Designation: ~~D4914 – 08~~ D4914/D4914M – 16

Standard Test Methods for Density ~~and Unit Weight~~ of Soil and Rock in Place by the Sand Replacement Method in a Test Pit[1]

This standard is issued under the fixed designation ~~D4914;~~D4914/D4914M; 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 cover the determination of the in-place density ~~and unit weight~~ of soil and rock using a pouring device and calibrated sand to determine the volume of a test pit. The word ~~"rock''~~"rock" in these test methods is used to imply that the material being tested will typically contain particles larger than 3 in. ~~(75 mm).~~ [75 mm].

1.2 These test methods are best suited for test pits with a volume from 0.03 to 0.17 m^3 ~~(1~~[1 to 6 ft^3~~).~~]. In general, the materials tested would have a maximum particle size of 75 to 125 mm ~~(3~~[3 to 5 ~~in.).~~in.].

1.2.1 ~~These test methods may be used for~~ For larger sized excavations ~~if desirable. However, for larger sized excavations,~~ and soil containing larger particles, Test Method D5030 is preferred.

1.2.2 Test Method D1556 or D2167 are usually used to determine the volume of test holes smaller than 0.03 m^3 ~~(1~~[1 ft^3~~).~~]. While the equipment illustrated in these test methods is used for volumes less than 0.03 m^3 ~~(1~~[1 ft^3~~),~~], the test methods allow larger versions of the equipment to be used when necessary.

1.3 Two test methods are provided as follows:

1.3.1 *Test Method A*—In-Place Density ~~and Unit Weight~~ of Total Material (Section ~~9~~10).

1.3.2 *Test Method B*—In-Place Density ~~and Unit Weight~~ of Control Fraction (Section ~~10~~11).

1.4 *Selection of Test Methods:*

1.4.1 Test Method A is used when the in-place ~~unit weight~~ density of total material is to be determined. Test Method A can also be used to determine percent compaction or percent relative density when the maximum particle size present in the in-place material being tested does not exceed the maximum particle size allowed in the laboratory compaction test (refer to Test Methods D698, D1557, D4253, D4254~~and~~ , and ~~D4254~~D7382). For Test Methods D698 and D1557 only, the ~~unit weight~~dry density determined in the laboratory compaction test may be corrected for larger particle sizes in accordance with, and subject to the limitations of Practice D4718.

1.4.2 Test Method B is used when percent compaction or percent relative density is to be determined and the in-place material contains particles larger than the maximum particle size allowed in the laboratory compaction test or when Practice D4718 is not applicable for the laboratory compaction test. Then the material is considered to consist of two fractions, or portions. The material from the in-place ~~unit weight~~dry density test is physically divided into a control fraction and an oversize fraction based on a designated sieve ~~size.~~ size (see Section 3). The ~~unit weight~~dry density of the control fraction is calculated and compared with the ~~unit weight(s)~~dry density(s) established by the laboratory compaction test(s).

~~1.4.2.1 Because of possible lower densities created when there is particle interference (see Practice D4718), the percent compaction of the control fraction should not be assumed to represent the percent compaction of the total material in the field.~~

~~1.4.3 Normally, the control fraction is the minus No. 4 sieve size material for cohesive or nonfree draining materials and the minus 3-in. sieve size material for cohesionless, free-draining materials. While other sizes are used for the control fraction (⅜,¾-in.), these test methods have been prepared using only the No. 4 and the 3-in. sieve sizes for clarity.~~

1.5 Any materials that can be excavated with hand tools can be tested provided that the void or pore openings in the mass are small enough (or a liner is used) to prevent the calibrated sand used in the test from entering the natural voids. The material being tested should have sufficient cohesion or particle interlocking to maintain stable sides during excavation of the test pit and through completion of this test. It should also be firm enough not to deform or slough due to the minor pressures exerted in digging the hole and pouring the sand.

---

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

Current edition approved ~~March 1, 2008~~March 1, 2016. Published ~~March 2008~~March 2016. Originally approved in 1989. Last previous edition approved in ~~1999~~2008 as ~~D4914 – 99.~~D4914 – 08. DOI: ~~10.1520/D4914-08.~~10.1520/D4914_D4914M-16.

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

1.6 These test methods are generally limited to material in an unsaturated condition and are not recommended for materials that are soft or friable (crumble easily) or in a ~~moisture~~water condition such that water seeps into the hand-excavated hole. The accuracy of the test methods may be affected for materials that deform easily or that may undergo volume change in the excavated hole from standing or walking near the hole during the test.

1.7 ~~These test methods use SI units with converted inch-pounds in parentheses.~~The values stated in either SI units or inch-pound presented in brackets 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.

