IN-SITU UNIT WEIGHT OF SOIL

(THE SAND CONE METHOD)

Purpose:

This lab is performed to determine the in-place density of undisturbed soil obtained by pushing or drilling a thin-walled cylinder. The bulk density is the ratio of mass of moist soil to the volume of the soil sample, and the dry density is the ratio of the mass of the dry soil to the volume the soil sample.

Standard Referance:

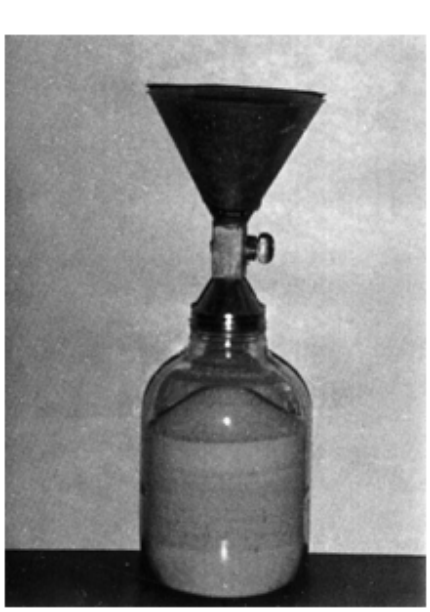
D1556-00 Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

Significance:

This test is used to determine the in-place density of soils. This test can also be used to determine density of compacted soils used in the construction of structural fills, highway embankments, or earth dams.

Equipment:

A one-gallon jar, a detachable metal appliance, a base plate, a calibration container



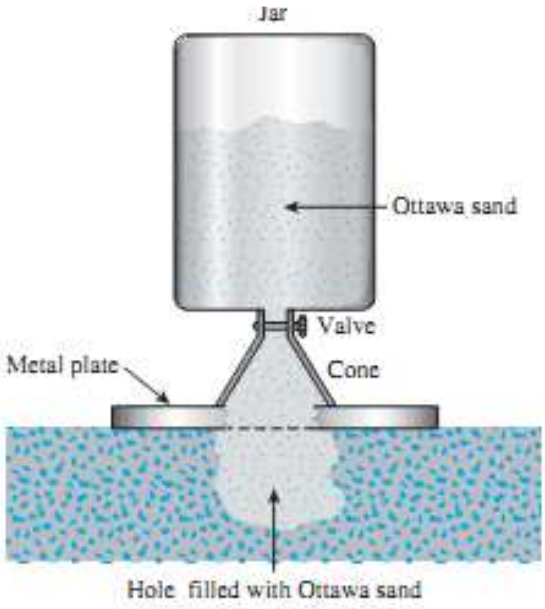


Figure: Base Plate, Apparatus, and Calibration Container

CONE CORRECTION AND DENSITY OF SAND:

The procedure for determination of the Cone Correction is summarized as follows:

1) Fill the apparatus with the calibration sand and record the weight to the nearest 0.01 lb

2) Place the base plate on a clean, level surface

3) Invert the apparatus onto the base plate and open the valve to allow the cone and the base plate to fill with sand

4) When the sand stops flowing into the cone, shut the valve and weigh the apparatus to the nearest 0.01 lb

5) The difference between the full weight of the apparatus and the final weight after filling the cone is referred to as the Cone Correction.

A calibration container with a known volume is required to determine the bulk density of the calibration sand. By knowing the volume of the calibration container and the weight of calibration sand required to fill the container, the bulk density of the calibration sand in pounds per cubic foot may be calculated.

The bulk density of the sand is determined as follows:

1) Fill the apparatus with the calibration sand and record the weight to the nearest 0.01 lb

2) Place the base plate on the calibration container

3) Invert the apparatus on the base plate and open the valve to allow the calibration container and the large cone to fill with sand

4) Shut the valve on the apparatus and weigh the apparatus to the nearest 0.01 lb.

The initial weight of the apparatus minus the final weight and minus the Cone Correction is the weight of the calibration sand required to fill the container. Divide the weight of the sand in the container by the volume of the container to determine the bulk density of the sand. The bulk density of the sand is calculated to the nearest 0.1 lb/ft^3.

Test Procedure:

(1) Select a location/elevation that is representative of the area to be tested, and determine the density of the soil in-place as follows:

1.1 Inspect the cone apparatus for damage, free rotation of the valve, and properly matched base plate. Fill the cone container with conditioned sand for which the bulk-density has been determined earlier, and determine the total mass.

1.2 Prepare the surface of the location to be tested so that it is a level plane. The base plate may be used as a tool for striking off the surface to a smooth level plane.

