculation of Relative Density[2]

D 4753 Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil, Rock, and Construction Material Testing[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

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 *Description of a Term 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 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.

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.08 on Special and Construction Control Tests.

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

[3] *Annual Book of ASTM Standards*, Vol 14.02.

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.

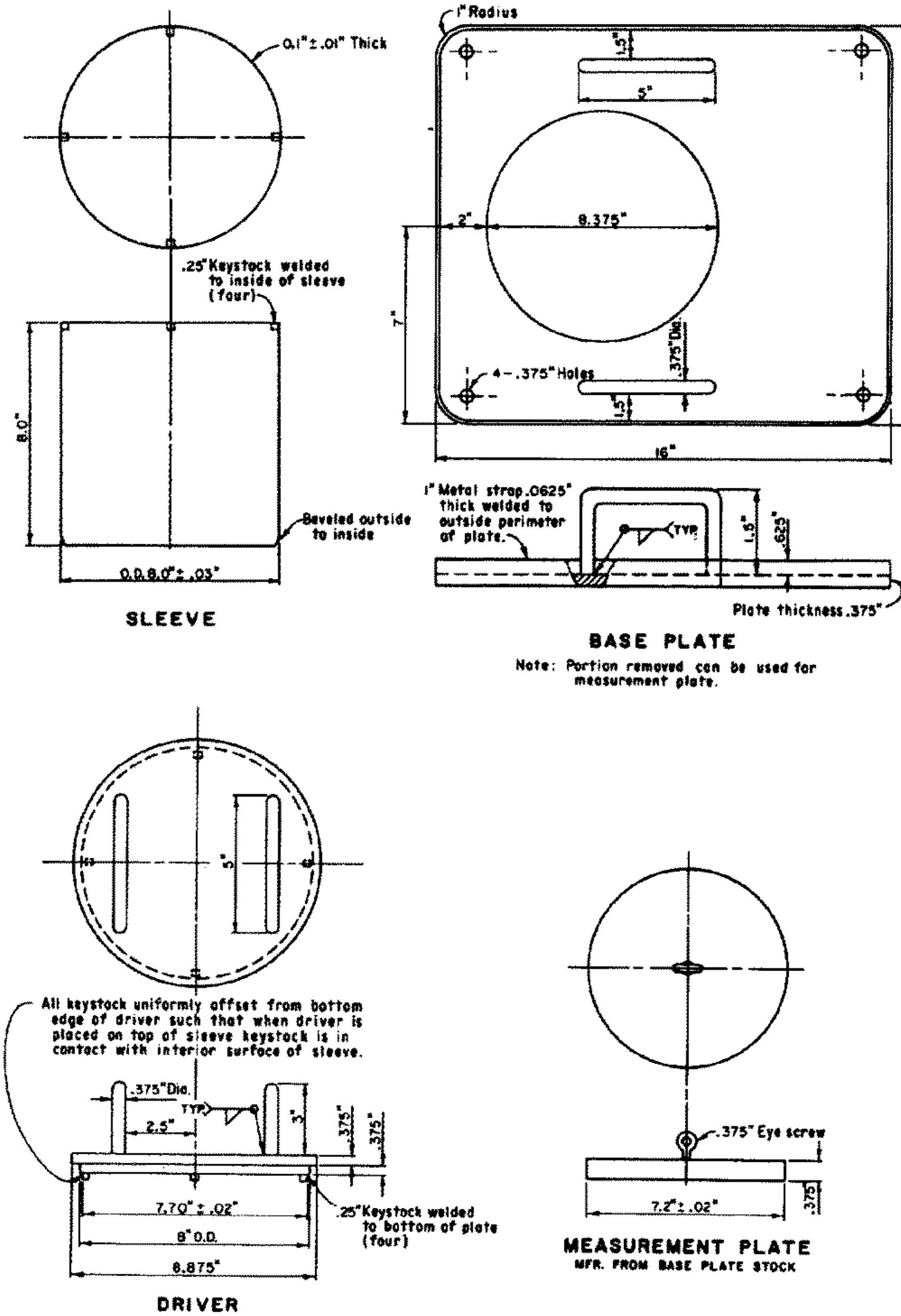

FIG. 1 Density Sleeve Apparatus

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.