~~1.7.1 In the engineering profession it is customary to use units representing both mass and force interchangeably, unless dynamic calculations are involved. This implicitly combines two separate systems of units, that is, the absolute system and the gravimetric system. It is undesirable to combine the use of two separate systems within a single standard. These test methods have been written using inch-pound units (gravimetric system) where the pound (lbf) represents a unit of force (weight). However, conversions are given in the SI system. 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 these test methods.~~

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

1.8.1 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; it is common practice to increase or reduce significant digits of 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.

1.9 *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.* For specific hazards statements, see Sections ~~7~~8 and A1.5.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
C566 Test Method for Total Evaporable Moisture Content of Aggregate by Drying
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3))
D1556 Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

D2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
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
D4718 Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
D4753 Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing
D5030 Test Method for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit
D6026 Practice for Using Significant Digits in Geotechnical Data
D7382 Test Methods for Determination of Maximum Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibrating Hammer
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

~~3.1 *Definitions:*~~
~~3.1.1 Except as follows in 3.2, all definitions are in accordance with Terminology D653.~~
3.1 *Definitions:*
3.1.1 For definitions of terms related to this standard, refer to Terminology D653.

[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.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *control* ~~*fraction—*~~*fraction, n—*the portion of a soil sample consisting of particles smaller than a designated sieve size.

3.2.1.1 *Discussion—*

This fraction is used to compare in-place ~~unit weights with unit weights~~ density with density obtained from standard laboratory tests. The control sieve size depends on the laboratory test used. Normally, the control fraction is the minus 4.75 mm, or No. 4 [0.187 in.] sieve size material for cohesive or non-free draining materials and the minus 75 mm [3-in.] sieve size material for cohesionless, free-draining materials. While other sizes are used for the control fraction, 9.5 or 19 mm [3⁄8, 3⁄4-in.], these test methods have been prepared using only the No. 4 and the 75 mm [3 in.] sieve sizes for clarity.

3.2.2 *oversize* ~~*particles—*~~*particles, n—*the portion of a soil sample consisting of the particles larger than ~~a~~the designated sieve ~~size.~~ size for the control fraction selected.

3.2.3 *sand pouring device(s), n—*handheld pouring device(s) that holds the density sand equipped with a long pouring spout for placing the sand with unobstructed flow at a constant drop height.

3.2.3.1 *Discussion—*

Multiple cans may be used but they must be of the same design and calibrated.

4. Summary of Test Method

4.1 The ground surface at the test location is prepared and a template (metal frame) is placed and fixed into position. The volume of the space between the top of the template and the ground surface is determined by filling the space with calibrated sand using a pouring device. The mass of the sand required to fill the template in place is determined and the sand removed. Material from within the boundaries of the template is excavated forming a pit. Calibrated sand is then poured into the pit and template; the mass of sand within the pit and the volume of the hole are determined. The wet density of the in-place material is calculated from the mass of material removed and the measured volume of the test pit. The water content is determined and the dry ~~unit weight~~ density of the in-place material is calculated.

4.2 The ~~unit weight~~ density of a control fraction of the material can be determined by subtracting the mass and volume of any oversize particles from the initial values and recalculating the ~~unit weight.~~density.

5. Significance and Use

5.1 These test methods are used to determine the in-place density of compacted materials in construction of earth embankments, road fills, and structure backfill. For construction control, these test methods are often used as the bases for acceptance of material compacted to a specified density or to a percentage of a maximum unit weight determined by a standard laboratory test method (such as determined from Test Method D698 or D1557), subject to the limitations discussed in 1.4.

5.2 These test methods can be used to determine the in-place density of natural soil deposits, aggregates, soil mixtures, or other similar material.

NOTE 1—~~Notwithstanding the statements on precision and bias contained in this test method, the precision of this test method~~ The quality of the result 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 these test methods are cautioned that compliance with Practice D3740 does not in itself ensure reliable results. Reliable testing depends on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Interferences

6.1 Because of possible lower densities created when there is particle interference (see Practice D4718), the percent compaction of the control fraction should not be assumed to represent the percent compaction of the total material in the field when using method B with oversize corrections.

6.2 A careful assessment must be made as to whether or not the volume determined is representative of the in-place condition when this test method is used for clean, relatively uniform-sized particles. The disturbance during excavation, due to lack of cohesion, and the void spaces between particles spanned by the liner (if used) may affect the measurement of the volume of the test pit.

NOTE 2—Experience with this test used in cohesionless uniform fine gravels, pea gravels, or processed uniform gravel drain materials have shown errors in test hole volume.

7. Apparatus

7.1 *Balance or Scale—*A balance (or scale) to determine the mass of the calibrated sand and the excavated soil having a minimum capacity of 20 kg ~~(44 lbm)~~[50 lbm] and meeting the requirements of Specification D4753 for a balance of 1-g ~~(0.002-lbm)~~[0.002-lbm] readability.

