03.09

product manual

H-3750.2F & H-3750.5F

Relative Density Apparatus

Introduction

Product Description

Apparatus determines the relative density of cohesionless, free-draining soils and provides well-defined results on soils that do not respond well to conventional moisture-density impact compaction testing. Soils for which this method is appropriate may contain up to 12 percent of soil particles passing a No. 200 (75µm) sieve, depending on the distribution of particle sizes, which causes them to have free-draining characteristics. Relative density of cohesionless soils uses vibratory compaction to obtain maximum density and pouring to obtain minimum density. Complete set includes: Vibrating table H-3756.2F, relative density mold sets H-3757 and H-3758 and relative density gauge set H-3759. Meets ASTM D4253, D4254. Shipping wt. 925 lbs. (420kg)

Models covered in manual include:

230V 60Hz, 12 amps 1ph AC— H-3750.2F
230V 50Hz, 12 amps 1ph AC— H-3750.5F

Relative Density of Cohesionless Soils

This method of test is intended for determining the relative density of cohesionless free-draining soils for which impact compaction will not produce a well defined moisture density relationship curve and the maximum density by impact methods will generally be less than by vibratory methods.

Definition

Relative density is defined as the state of compactness of a soil with respect to the loosest and densest states at which it can be placed by the laboratory procedures described in this method. It is expressed as the ratio of:

(1) the difference between the void ratio of a cohesionless soil in the loosest state and any given void ratio, to

(2) the difference between its void ratios in the loosest and densest states.

Mathematical expressions for this definition are presented in later paragraphs.

Apparatus

The assembly of the apparatus is shown in Figure 1. Individual components and accessories shall be as follows:

a) H-3756 Vibratory Table. A steel table with a cushioned steel vibrating deck about 30” x 30”, actuated by an electromagnetic vibrator.
b) Molds. Cylindrical metal unit weight molds of 0.1 and 0.5 cu ft capacity.
c) Guide Sleeves.
d) Surcharge Base Plates.
e) Surcharge Weights.
f) Surcharge Base Plate Handle.

g) Dial Indicator Gage Holder.
h) Dial Indicator.
i) Calibration Bar.

Calibration
Determine the volume of the mold by direct measurement and check the volume by filling with water as provided in a).

Determine the initial dial reading for computing the volumes of the specimen as provided in b).

a) Volume by Direct Measurement. Determine the average inside diameter and height of the mold to 0.001 inches. Calculate the volume of the 0.1 cu ft mold to the nearest 0.0001 cu ft and the 0.5 cu ft mold to the nearest 0.0001 cu ft. Calculate also the average inside cross-sectional area of the mold in square feet.

b) Initial Dial Reading. Determine the thickness of the surcharge base plate and the calibration bar to 0.001 inches using a micrometer. Place the calibration bar across a diameter of the mold along the axis of the guide brackets. Insert the dial indicator gage holder in each of the guide brackets on the measure with the dial gage stem on top of the calibration bar and on the axis of the guide brackets. The dial gage holder should be placed in the same position in the guide brackets each time by means of matchmarks on the guide brackets and the holder. Obtain six dial indicator readings, three on the left side and three on the right side, and average these six readings. Compute the initial dial reading by adding together the surcharge base plate thickness and the average of the six dial indicator readings and subtract the thickness of the calibration bar. The initial dial reading is constant for a particular measure and surcharge base plate combination.

Sample
Select a representative sample of soil. The weight of sample required is determined by the maximum size of particle as follows:

Maximum Size of Soil Particle	Weight of Sample Required (lb.)	Pouring Device to be used in Minimum Density Test	Size of Mold to be used (cu. ft.)
3 inch	100	Shovel or extra large scoop	0.5
1 – ½ inch	25	Scoop	0.1
3/4 inch	25	Scoop	0.1
3/8 inch	25	Pouring Device (1" diameter spout)	0.1
No 4 (4.75 mm)	25	Pouring Device (1/2" diameter spout)	0.1

Dry the soil sample in an oven at a temperature of 230 ± 9 F (110 ± 5C). Process the soil through a sieve with openings sufficiently small to break up all weakly cemented soil particles.

Minimum Density Procedure
Determine the minimum density (zero relative density), (maximum void ratio) as follows:

a) Select the pouring device and mold according to the maximum size of particle as indicated on the chart in Sample section. Weigh the mold and record the weight. Use oven dried soil.

b) Place soil containing particles smaller than 3/8 inch as loosely as possible in the mold by pouring the soil from the spout in a steady stream while at the same time adjusting the height of the spout so that the free fall of the soil is 1 inch. At the same time, move the pouring device in a spiral motion from the outside toward the center to form a soil layer of uniform thickness without segregation. Fill the mold approximately 1 inch above the top and screed off the excess soil level with the top by making one continuous pass with the steel straight-edge. If all excess material is not removed, an additional continuous pass shall be made but great care must be exercised during the entire pouring and trimming operation to avoid jarring the mold.

c) Place soil containing particles larger than 3/8 inch by means of a large scoop (or shovel), hold as close as possible to and just above the soil surface to cause the material to slide rather than fall onto the previously placed soil. If necessary, hold large particles back by hand to prevent them from rolling off the scoop. Fill the mold to overflowing but not more than 1 inch above the top. With the use of the steel straightedge (and the fingers when needed), level the surface of the soil with the top of the measure in such a way that any slight projections of the larger particles above the top of the mold shall approximately balance the larger voids in the surface below the top of the mold.

d) Weigh the mold and soil and record the weight.