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,

SLEEVE DENSITY RECORD

Test No. ______ Feature ______ Tested by ______

Location ______ Offset ______ Elev. ______ Zone ______ Computed by ______

Soil Identification ______ Date of Test ______

Sleeve No. #2c Sleeve Insertion Sequence ½, ¾, full depth

Field Measurements:

(1)	Depth measurements	(a) 7.57 ,	7.68	in.
		(b) 7.53 ,	7.42	in.
(2)	Average depth (a + b)/2	7.55	7.55	in.
(3)	Wet mass soil + can		24.06	lb
(4)	Mass can No. 2		2.16	lb
(5)	Wet mass soil (3)–(4)		21.90	lb
(6)	Mass of wet soil per inch of hole depth (5)/(2)		2.90	lb/in.
(7)	Mass of dry soil per inch of hole depth (M) $= (6)/\left(1 + \frac{13}{100}\right)$		2.85	lb.in.

Moisture Determination:

(8)	Wet mass soil + pan	12.61	lb
(9)	Dry mass soil + pan	12.42	lb
(10)	Mass pan No. 3	2.18	lb
(11)	Mass of water (8)–(9)	0.19	lb
(12)	Mass dry soil (9)–(10)	10.24	lb
(13)	Moisture content [(11)/(12)] × 100	1.9	%

In-Place Density Determination:

(14) Calibration equation:
In-place dry density = (47.769) M −38.8

(15) In-place dry density [insert (7) into calibration equation]

$$(47.769)(2.85) - 38.8 = 97.3 \text{ lb/ft}^3$$

FIG. 2 Example Test Data

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.

9.6 Place the measurement plate on the soil at the bottom of the hole and rotate gently to seat the plate. Lift the measurement plate and inspect the bottom of the hole for surface irregularities. After inspecting and smoothing the surface, if necessary, gently reseat the plate. Measure and record the depth of the hole from the top of the measurement plate to the top of the baseplate using the trisquare or machinist's square. Perform the measurement four times, once at each keystock on the sleeve. Two measurements, 180° apart, are all that is necessary to determine the average depth of the hole; however, since the depth measurement is critical, the other two measurements provide a useful check.

9.7 Calculate the average depth of the hole using the measurements at two opposite keystocks. Calculate the average depth measured at the other two keystocks. If the two average depth values are not within 0.05 in. (1.3 mm) of each other, remeasure the depths. For calculations, use the first two measurements. It may be useful to place identifying marks at each keystock.

9.8 Determine the mass of the soil removed from the test hole and record.

9.9 Determine the moisture content of the material removed from the hole in accordance with Method D 2216.

NOTE 4—If the moisture content obviously varies in the material being tested (for example, free water standing in bottom of the excavation inside the sleeve), the moisture content specimen may not be representative. In this case, the entire sample should be ovendried to arrive at the dry mass of material.

9.10 Calculate the dry mass of the material removed from the hole.

9.11 Calculate the dry mass per inch of test hole.

9.12 Using the calibration equation, calculate the in-place dry density.

10. Calculation

10.1 Make depth measurements to the nearest 0.01 in. (0.3 mm) or nearest 1/64 in. converted to the nearest 0.01 in. Calculate the average depth as follows:

$$D_a = (a + b)/2$$

where:

D_a = average depth of hole, in. (mm),
a = initial depth measurement, in. (mm), and
b = measurement at opposite keystock, in. (mm).

10.2 Calculate the moisture content and the dry mass of the material removed from the test hole as follows:

$$w_f = [(m_1 - m_2)/m_2] \times 100$$

$$m_4 = \frac{m_3}{1 + \frac{w_f}{100}}$$

where:

w_f = moisture content of material from test hole, %,
m_1 = wet mass of moisture sample, g or lb,
m_2 = dry mass of moisture sample, g or lb,
m_3 = wet mass of the material from the test hole, lb (g), and
m_4 = dry mass of the material from the test hole, lb (g).

10.3 Calculate the mass of dry soil per inch of test hole as follows:

$$M = m_4/D_a$$

where:
M = mass of dry soil per inch of test hole, lb/in. (g/mm),
m_4 = dry mass of the material from test hole, lb (g), and
D_a = average depth of hole, in. (mm).

10.4 Calculate the in-place dry density using the calibration equation determined in accordance with Annex A1, as follows:

$$\text{in-place dry density} = (S \cdot M) + Y$$

where:
S = slope of the line through the plot of calibration data,
M = mass of dry soil per inch of test hole, lb/in. (g/mm), and
Y = Y intercept of the line through the plot of calibration data.