7.2 *Balance or Scale*—A balance (or scale) to determine ~~moisture~~water content of minus No. 4 material having a minimum capacity of 1000 g ~~(2.2-lbm)~~[2-lbm] and meeting the requirements of Specification D4753 for a balance of 0.1 g ~~readability.~~ [0.001 lbm] readability.

7.3 *Drying Oven*—An oven, thermostatically controlled, preferably of the forced-draft type, and capable of maintaining a uniform temperature of 110 ± 5°C throughout the drying chamber.

7.4 *Sieves*—No. ~~4 (4.75-mm)~~ 4, 4.75-mm [0.187-in.] sieve and 75-mm ~~(3-in.)~~[3-in.] sieve, conforming to the requirements of Specification E11.

7.5 *Metal Template*—A square or circular template to serve as a pattern for the excavation. Template dimensions, shapes, and material may vary according to the size of the test pit to be excavated. Refer to Appendix X1 for recommended template sizes. The template shall be rigid enough not to deflect or bend.

NOTE 3—The template shown in Fig. 1 represents a design that has been found suitable for this purpose.

7.6 *Liner,* approximately ~~0.013 mm (0.0005 in.)~~ less than 25 µm [1 mil, 0.001 in.] thick and large enough to line the test pit with about 0.3 m ~~(1 ft)~~[1 ft] extending beyond the outside of the template. Any type of material, plastic sheeting, etc., can be used as long as it is flexible enough to conform to the ground surface.

7.7 *Sand Pouring Devices*—(See Fig. 2 for some typical devices.) Many types of pouring devices are available. Use multiple 10 to 15-L [3 to 4-gal] containers as long as they meet spout requirements. Larger containers may be used as long as the vertical 50-mm [2-in.] drop height can be maintained. The device must have a spout that will reach into a field test pit so that the drop distance from the end of the spout to the sand surface can be maintained at about ~~2 in. (50 mm).~~50 mm [2 in.]. The inside diameter of the spout must also be large enough to allow free flow of the sand without clogging.

7.8 *Metal Straightedge,* about 50 mm ~~(2 in.)~~[2 in.] high, at least 3 mm ~~(~~[⅛ ~~in.)~~in.] thick, and with a length 1.5 times the side length (or diameter) of the metal template, used for screeding excess sand placed in template. It must have a thickness or rigidity such that it will not bend when screeding the sand.

7.9 *Sand*—The sand must be clean, dry, uniform, uncemented, durable, and free flowing. The gradation, physical characteristics, selection, and storage of the sand shall meet the requirements of Test Method D1556 except that the maximum particle size may be No. ~~4 (4.75-mm)~~ 4, 4.75-mm [0.187-in.] sieve.

7.9.1 If the test methods are used for test pits larger than about ~~0.17~~0.2 m^3 ~~(6~~[6 ft^3~~),~~], a one-size material relatively free of fines and of a larger particle size, such as pea gravel, may be used.

7.10 *Miscellaneous Equipment*—Shovels for preparing test surface; hammer for seating template; assorted small brushes, picks, chisels, bars, knives, and spoons for digging test pit; buckets with lids, seamless cans with lids, or other suitable containers for

