GDT 20

A. Scope

For a complete list of GDTs, see the Table of Contents.

This method of test covers the procedures for determining the in-place density of soils in embankments, cuts, subgrades, subbases, bases, shoulders, etc., where the percent of material retained on the No. 10 (2 mm) sieve is less than 45. The method requires the use of the sand cone for volume determination.

B. Apparatus

1. Density Apparatus—A density apparatus consisting of a 1 gal (3.785 L) jar and a detachable appliance consisting of a cylindrical valve with an orifice ½ in (12.5 mm) in diameter and having a small funnel continuing to a standard G Mason jar top on one end and a large funnel on the other end. The valve shall have stops to prevent rotating the valve past the completely open or completely closed positions. The apparatus shall conform to the requirements shown in Figure 1 (WD- 1).
2. Mold—A cylindrical metal mold approximately 4 in (100 mm) in diameter and 4.6 in (116.8 mm) in height and having a volume of 1/30 ft^3 (0.0009 m^3) (WM-07).
3. Sand—Any clean, dry sand graded to pass at least a No. 10 (2 mm) sieve with not more than 5 percent passing the No.50 (300 μm) sieve (OS-17).
4. Base Plate—A metal plate 12 in (304.8 mm) square or in diameter, with a 6 in (152.4 mm) diameter hole in the center of plate (WD-1-1).
5. Straightedge—A steel straightedge, 12 in (304.8 mm) or more in length (WS-13-1).
6. Drying Device—A stove or oven capable of rapidly drying the moisture determination samples.
7. Scales and Balances—A scale of 20 kilogram capacity, sensitive to and graduated in 1.0 gram increments, and a 500 gram capacity balance, sensitive to and graduated in 0.1 gram increments (WB-6 and WB-5).
8. Miscellaneous Tools
    a. Trowel (optional) (WT-7)
    b. Containers (large pie pans, baking pans made of steel) (WP-12, 18 in diameter (457.2 mm)
    c. Spoon (WS-14)
    d. Brush (2 in (50.8 mm) or 3 in (76.2 mm) paint brush) (OB-02)
    e. Small pie pans or evaporating dishes (WP-01 or WD-3)
    f. Scoop (WS-03)
    g. Chisel (optional)
    h. Hammer or mallet (optional) (wooden mallet WM-01)
    i. Elutriation bottles or equivalent (WB-03)

C. Sample Size and Preparation

Before making density measurements, calibrate the sand to determine its density [dry weight in pounds per cubic foot (kilograms per cubic meter)].

NOTE: Perform the calibration with extreme care—a small error in the weight per cubic foot of the sand will cause a large error in the in-place density calculation.

1. Determine Density of the Sand
    a. Place the base plate and sand cone ¾ in (19.0 mm) plus or minus ¼ in (6.35 mm) above a 1/30 cubic foot (0.0009 cubic meter) density mold as is shown in Figure 2.
    b. Open the valve in the sand cone and fill 1/30 cubic foot (0.0009 cubic meter) mold until it overflows.
    c. Close the valve and remove the sand cone and base plate from above mold, being extremely careful not to jar the mold.

Sand Calibration "Set Up" Figure 2.

d. Strike off the sand very carefully until it is even with the top of the1/30 cubic foot (0.0009 cubic meter) mold. Clean all sand from the outside of the mold.

e. Weigh the mold filled with sand, and record to the nearest gram.

f. Repeat the above procedure described in steps a. through e. above at least 3 times.

g. Weigh the empty density mold.

h. Calculate the density of the sand by the following formula:

Density of Sand = PCF

$$\frac{Wt - Wm}{454 \times Vm}$$

Where:

Wt = weight in grams of mold and sand

Wm = weight in grams of mold

Vm = volume of mold in cubic feet*

*Mold volume is 1/30 cubic foot

Density of Sand = kilograms per m^3

$$\frac{Wt - Wm}{1000 \times Vm}$$

Where:

Wt = weight in grams of mold and sand

Wm = weight in grams of mold

Vm = volume of mold in cubic meters*

*Mold volume is 0.0009 cubic meter

Determine the Weight of Sand Required to Fill the Cone and Base Plate

a. Put the sand in the apparatus and weigh, in grams.

b. Seat the inverted apparatus on the base plate on a clean, level surface.

c. Open the valve until the sand stops running, then close the valve sharply.

d. Weigh, in grams, the apparatus with the remaining sand, and the difference in original weight. The final weight is the weight of sand required to fill cone and base plate.

D. Procedures

This method of test requires excavating the density of the sample, determining the volume of the density hole, and determining the proper theoretical maximum dry density.

1. Excavating the Density Sample

   a. Prepare the surface of the location to be tested so that it is a level plane. Remove all loose material on the surface from an area large enough for placing the base plate.

   b. Seat the base plate on the surface.

   c. Dig the in-place material out through the hole in the plate to the full depth of the course being tested. Dig a 6 in (152.4 mm) diameter hole for lifts or courses up to 6 in (152.4 mm) thick, and dig a 4 in (101.6 mm) hole for lifts thicker than 6 in (152.4 mm). Ensure that the sides of the hole are approximately vertical.

   d. Place the material from the hole in the large pie pan, being very careful not to lose any of the material. Take care not to loosen or disturb the materials surrounding the hole. Remove and retain all of the loosened material from the hole.