NOTE 5—Using the data shown in Fig. 2 as an example, the in-place dry density would be calculated as follows:

$$\text{in-place dry density} = (47.769)(2.85) + (-38.8) = 97.3 \text{ lb/ft}^3$$

11. Report

11.1 The data may be reported on a form similar to Fig. 2. The report shall contain the following information:

11.1.1 Test number and location.
11.1.2 Sleeve identification.
11.1.3 Mass of dry soil per inch of test hole.
11.1.4 Moisture content.
11.1.5 Calibration equation.
11.1.6 In-place dry density.
11.1.7 Soil identification.

12. Precision and Bias

12.1 For the value of the in-place density, no methods are available which can provide absolute values of the density of soil against which this test method can be compared. The variability of soil and the destructive nature of this test do not provide for repetitive duplication of test results to obtain a meaningful statistical evaluation of bias. Data are being evaluated to determine the precision of the test method.

13. Keywords

13.1 compaction control; density testing; field density; field test; in-place density; quality control; relative density; soil compaction; soil test

ANNEX

(Mandatory Information)

A1. DETERMINATION OF THE CALIBRATION EQUATION FOR THE DENSITY OF SOILS IN PLACE BY THE SLEEVE METHOD

A1.1 Scope

A1.1.1 This test method describes the procedure for obtaining the calibration equation used in the determination of the density of soil in place by the sleeve method.

A1.1.2 There may be certain soils meeting the general description in 1.2 for which the calibration equation may not be applicable or may be applicable for only a certain range of densities.

A1.1.3 The calibration equation must be determined for a particular soil prior to using the sleeve method for determining the density of that soil in place. The calibration equation also must be redetermined whenever there is a significant change in the gradation or particle angularity of the soil.

A1.2 Significance and Use

A1.2.1 The calibration equation is used to calculate the density of soil in place from the mass of dry soil per inch of test hole depth measured by the sleeve method.

A1.2.2 The density of the soil in place calculated using the calibration equation has been determined to be a reliable value for use in the construction control of soils meeting the requirements described in 1.2.

A1.2.3 It is assumed there is a linear relationship between the density in place and the mass of dry soil per inch of hole depth measured using the sleeve method. This may not be true for certain soils, or the linear relationship may exist only for a particular range of densities. After determining the calibration equation, the results must be analyzed and evaluated as to the applicability of the calibration equation.

A1.3 Apparatus

A1.3.1 *Sleeve Baseplate, Sleeve, Measurement Plate, and Driver,* see Fig. 1.

A1.3.2 *Trisquare or Machinist's square,* trisquare (12 in.) to 1/64 in. (0.4 mm) or machinist's square to 1/100 in. (0.3 mm).

A1.3.3 *Calibration Container,* large, rigid container approximately 1 ft (0.3 m) high with a volume of 12 to 14 ft^3 (0.3 to 0.4 m^3).

A1.3.4 *Concrete Vibrator.*

A1.3.5 *Suitable Screed.*

A1.3.6 *Scoops, Buckets with Lids, and Square Point Shovel.*

A1.4 Conditions of Test

A1.4.1 The sleeve should be perpendicular to the baseplate when pushed into the soil. Take care to rotate the sleeve consistently in a clockwise direction while performing the test.

A1.4.2 The soil sample used to determine the calibration equation must be representative of the soil that will be tested using the sleeve method. If the soil will range significantly in gradation, the calibration equation should be determined on samples of the soil representing the coarsest, average, and finest gradations.

A1.4.3 The calibration container should have smooth walls and floor and be rigid enough so that its shape or volume does not change during performance of calibration testing. A surface area of 12 to 14 ft^2 (1.1 to 1.3 m^2) will be sufficient. A larger size may create difficulty in maintaining a uniform density throughout the container.

A1.5 Sampling, Test Specimens, and Test Units

A1.5.1 Obtain a representative sample of the soil with about 25 % more mass than the amount required in A1.5.2.

A1.5.2 Multiply the maximum index density of the soil, obtained in accordance with Test Methods D 4253, by the volume of the container to arrive at the amount of soil needed to perform this procedure.

A1.5.3 Thoroughly mix the representative sample.

A1.6 Conditioning

A1.6.1 Conduct the calibration inside a laboratory or protected area under conditions that will allow preservation of a uniform soil moisture content.

A1.6.2 Precondition the soil sample to a uniform moisture content. It may be necessary to vary the moisture in the soil from air dry to wet during the performance of this procedure to obtain certain densities.