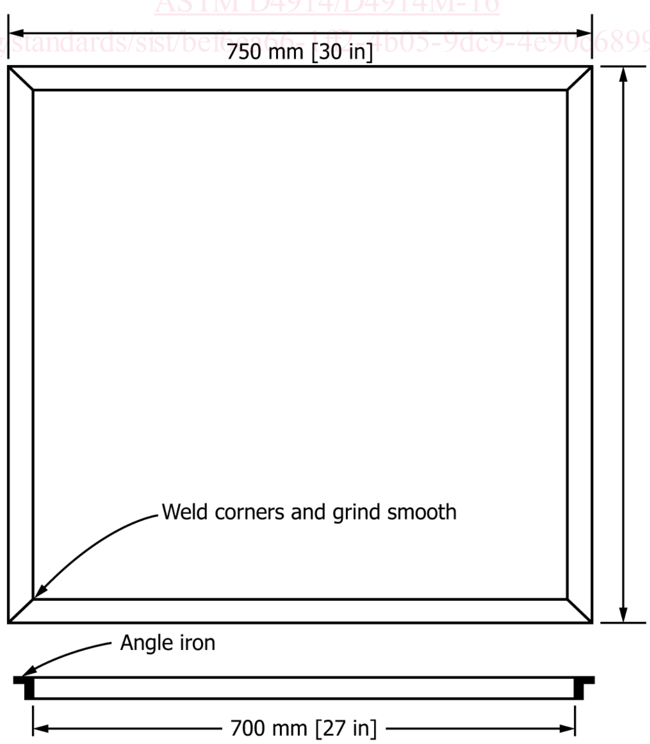

FIG. 1 Typical Metal Template for Excavating Test Pit ~~(Dimensions in Inches)~~

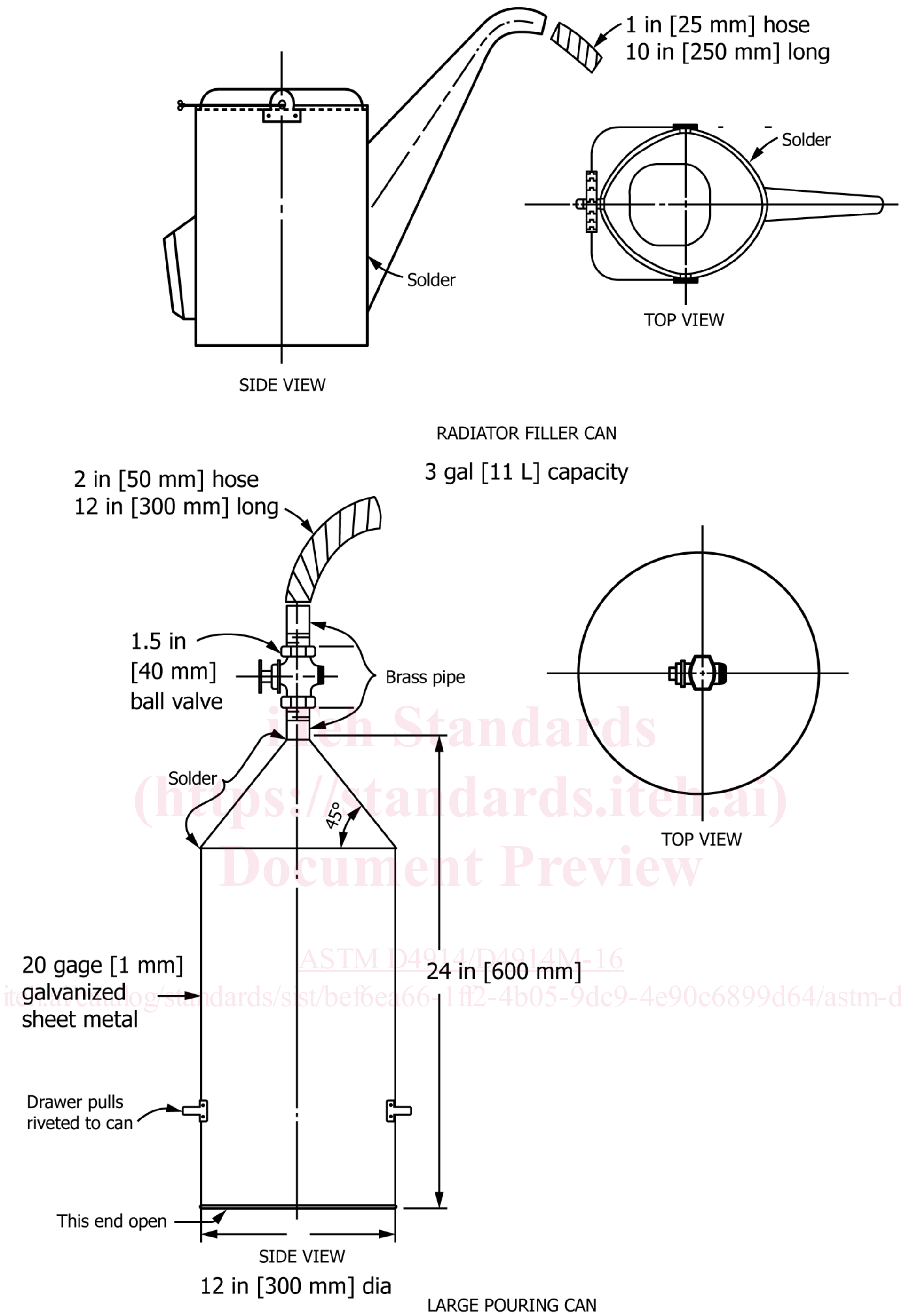

FIG. 2 Typical Sand Pouring Devices (Dimensions in ~~Inches)~~Inches with Rationalized SI Equivalent)

retaining the test sample and sand without ~~moisture~~ water content change; bags or other suitable containers for waste sand; cloth for collecting excess sand or soil; and assorted pans and porcelain dishes suitable for drying ~~moisture~~water content specimens.

8. Hazards

8.1 *Precaution:*

8.1.1 These test methods may involve handling heavy loads.

8.1.2 Some sands used in the procedures outlined herein may be dusty and appropriate precautions should be taken when mixing and pouring. Use dust masks during sand pouring operations to avoid inhalation of silica dust.