NOTE: If the course being tested has a specified thickness, the thickness may be measured at this time.

   e. Immediately weigh the material removed from the hole before there is any loss in field moisture. Record the weight as weight of wet material from the hole.

   f. Weigh approximately 500 grams of the wet material for moisture determination. Record as wet weight under moisture determination. Dry this sample and calculate moisture content to the nearest 0.1% by the following formula:

   Moisture Content,% =

$$\frac{A - B}{B} \times 100$$

A = weight of wet sample

B = weight of dry sample

2. Determining the Volume of the Density Hole
   a. Weigh the sand cone apparatus and sand and record as gross weight of sand, cone, and jar.
   b. Seat the apparatus on the base plate over the excavated hole, and open the valve until the sand stops running.
   c. Close the valve sharply and weigh the apparatus with remaining sand and record as tare weight sand, cone, and jar.
3. Determining the Proper Theoretical Maximum Dry Density
   a. Determine the percentage of plus No. 10 (2 mm) material contained in the sample excavated from the density hole by GDT 4. Use the total amount excavated for this determination, with the exception of the material used for the moisture test, if the total amount of plus 2 mm is estimated to be more than 10%. If the total amount of plus No. 10 (2 mm) is estimated to be less than 10%, the percentage of plus No. 10 (2 mm) may be determined from the moisture sample.
   b. Determine the theoretical maximum dry density of the minus No. 10 (2 mm) material at the test location according to GDT 7. This density may be performed on material from this specific location at the time of the compaction test, or previous tests of material from this or an adjacent location.
   c. Correct the minus No. 10 (2 mm) density according to the Correction Tables given in the Testing Manual. Use this density as the maximum dry density for use in calculating the percent compaction as outlined below.

E. Calculations

1. Calculate the in-place wet density of the material removed to the nearest 0.1 lbs/ft^3 (kg/m^3) by the following formula:

$$\text{Inplace Wet Density in lb/ft}^3\ (\text{kg/m}^3) = \frac{Ww \times Ds}{Ws}$$

2. Determine the in-place dry density to the nearest 0.1 lb/ft^3 (nearest kg/m^3) by the following formula:

$$\text{Inplace Dry Density in lb/ft}^3\ (\text{kg/m}^3) = \frac{Dw}{1 + M}$$

3. Calculate the percent compaction to the nearest percent from the maximum dry density [determined to the nearest 0.1 lb/ft^3 (nearest kg/m^3)]as determined by GDT 7 or GDT 19 or GDT 67 and the above in-place dry density [determined to the nearest 0.1 lb/ft^3)] using the following formula:

$$\% \text{ Compaction} = \frac{Dd \times 100}{MMD}$$

Ww = wet weight of material from hole

Ds = density of sand

Ws = weight of sand used to fill hole

Dw = in-place wet density

Dd = inplace dry density

MMD = maximum dry density

M = moisture content,%

F. Report

No report is listed for this test method.

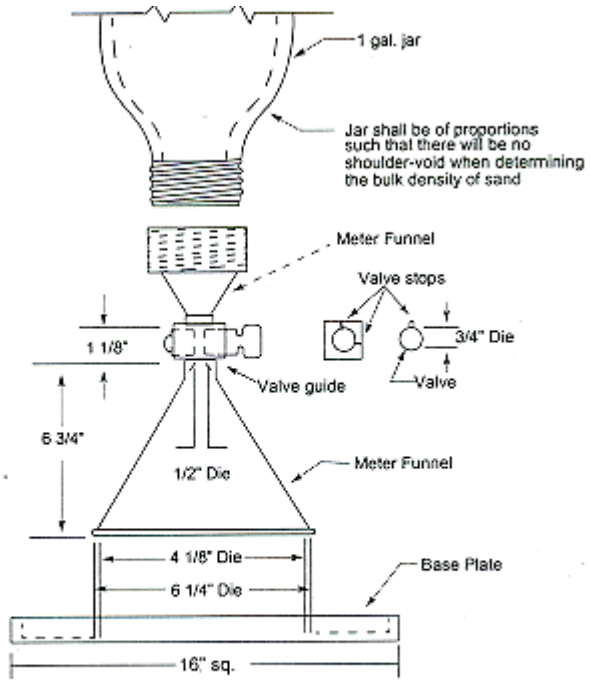

Figure 1

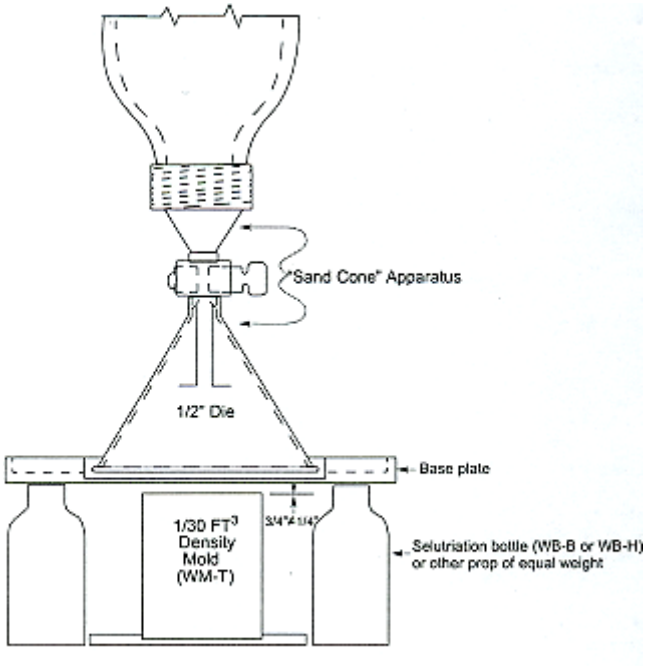

Figure 2