GDT 21

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 soil-aggregate mixtures in embankments, cuts, subgrades, subbases, bases, etc., where the percent of material retained on the No. 10 (2 mm) sieve is 45 or more, or where the percent of material retained on the 1 in (25 mm) sieve is 10 percent or more.

B. Apparatus

1. Ring—A steel ring 12 in (304.8 mm) in diameter (mold or extension WM-06).
2. Sand—Any clean, dry sand graded to pass at least a No. 10 (2 mm) sieve but with no clay or silt.
3. Straightedge—A steel straightedge, 24 in (610 mm) long (WS13-2).
4. Drying Device—A stove or oven capable of rapidly drying the moisture determination samples.
5. Scales and Balances—A scale of at least 100 lb. (45.36 kg) capacity, sensitive to 2 oz; and a 20 kg balance with an accuracy of 1 g or 0.1 percent of the sample being tested.
6. Density Mold—A 12 in (304.8 mm) mold (WM06).
7. Bucket—A 12 in (304.8 mm) measure (WM-02) (optional).
8. Miscellaneous Tools
    a. Soil auger (optional) (WA-3)
    b. Trowel (optional) (WT-07)
    c. Containers (large pie pans or baking pans) (WP- 12)
    d. Spoon (WS-14)
    e. Brush (2 in or 3 in (50.8 or 76.2 mm) paint brush) (OB-02)
    f. Small pie pans or evaporating dishes (WP-01 or WD-3)
    g. Scoop (WS-03)
    h. Chisel
    i. Hammer or mallet (wooden mallet WM-01)

C. Sample Size and Preparation

Before making density measurements, calibrate the sand to determine its weight in pounds per cubic foot (kilograms per cubic meter). Perform the sand calibration in a manner designed to duplicate the method of pouring the sand into the sample hole.

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

1. Weigh the empty volume mold.

NOTE: Calibrate by using a 12 in (304.8 mm) density mold with base plate attached or by using a 1/2 ft^3 (0.0142 m^3) bucket.

2. Pour the sand into the mold or bucket until it is full. Use a method comparable to that used in pouring in the sample hole. Strike off the sand level with the top.
3. Weigh the filled mold or bucket and record as gross weight of mold and plate (or bucket) and sand. Determine the weight of sand used by subtracting weight of mold and plate (or bucket).
4. Repeat the above operations 3 times and average the weight of the sand.
5. Calculate the density of the sand.

D. Procedures

You must excavate density samples and then determine the volume of the density hole.

1. Excavating Density Samples
   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 to place the 12 in (304.8 mm) ring.
   b. Seat the 12 in (304.8 mm) ring on the surface and mark an outline of the ring.
   c. Dig the in-place material out through the ring by using the right outline as a guide to the full depth of the course being tested. Ensure that the sides of the hole are approximately vertical.
   d. Place the material from the hole in the large container, 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 the loosened material for the full depth.

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

   e. Immediately weigh the material removed from the hole before moisture is lost. Record the weight as weight of wet material from the hole.
   f. Weigh a representative sample of approximately 2,000 grams of the wet material for moisture determination. Record as weight of wet sample. Dry this sample and weigh, recording as weight of dry sample. Calculate as moisture content.
2. Determining Volume of Density Hole
   a. Place more than enough calibrated density sand needed to fill the sample hole into a container or sack and weigh. Record this weight as initial weight of sand and container.
   b. Fill the sample hole with the sand. Pour the sand from the container or sack using a method comparable to that used in calibrating the sand. Pour slowly and evenly until the sand is approximately 1 in (25.4 mm) below the top of the hole.

   Use a small container (such as a tin cup) to complete the filling. Replace all unused sand into the container or sack. You may level the sand even with the top of the hole using the hand or small straightedge, but never compress or vibrate the sand.
3. Weigh the container with the remaining sand. Determine the weight of sand used to fill the sample hole by subtracting the weight of the remaining sand and container from the original weight of sand and container. Record this weight as weight of sand used.

E. Calculations

1. Calculate the density of sand from calibration as follows:

Density of Sand = Pounds per cubic feet

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

Where:

Wt = weight of mold, plate and sand, or bucket and sand

Wm = weight of mold and plate or bucket

V = volume of mold or bucket in cubic feet*

Density of Sand = kilograms per cubic meter

$$\frac{Wt - Wm}{1000 \times V}$$ where

Where:

V = volume of mold or bucket in cubic meters*

***NOTE: Mold volume is .3927 ft^3 (0.0111 m^3), bucket volume is 0.5 ft^3 (0.0142 m^3).**

2. Calculate the in-place wet density of the material removed, in pounds per cubic foot (kilograms per cubic meter), by the following:

   In-Place Wet Density, pounds per cubic foot (kilograms per cubic meter) =

   $$\frac{W_w \times D_s}{W_s}$$

   W_w = wet weight of material from hole

   Ds = density of sand

   W_s = weight of sand used

3. Calculate the moisture content as follows:

   Moisture Content, % =

   $$\left(\frac{A-B}{B}\right) \times 100$$

   A = weight of wet sample

   B = weight of dry sample

4. Calculate the in-place dry density of the material removed from the hole, as follows:

   In-Place Dry Density, pounds per cubic foot (kilograms per cubic meter) =

   $\frac{D_w \times 100}{100+M}$ where

   D_w = in-place wet density

   M = moisture content in percent

5. The percent compaction is calculated from the maximum dry density as determined by GDT 24 or AASHTO T 180 Method D whichever is applicable and the above in-place dry density using the following formula:

   $$\% \text{ Compaction} = \frac{\text{in place dry density lb./ft}^3 \text{ (kg/m}^3\text{)} \times 100}{\text{maximum dry density lb./ft}^3 \text{ (kg/m}^3\text{)}}$$

NOTE: If the material being compacted contains less than 45% plus No. 10 (2 mm), but more than 10% retained on the 1 in (25 mm) sieve, determine the maximum dry density for use in compaction control according to GDT 7 or GDT 67 whichever is applicable.

F. Report

No report is listed for this method.