8.2 *Caution:*

8.2.1 Materials that may flow or deform during the test must be identified and appropriate precautions taken.

8.2.2 Movement of heavy equipment in the immediate test area should not be permitted during the volume determination.

8.2.3 Errors may arise in the computed ~~unit weight~~ density of material due to the influence of excessive ~~moisture~~water in the soil. These errors may be significant in materials with high permeability, such as sands and gravels, where the bottom of the test hole is close to or below the water table. Errors may also arise due to change in density of the calibrated sand as it becomes wetted from capillary or freestanding water while performing the test. This problem becomes evident when removing the calibrated sand from the test hole and wet sand is observed on the bottom or sides of the test hole. When a liner is used, the buoyant forces of free water beneath or behind the liner may adversely affect the volume determination.

8.2.4 Suitably protect the test area and equipment during periods of inclement weather such as rain, snowfall, or high wind. If the in-place ~~moisture~~water content value is required, it may be necessary to protect the area from direct sunlight.

8.2.5 Numerous containers may be required during performance of these test methods. Properly label all containers to avoid a possible mix-up.

8.2.6 The total mass of the calibrated sand, or the soil sample, or both, may exceed the capacity of the scale used, requiring cumulative determinations of mass. Take care to ensure that the total mass is properly determined.

8.2.7 Pouring devices with valves provide consistent sand flow from test to test only if the valve is opened completely each time. A valve that is only partially open can significantly alter the flow characteristics of the device. Each individual pouring device has unique characteristics which may cause the sand to flow from it differently. The final calibration values are affected by changes in these flow characteristics. Consequently, calibration values are not interchangeable, even for devices which may appear to be identical.

8.2.8 Do not allow pouring devices to run out of sand during the pouring operation. The size of the stream of poured sand from the pouring device should be constant. If the reservoir capacity of the pouring device is too small to fill the test pit with one pour, use two or more pours to fill the test pit. Stop the stream of sand when the reservoir is about three-fourths empty and before the size of the stream diminishes. Refill the reservoir and resume pouring.

8.2.9 Pouring devices permit a varied sand drop distance that must be carefully controlled if consistent results are to be achieved. A distance of 50 mm ~~(2 in.)~~[2 in.] from the end of the spout to the surface being poured is recommended. Variations in the drop distance can significantly affect results. The drop distance is directly affected by the ~~operator's~~operator's ability to control the pouring device and by the operator's judgment of the drop distance while doing so. This involves stooping while holding a pouring device with an initial mass of 20 kg ~~(44 lbm)~~[50 lbm] or more that is constantly changing in mass as the sand flows into the test pit. Calibration values are not interchangeable from device to device and are not necessarily interchangeable from operator to operator. Individual operators must demonstrate that they can duplicate the calibration values for a device before they may use them, preferably within 1 % of the average value for another operator. Otherwise, separate calibrations for the various operators are required.

9. Calibration and Standardization

9.1 Calibrate the sand pouring equipment and sand in accordance with Annex A1.

10. Test Method A, Procedure—In-Place Density ~~and Unit Weight~~ of Total Material

10.1 Use Test Method A to determine a total ~~unit weight~~in-place density (see 1.4).

10.2 Determine the recommended sample volume and select the appropriate template for the anticipated material gradation in accordance with Annex A2. Assemble the remainder of the required equipment.

10.3 Determine the mass of each combination of empty container, lid, and container liner (if used) that will contain the excavated material. Number the containers and mark as to use. Write the mass on the container or prepare a separate list.

10.4 Prepare the quantity of calibrated sand to be used.

10.4.1 Two sets of calibrated sand are necessary. Determining the volume of the test pit requires two separate sand pours to (*1*) measure the mass of sand used to fill the space between the soil surface and the top of the template, and (*2*) measure the mass of sand used to fill the test pit up to the top of the template. The difference between the two gives the mass of sand in the test pit.

10.4.2 Estimate the mass of calibrated sand and the number of containers required to fill the space between the soil surface and the top of the template. Calculate the estimated mass by multiplying the template volume by the density of the calibrated sand. Number the containers to be used and mark as to use, for example, "template correction." Fill the containers with sand. Determine and record on a separate list the mass of the containers and sand.

10.4.3 From the anticipated volume of the test pit, estimate the mass of calibrated sand required to fill the test pit. Increase this amount by about 25 % to ~~ensure~~ make sure that a sufficient sand supply is available at the site, and then add to it the mass of sand calculated in ~~9.4.2~~10.4.2. Calculate the estimated mass to be used for the test pit by multiplying the anticipated volume of the test pit by the density of the calibrated sand. Determine the number of containers required, number them, and mark as to use, for example, "test ~~pit.''~~pit." Fill the containers with sand. Determine and record on a separate list the mass of the containers and sand.