A1.7 Preparation for Testing

A1.7.1 Place the calibration container on a smooth floor, making sure the container is level. Measure and record the diameter or width and length of the container at four different locations (equally spaced), obtaining an average dimension. Measure and record the height of the container at four different locations, equally spaced, and compute the average height. Use these measurements to compute the volume of the calibration container.

A1.7.2 From the maximum and minimum index density information obtained in accordance with Test Methods D 4253 and D 4254, plan the in-place densities to use for calibration. Ten different container densities are required and should range from about the minimum index density to the maximum index density.

SLEEVE-SOIL CALIBRATION RECORD

Project ______ Feature ______ Date ______

Soil Identification ______ % Gravel ______ Sand ______ Fines ______

Sleeve Identification #2c Tested by ______ Checked by ______

Control (In-Place) Dry Density Determination:

1.	Desired control dry density	91.8	lb/ft3
2.	Volume of calibration container	12.66	ft^3
3.	Dry mass of soil required: density (1) × volume (2)	1162.2	lb
4.	Wet mass of soil required: dry mass (3) × (1 + w/100)	1165.7	lb
5.	Wet mass of soil not used	—	lb
6.	Wet mass of soil used (4)–(5)	1165.7	lb
7.	Dry mass of soil used: wet mass (6)/(1 + w/100)	1162.2	lb
8.	Control dry density: dry mass (7)/volume (2)	91.8	lb/ft^3

Test Series: Five trials required per control density

			1	2	3	4	5	
9.	Depth measurements	(a)	7.06,	6.90,	6.98,	6.88,	6.63,	in.
		(b)	7.10,	6.98,	7.28,	6.74,	6.77,	in.
10.	Average depth [(9a) + (9b)]/2		7.08,	6.94,	7.13,	6.81,	6.70,	in.
11.	Mass wet soil + can		21.16,	21.28,	22.36,	21.00,	20.63,	lb
12.	Mass of can No. 2		2.55,	2.55,	2.55,	2.55,	2.55,	lb
13.	Mass of wet soil (11)–(12)		18.61,	18.73,	19.81,	18.45,	18.08,	lb
14.	Mass of dry soil (13)/(1 + *w*/100)		18.55,	18.67,	19.75,	18.39,	18.03,	lb
15.	Mass of dry soil per inch of hole depth (14)/(10)		2.62,	2.69,	2.77,	2.70,	2.69,	lb/in.

Moisture content (*w*) = 0.3 %

FIG. A1.1 Density Sleeve – Soil Calibration Record

SUMMARY OF SLEEVE-SOIL CALIBRATION TEST RESULTS

Soil Identification ______ Sleeve Identification ______ #2c

Calibration container Control density (lb/ft³)	Mass of dry soil per inch of hole depth (lb/in.) 1	2	3	4	5
91.8	2.62	2.69	2.77	2.70	2.69
92.8	2.73	2.76	2.77	2.80	2.79
93.8	2.85	2.78	2.83	2.70	2.73
94.8	2.81	2.81	2.74	2.80	2.80
95.9	2.86	2.87	2.80	2.83	2.84
96.9	2.83	2.87	2.85	2.88	2.86
97.9	2.82	2.85	2.93	2.92	2.83
100.0	2.89	2.88	2.96	2.92	2.89
102.1	2.97	2.88	2.95	2.95	2.91
102.1	2.91	2.96	2.96	2.97	2.95
104.1	2.92	2.97	3.01	3.01	3.01

FIG. A1.2 Summary Form for Density Sleeve Calibration

A1.7.2.1 In instances where the variation from minimum to maximum index density is small, it may be necessary to plan two series of five trials repeating some of the densities.

A1.7.3 Perform a trial run (A1.8.2 through A1.8.5) at a high in-place dry density (95 % relative density or higher). The trial run acquaints the user with performing the test and establishes a sequence of depths used for advancing the sleeve into the material. A pattern of sleeve advancement for each soil calibration is required to ensure that the disturbance caused by insertion of the sleeve is constant and, therefore, correctly accounted for in the calibration equation.

A1.8 Procedure

A1.8.1 To minimize emptying and refilling the calibration container more often than necessary, start at a low density and increase the density for each succeeding trial. It may be necessary to air dry the soil to obtain the lower densities. Adding soil into the calibration container to increase the density may be repeated twice without removing the soil. After the second addition of soil and the subsequent testing, the soil must be removed from the container or very thoroughly mixed before recompaction. This will minimize variations in density within the container. Increase the density using a concrete vibrator at uniformly spaced insertion locations. It may be necessary to tap the sides of the container uniformly to assist in getting the desired density. If the addition of water is necessary to achieve the desired density, adequate time for drainage must be allowed before beginning the next sequence of tests. Care should be taken to maintain a uniform density throughout the calibration container.