Maximum Density Procedure
Determine the maximum density (100 percent relative density, minimum void ratio) by either the dry or wet method as follows:

a) Dry Method:
1 Mix the sample of oven dried soil to provide an even distribution of particle sizes with as little segregation as possible.

2 Assemble the guide sleeve on top of the mold and tighten the clamp assemblies so that the inner wall of the sleeve is in line with the inner wall of the mold. Tighten the lock nuts on the two set screws equipped with lock nuts. Loosen the clamp assembly having no lock nuts. Remove the guide sleeve. Weigh the empty mold and record the weight.

3 Fill the mold with soil by the procedure specified in b) or c). Min. Den. Proc.

4 Attach the guide sleeve to the mold and place the surcharge base plate on the soil surface. Lower the surcharge base plate, using a hoist in the case of the 0.5 cu ft mold.

5 Set the vibrator control at maximum amplitude and vibrate the loaded specimen for 8 minutes. Remove the surcharge weight and guide sleeve from the mold. Obtain and record dial indicator gage readings on two opposite sides of the surcharge base plate, average, and record the average. Weigh the mold and soil, if this has not been done in the minimum density determination or if an appreciable amount of fines has been lost during vibration. Record the weight.

b) Wet Method:

1 The wet method may be conducted on oven dried soil to which sufficient water is added or, if preferred, on wet soil from the field. If water is added to dry soil, allow a minimum soaking period of ½ hour.

2 Fill the mold with wet soil by means of a scoop or shovel. Add sufficient water to the soil to allow a small amount of free water to accumulate on the surface of the soil during filling. The correct amount of water can be estimated by a computation of the void ratio at expected maximum density or by experimentation with the soil. During and just after filling the mold, vibrate the soil for a total of 6 minutes. During this period, reduce the amplitude of the vibrator as much as necessary to avoid excessive boiling and fluffing of the soil, which may occur in some soils. During the final minutes of vibration, remove any water appearing above the surface of the soil.

3 Assemble the guide sleeve, surcharge base plate, and surcharge weight as described in Paragraph a) 4).

4 Vibrate the specimen and surcharge weight for 8 minutes. After the vibration period, remove the surcharge weight and guide sleeve from the mold. Obtain and record dial indicator gage readings on two opposite sides of the surcharge base place. Carefully remove the entire wet specimen from the mold and dry to constant weight. Weigh dry specimen and record.

Calculations

a) Minimum Density. Calculate minimum density in pounds per cubic foot, as follows:

$$\gamma\,dmin = \frac{W_s}{V_c}$$

b) Maximum Density. Calculate maximum density, in pounds per cubic foot as follows:

$$\gamma\,dmax = \frac{W_s}{V_f}$$

Where:

W_s	=	weight of dry soil, pounds
V_c	=	calibrated volume of mold, cubic feet
V_f	=	volume of soil, cubic feet = $V_c - (R_i - R_f) / 12$ x cu. ft.
R_f	=	final dial gage reading on the surcharge base plate after completion of the vibration period, inches
R_i	=	initial dial gage reading, inches
A	=	cross-sectional area of mold, square feet.

c) Density of Soil in Place. Determine the density of the soil in place, Yd, in a compacted fill or a natural deposit in accordance with either the Method of Test for Density of Soil in Place by the Sand-Cone Method ASTM Designation: D1556 or the Method of Test for Density of Soil in Place by the Rubber-Balloon Method ASTM Designation: D2167.

d) Relative Density. Calculate relative density, D_d, expressed as a percentage as follows:

$$D_d = \frac{\gamma\,dmax\,(\gamma - \gamma\,dmin)}{\gamma\,(\gamma\,dmax - \gamma\,dmin)} \times 100$$

or in terms of void ratio:

$$D_d = \frac{(e_{max} - e)}{(e_{max} - e_{min})} \times 100$$

Where:

e	=	the volume of voids divided by the volume of solid particle
e_{max}	=	void ratio in loosest state
e_{min}	=	void ratio in most compact state.

Relative Density Mold Set

Warranty

Humboldt Mfg. Co. warrants its products to be free from defects in material or workmanship. The exclusive remedy for this warranty is Humboldt Mfg. Co., factory replacement of any part or parts of such product, for the warranty of this product please refer to Humboldt Mfg. Co. catalog on Terms and Conditions of Sale. The purchaser is responsible for the transportation charges. Humboldt Mfg. Co. shall not be responsible under this warranty if the goods have been improperly maintained, installed, operated or the goods have been altered or modified so as to adversely affect the operation, use performance or durability or so as to change their intended use. The Humboldt Mfg. Co. liability under the warranty contained in this clause is limited to the repair or replacement of defective goods and making good, defective workmanship.

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