10.5 Select a representative area for the test, avoiding locations where removal of large particles would undermine the template.

10.6 Prepare the surface of the area to be tested.

10.6.1 Remove all loose material from an area large enough on which to place the template. Prepare the exposed surface so that it is a firm, level plane.

10.6.2 Personnel should not step on the area selected for testing. Provide a working platform when testing materials which may flow or deform.

10.7 Place and seat the template on the prepared surface.

10.7.1 Use a hammer to firmly seat the template to avoid movement of the template while the test is performed. The use of nails, weights, or other means may be necessary to maintain the position.

10.7.2 Remove any material loosened while placing and seating the template, taking care to avoid leaving any void space under the template. If necessary, fill voids under the template with plastic soil, modeling clay, or other suitable material, provided that this material is not subsequently excavated as part of the material removed from the test pit.

10.8 Determine the mass of sand used to fill the space between the soil surface and the top of the template.

10.8.1 Irregularities of the soil surface within the template must be taken into account. To do this, determine the mass of sand required to fill the space between the soil surface and the top of the template.

10.8.2 It is recommended that a cloth with a hole slightly larger than the template center hole be placed over the template to facilitate locating and collecting any excess sand, or loose material, or both.

10.8.3 Place a liner ~~(approximately ½-mil thick)~~ over the template and shape it by hand to conform to the irregular soil surface and the template. The liner should extend approximately 0.3 m ~~(1 ft)~~[1 ft] outside the template. The liner should not be stretched too taut or contain excessive folds or wrinkles (see Fig. 3).

10.8.4 Pour the calibrated sand onto the liner inside the template using a sand pouring device (see Fig. 4). Slightly overfill the template (see ~~7.2.7~~8.2.7 – ~~7.2.9~~8.2.9). Return any sand remaining in the pouring device to the original container.

10.8.5 Carefully level the calibrated sand by screeding with the steel straightedge across the top edges of the template. Return all screeded excess sand to the original container. Take care to avoid the loss of any excess sand.

10.8.6 Remove the calibrated sand in the template and, if the sand is to be reclaimed, place it in a specially marked container. Remove the liner.

10.9 Excavate the test pit.

10.9.1 Using hand tools (chisel, knife, bar, etc.), excavate the center portion of the test pit.

10.9.1.1 Do not permit any movement of heavy equipment in the area of the test pit as deformation of the soil within the test pit may occur.

10.9.2 Place all material removed from the test pit in the container(s) (see Fig. 5), being careful to avoid losing any material (see ~~9.8.2~~10.8.2).

10.9.3 Avoid ~~moisture~~water loss by keeping the container covered while material is not being placed in it. Use a sealable plastic bag inside the container to hold the material.

10.9.4 Carefully trim the sides of the excavation so that the dimensions of the test pit at the soil-template contact are as close as possible to that of the template hole. Avoid disturbing the template or the material beneath or outside the template.

10.9.5 Continue the excavation to the required depth, carefully removing any material that has been compacted or loosened in the process.

10.9.5.1 If during excavation of material from within the test pit, a particle(s) is found that is about 1½ times, or more, larger than the maximum particle size used to establish the dimensions and minimum volume of the test pit (see Annex A2), set the particle(s) aside and mark appropriately. Determine the mass and volume of the particle(s) and then subtract them from the mass and volume of the material removed from the test pit. Consider the larger particle(s) as ~~"oversize''~~"oversize" and follow the procedure outlined in Section ~~10~~11, except that the ~~"total'' unit weight,~~ "total" density, which would include the larger particle(s), need not be calculated. The "control ~~fraction''~~fraction" values determined then become the values for the total material from the test pit. If enough of these particles are found so that their mass is determined to be about 5 % or more of the mass of the excavated material, repeat the test with a larger test pit in accordance with the guidelines in Annex A2.

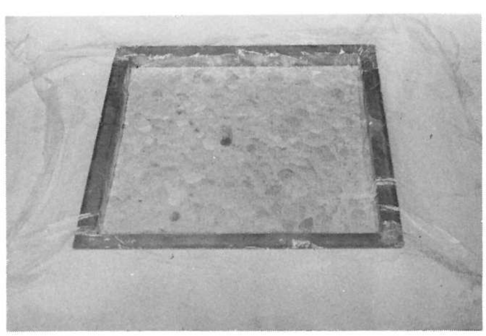

FIG. 3 Plastic Liner Placed Over the Template

FIG. 4 Sand Being Poured Into the Template

FIG. 5 Excavation of the Test Pit

10.9.6 The sides of the pit should slope inward slightly. Materials that do not exhibit much cohesion may require a more conical-shaped test hole.

10.9.7 The profile of the finished pit must be such that poured sand will completely fill the excavation. The sides of the test pit should be as smooth as possible and free of pockets or overhangs or anything that might interfere with the free flow of the sand.

