October 19, 2004 Matls. IM 326
Supersedes April 20, 2004

DETERMINING THE DENSITY OF UNDISTURBED SOIL CORES BY DISPLACEMENT

SCOPE

This method of test is intended to determine the density of cohesive soils in the natural state or after compaction by measuring the weight, volume and moisture content of the undisturbed sample. This test method is the field procedure for Laboratory Test Method 102.

PROCEDURE

A. Apparatus

1. Core sampling device consisting of a bit, bit head, rod, driving head and driver
2. Balance accurate to 0.5 gram
3. Graduate, 500 ml
4. 1 gallon (4 liter) can
5. Supply of liquid. May be either kerosene or No. 2 diesel fuel.
6. Volume-measuring device, consisting of a 9 1/2 in. high by 5 1/2 in. (241.3 mm x 139.7 mm) diameter brass tube and a 9 1/2 in. by 2 in. (241.3 mm x 50.8 mm) diameter brass tube connected near their base by a 1 in. (25.4 mm) diameter cross tube. The 20 in. (50.8 mm) diameter tube acting as a surge tank has an anti-siphoning overflow outlet near its top.
7. Core carrier
8. Trimming knife
9. Waxed paper or cellophane
10. Extruding pedestal
11. Suitable containers for transporting the sample
12. Stove or other suitable device for drying sample

B. Sample Procedure

1. Hold the sampling device in a vertical position and drive to the bottom of the lift of material to be tested. Do not overdrive as this will compact and disturb the sample. During this driving procedure exercise care to keep the four cap screws and the screwed joints on each end of the rod tight to prevent damage to the threads.

2. Rotate the driving head in a circular motion to break the core loose. It can then be lifted out easily.

3. After disconnecting the bit from the bit head, remove the core by pushing it on through the top of the bit head using the extruding pedestal.

4. Wrap the sample in cellophane or waxed paper to maintain its moisture content until tested.

5. Place the wrapped specimen with proper identification in a suitable container for transporting.

C. Test Procedure

1. Trim the moisture test sample from the sides of the core leaving a representative sample for the full depth of the lift of material to be tested. The moisture test sample obtained in this manner should be of a size equal to between 3 and 4 grams per lineal millimeter of core.

2. Immediately weigh the moisture test sample, dry to a constant mass (weight), and reweigh the dried sample to determine the moisture content of the specimen.

3. Weigh the remainder of the core.

4. Place the core carrier in the volume-measuring device and fill with liquid until the overflow is running freely. After the overflow cuts off, place the 500-ml. graduate (or larger container if needed) under the outlet.

5. Remove the core carrier, place the core in it and carefully lower into a 1 gallon (4 liter) can containing sufficient liquid to cover the specimen. Soak the core in liquid until the air bubbles cease, indicating the filling of air voids. Remove the sample and allow the excess liquid to drain from the sides of the specimen.

6. Carefully lower the core carrier and sample into the volume-measuring device. Do not allow any liquid to run over the top of the device during this procedure.

7. Allow the displaced liquid to run into the 500-ml. graduate (or a larger container, if needed, and then measure in the graduate) until it stops. The volume of this displaced liquid is the volume of the sample.

8. Make certain that no portion of the samples extends above the level of the liquid at the time the liquid stops flowing.

D. Calculations

1. $$\%M = \frac{(W - D)(100)}{D}$$

Where:

W = Wet mass (weight) of moisture test sample
D = Dry mass (weight) of moisture test sample
M = Moisture content, in percent

2. $$D_w = \frac{A}{V}$$

Where:

A = Wet mass (weight) of density sample
V = Volume of displaced liquid.
D_w = Wet density of soil (kg/m^3)

3. $$D_D = \frac{D_w(100)}{1 + \frac{M}{100}}$$

Where:

D_D = Dry density of soil in kilograms per cubic meter (pounds per cubic foot).

Example:

Wet mass (weight) of moisture sample (W) = 500 g.
Dry mass (weight) of moisture sample (D) = 447 g.
Wet mass (weight) of density sample (A) = 1400 g.
Volume of liquid displaced (V) = 695 ml.

$$M = \frac{500 - 447}{447} \text{ x } 100 = 11.9\%$$

$$D_w = \frac{1400}{695} = 2.01 \text{ g/ml}$$

$$D_D = \frac{2.01(100)}{1 + \frac{11.9}{100}} 1796.2 \text{ kg/m}^3$$

Figure 1. Volume-measuring Device