1.3 Seat the base plate on the plane surface, making sure there is contact with the ground surface around the edge of the flanged center hole. Mark the outline of the base plate to check for movement during the test, and if needed, secure the plate against movement using nails pushed into the soil adjacent to the edge of the plate, or by other means, without disturbing the soil to be tested.

1.4 In soils where leveling is not successful, or surface voids remain, the volume horizontally bounded by the funnel, plate and ground surface must be determined by a preliminary test. Fill the space with sand from the apparatus, determine the mass of sand used to fill the space, refill the apparatus, and determine a new initial mass of apparatus and sand before proceeding with the test. After this measurement is completed, carefully brush the sand from the prepared surface.

1.5 The test hole volume will depend on the anticipated maximum particle size in the soil to be tested. Test hole volumes are to be as large as practical to minimize the errors and shall not be less than the volumes indicated in Table 1.

TABLE 1 Minimum Test Hole Volumes Based on Maximum Size of Included Particle

Maximum Particle Size		Minimum Test Hole Volumes	
in.	(mm)	cm^3	ft^3
½	(12.7)	1415	0.05
1	(25.4)	2125	0.075
1½	(38)	2830	0.1

1.6 Dig the test hole through the center hole in the base plate, being careful to avoid disturbing or deforming the soil that will bound the hole. The sides of the hole should slope slightly inward and the bottom should be reasonably flat or concave. The hole should be kept as free as possible of pockets, overhangs, and sharp obtrusions since these affect the accuracy of the test. Soils that are essentially granular require extreme care and may require digging a conical-shaped test hole. Place all excavated soil, and any soil loosened during digging, in a moisture tight container that is marked to identify the test number. Take care to avoid losing any materials. Protect this material from any loss of moisture until the mass has been determined and a specimen has been obtained for a water content determination.

1.7 Clean the flange of the base plate hole, invert the sand-cone apparatus and seat the sand-cone funnel into the flanged hole at the same position as marked during calibration . Eliminate or minimize vibrations in the test area due to personnel or equipment. Open the valve and allow the sand to fill the hole, funnel, and base plate. Take

care to avoid jarring or vibrating the apparatus while the sand is running. When the sand stops flowing, close the valve.

1.8 Determine the mass of the apparatus with the remain-ing sand, record, and calculate the mass of sand used.

1.9 Determine and record the mass of the moist material that was removed from the test hole. When oversized material corrections are required, determine the mass of the oversized material on the appropriate sieve and record, taking care to avoid moisture losses.

1.10 Mix the material thoroughly, and either obtain a representative specimen for water content determination, or use the entire sample.

1.11 Determine the water content in accordance with Test Method used to determine the water content.

(2) Water content specimens must be large enough and selected in such a way that they represent all the material obtained from the test hole. The minimum mass of the water content specimens is that required to provide water content values accurate to 1.0 %.

Calculation:

(1) Calculations shown are for mass in grams and volumes in cubic centimetres. Other units are permissible provided theappropriate conversion factors are used to maintain consistency of units throughout the calculations.

(2) Calculate the volume of the test hole as follows:

$$V = (M_1 - M_2)/\rho_1$$

where:

V= volume of the test hole, cm^3,

M1 = mass of the sand used to fill the test hole, funnel and base plate, g

M2=mass of the sand used to fill the funnel and base plate ,g

ρ_1 = bulk density of the sand, g/cm3.

(3) Calculate the dry mass of material removed from the test hole as follows:

$$M_4 = 100\, M_3/(w + 100)$$

where:

w = water content of the material removed from test hole, %,

M_3 = moist mass of the material from test hole, g

M_4 = dry mass of material from test hole, g

(4) Calculate the in-place wet and dry density of the material tested as follows:

$$\rho_m = M_3/V$$
$$\rho_d = M_4/V$$

where:

V = volume of the test hole, cm3

M_3 = moist mass of the material from the test hole, g

M_4= dry mass of the material from the test hole, g

ρ_m = wet density of the tested material g/cm3

ρ_d = dry density of the tested material, g/cm3

(5) It may be desired to express the in-place density as a percentage of some other density, for example, the laboratory densities determined in accordance with ASTM Test Method. This relation can be determined by dividing the in-place density by the laboratory density and multiplying by 100.

UNIT WEIGHT DETERMINATION
DATA SHEET

Date Tested:

Tested By:

Project Name:

Sample Number:

Sample Description:

Measurement	Trial 1	Trial 2
M1		
M2		
V		
M3		
M4		
ω		
ρ_m		
ρ_d		