10.9.8 Clean the bottom of the test pit of all loosened material.

10.10 Determine the volume of the test pit.

NOTE 4—A liner may be required to prevent migration of the calibrated sand into the natural voids of the material mass. The liner, approximately ½-mil thick, should be large enough to extend approximately 0.3 m (1 ft) outside of the template after having been carefully placed and shaped to the soil surface within the pit. Allowances must be made for slack. The liner should not be stretched too taut nor contain excessive folds or wrinkles. Inspect the linear for punctures before use.

10.10.1 Pour the calibrated sand using the sand pouring device. Use the same pouring technique as used in the calibration procedure described in Annex A1. Slightly overfill the template. Return any sand remaining in the pouring device to the original container.

10.10.1.1 While the sand is being poured, avoid any vibrations in the test area.

10.10.2 Carefully level the calibrated sand by screeding with the steel straightedge across the top edges of the template. Return all screeded excess sand to the original container. Take care to avoid the loss of any excess sand.

10.10.3 If the calibrated sand is to be reclaimed, remove the used sand and place it into a specially marked container. Remove the liner and template.

10.11 Determine the dry ~~unit weight.~~density. Equations for calculations are shown in Section 12.

10.11.1 Determine the mass of calibrated sand in the template (sand used to fill the space between the soil surface and the top of the template) as follows:

10.11.1.1 Calculate and record the total mass of the sand and containers prepared in ~~9.4.2~~10.4.2. Record the container numbers.

10.11.1.2 Determine and record the total mass of the empty containers plus the sand residue (sand not used) and containers.

10.11.1.3 Calculate the mass of sand in the template and record.

10.11.2 Determine the mass of calibrated sand in the test pit and template (sand used to fill the test pit to the top of the template) as follows:

10.11.2.1 Calculate and record the total mass of the sand and containers prepared in ~~9.4.3~~10.4.3. Record the container numbers.

10.11.2.2 Determine the total mass of the empty containers plus the sand residue and containers and record.

10.11.2.3 Calculate the mass of sand in the test pit and template (mass of sand used) and record.

10.11.3 Calculate the mass of the calibrated sand used to fill the test pit and record.

10.11.4 Record the density of the calibrated sand (determined in the calibration procedure described in Annex A1).
10.11.5 Calculate the volume of the test pit and record.
10.11.6 Determine the total mass of the excavated material and containers.
10.11.7 Calculate and record the total mass of the containers used to hold the excavated material. Record the container numbers.
10.11.8 Calculate the mass of the excavated material and record.
10.11.9 Calculate the wet density of the excavated material.
10.11.10 If the excavated material contains oversize particles (normally larger than the ~~No. 4 (4.75-mm)~~4.75-mm (No. 4) sieve for cohesive materials and 75-mm ~~(3-in.)~~[3-in.] sieve for cohesionless materials), separate the material using the appropriate size sieve. If the material contains about 3 % (wet basis) or more oversize particles, Test Method B should be used.
10.11.11 If 2 % or less oversize particles are present, obtain a ~~moisture~~water content specimen representative of the excavated material and determine the ~~moisture~~water content in accordance with Test Method D2216 or C566 and record.

NOTE 5—For rapid ~~moisture~~water content determination of materials containing less than 15 % fines (minus No. 200), use a suitable source of heat such as an electric or gas hotplate. If a source of heat other than the controlled temperature oven is used, stir the test specimen to accelerate drying and avoid localized overheating. The material may be considered dry when further heating causes, or would cause, less than 0.1 % additional loss of mass.

10.11.12 ~~If required or desired, calculate~~ Calculate and record the dry density ~~and dry unit weight~~ of the material.

11. Test Method B, Procedure—In-Place Density ~~and Unit Weight~~ of Control Fraction

11.1 This test method is used when the material being tested contains oversize particles and the percent compaction or percent relative density of the control fraction are to be determined (see 1.4).

11.2 Obtain the in-place wet density of total material by following the procedure for Test Method A, as stated in ~~9.1~~10.1 – ~~9.11.9~~10.11.9.

11.3 To obtain the wet density of the control fraction, determine the mass and volume of the oversize particles and subtract them from the total mass and total volume to get the mass and volume of the control fraction. Then calculate the density of the control fraction from the mass and volume of the control fraction. Equations for calculations are shown in Section 12.
11.3.1 Normally, the wet density of the control fraction is determined and the dry density calculated using the ~~moisture~~water content of the control fraction.
11.3.2 In addition, the ~~moisture~~water content of the oversize particles, the ~~moisture~~water content of the total material, and the percentage of oversize particles may be determined.