A1.8.2 Multiply the desired density by the volume of the

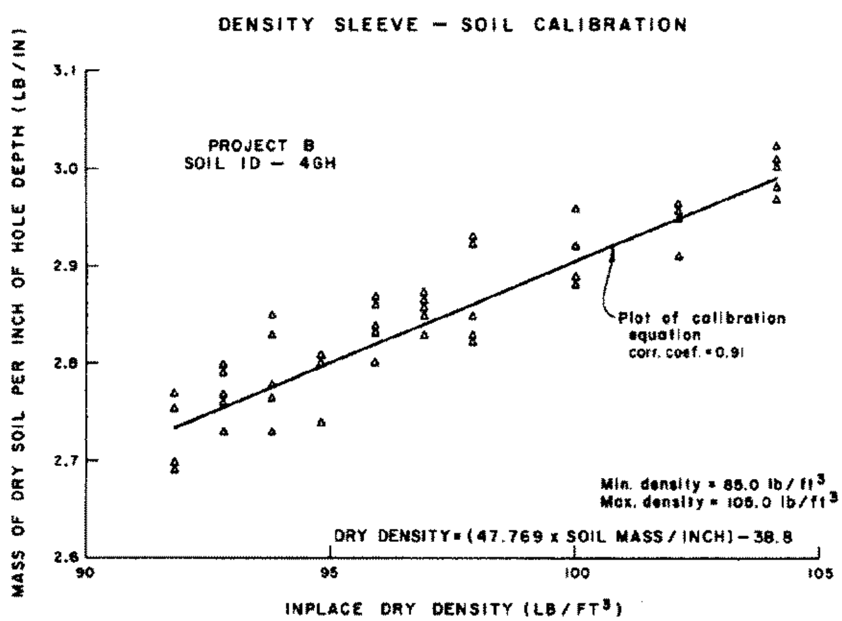

FIG. A1.3 Plot of Calibration Equation

calibration container to arrive at the required amount of soil.

A1.8.3 Place the soil uniformly in the container. Using a screed, level the soil with the top edge of the container. Collect and determine the mass of the excess material and subtract the mass of the excess soil from the total mass. Obtain moisture content samples and determine the moisture content in accordance with Method D 2216. Compute the dry density of the soil in the calibration container (in-place dry density).

A1.8.4 Select an area in the calibration container to begin testing, considering that five tests are required for each container density. Take care throughout the test procedure not to apply pressure on the surface adjacent to the baseplate; this could possibly disturb the in-place condition of the soil.

A1.8.5 Follow 9.1 to 9.7 for each of the five test locations, except that the soil shall be replaced in each of the density excavations before removing the sleeve. Take every precaution to avoid disturbing the soil in the container during this procedure.

A1.8.6 Perform A1.8.2 through A1.8.5 a total of 10 times, once at each density established in the outline made in A1.7.2.

A1.8.7 Calculate the mass per inch for each sleeve determination for each container density (see Fig. A1.1) and summarize for all container densities (see Fig. A1.2).

A1.8.8 Perform a linear regression analysis on the data to determine the calibration equation (see Fig. A1.2) that can be plotted as shown in Fig. A1.3. Make an evaluation as to the applicability of the calibration equation to the particular soil being tested.

A1.8.8.1 Examine the data points for consistency. Calculating a correlation coefficient for the fit of the calibration equation to the data points can be useful. Depending on the application of the determination of the in-place density, the correlation coefficient should normally not be less than 0.9.

A1.8.8.2 For some soils, the data may show unacceptable scatter at lower densities. It may be necessary to eliminate these points in order to determine a valid calibration equation. The calibration equation would then only be applicable above a certain density value.

A1.9 Calculation

A1.9.1 The calculations necessary for this procedure are given in 10.1 and 10.3.

A1.10 Report

A1.10.1 Report the following information:

A1.10.1.1 Written description and photograph of calibration container.

A1.10.1.2 Gradation analysis of material.

A1.10.1.3 Written description of angularity of soil with photographs.

A1.10.1.4 Completed forms, such as Figs. A1.1 and A1.2.

A1.10.1.5 Copies of data sheets from the performance of Test Methods D 4253 and D 4254.

A1.10.1.6 A graphic plot of the calibration equation, such as Fig. A1.3.