11.4 After obtaining the wet mass of total material removed from the test pit, separate the material into the control fraction and the oversize particles using the designated sieve. Do this rapidly to minimize loss of ~~moisture.~~water. If the test is for construction control, place the control fraction in an airtight container for further tests.

11.5 Wash the oversize particles and reduce the free water on the surface of the particles by blotting, draining, or a similar method.

11.6 Determine the wet mass of the oversize particles plus a container of predetermined mass, and record.

11.7 Calculate the wet mass of the oversize particles and record.

11.8 Calculate the wet mass of the control fraction and record.

11.9 Determine the volume of the oversize particles by one of the following procedures:
11.9.1 Determine and record the mass of all oversize particles suspended in water using the procedures and principles of Test Method C127, disregarding the oven drying and 24-h soaking period. Calculate and record the volume of the oversize particles.
11.9.2 Calculate the volume of the oversize particles using a known bulk specific gravity value. If previous tests for bulk specific gravity of similar oversize particles from a particular source have been performed and the value is relatively constant, a bulk specific gravity may be assumed. The bulk specific gravity value used must correspond to the ~~moisture~~water condition of the oversize particles when their mass is determined. As used in this test method, determine the bulk specific gravity on the oversize particles in the ~~moisture~~water condition as stated in ~~10.5~~11.5 – ~~10.7~~11.7. If an oven dry or saturated surface dry (SSD) bulk specific gravity is used, then also determine the mass of the oversize particles for this test method on oven dry or SSD material, respectively.

11.10 Calculate the volume of the control fraction and record.

11.11 Calculate the wet density of the control fraction.

11.12 Determine the ~~moisture~~water content of the control fraction in accordance with Test Method D2216 or C566 (see Note ~~4~~5) and record.

11.13 Calculate the dry density ~~and dry unit weight~~ of the control fraction and record.

11.14 If desired, determine and record the ~~moisture~~water content of all oversize particles in accordance with Test Method D2216 or C566 (see Note ~~4~~5). If previous tests for ~~moisture~~water content of the oversize particles from a particular source have been performed and the value is relatively constant, a ~~moisture~~water content may be assumed.

11.15 If desired, determine the percentage of oversize particles as follows:

11.15.1 Calculate the dry mass of the control fraction and record.

11.15.2 Calculate the dry mass of the oversize particles and record.

11.15.3 Calculate the dry mass of the total sample and record.

11.15.4 Calculate the percentage of oversize particles and record.

11.16 Calculate the ~~moisture~~water content of the total material.

11.17 ~~If desired, calculate~~ Calculate the dry density ~~and dry unit weight~~ of the total material and record.

12. Test Method A, Calculation

12.1 The calculations use units of kg and m^3, for mass and volume calculation and then density is expressed in Mg/m^3 using a conversion factor. Density can also be reported as kg/m^3 without the conversion factor. Units of lbm and ft^3 can also be substituted and used in the same equations for mass and volume and the density can be expressed in lbm/ft^3.

12.2 Calculate the mass of the sand contained in the template as follows:

$$m_6 = m_2 - m_4 \qquad (1)$$

where:

m_6 = mass of sand in template, kg,
m_2 = mass of template sand and container(s) (before test), kg, and
m_4 = mass of template sand residue and container(s) (after test), kg.

12.3 Calculate the mass of the sand used to fill the test pit and template as follows:

$$m_5 = m_1 - m_3 \qquad (2)$$

where:

m_5 = mass of sand used, kg,
m_1 = mass of sand and container(s) (before test), kg, and
m_3 = mass of sand residue and container(s) (after test), kg.

12.4 Calculate the mass of the sand used to fill the test pit as follows:

$$m_7 = m_5 - m_6 \qquad (3)$$

where:

m_7 = mass of sand in test pit, kg,
m_5 = mass of sand used, kg, and
m_6 = mass of sand in template, kg.

12.5 Calculate the volume of the test pit as follows:

$$V_T = \frac{m_7}{\rho_s} \times \frac{1}{10^3} \qquad (4)$$

where:

V_T = volume of test pit, m^3,
m_7 = mass of sand in test pit, kg, and
ρ_s = density of calibrated sand, Mg/m^3.

12.6 Calculate the mass of the wet material removed from test pit as follows:

$$m_{10} = m_8 - m_9 \qquad (5)$$

where:

m_{10} = mass of wet material removed from test pit, kg,
m_8 = mass of wet material removed from test pit plus mass of container(s), kg, and
m_9 = mass of container(s) for m_8, kg.

12.7 Calculate the wet density of the material removed from test pit as follows:

$$\rho_{wet} = \frac{m_{10}}{V_T} \times \frac{1}{10^3} \qquad (6)$$

where:

ρ_{wet} = wet density of material excavated from test pit, Mg/m^3,
m_{10} = mass of wet material removed from test pit, kg, and
V_T = volume of test pit, m^3.