GDT 19

A. Scope

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

This method covers the procedures for determining the relationship between the moisture content and the density of soil-cement mixtures when compacted before cement hydration where the soil-cement contains more than 45% retained on the No. 10 (2mm) sieve. Perform the test according to GDT 24 with the prescribed amount of cement added to the sample as described herein.

B. Apparatus

The apparatus shall be as prescribed in GDT 7, and in addition:

1. Container—A pan or vessel large enough to contain the sample.
2. Spatula

C. Sample Size and Preparation

1. Prepare the sample for testing by breaking up the soil aggregations to pass the No. 10 (2 mm) sieve in a manner that avoids reducing the natural size of the individual particles. When necessary, first dry the sample until it is friable. Dry the sample by air drying or by using drying apparatus such that the temperature of the sample does not exceed 140 °F (60 °C).
2. Select a representative sample (weighing approximately 6 lbs (3 kg) or more) of the prepared soil.

D. Procedures

1. Add to the soil the required amount of cement. Mix the cement and soil thoroughly to a uniform color. When needed, add sufficient potable water to dampen the mixture to approximately 4 to 6 percentage points below the estimated optimum moisture content and mix thoroughly.

   At this moisture content, plastic soils, tightly squeezed in the palm of the hand will form a cast that will fracture with only slight pressure applied by the thumb and fingertips, nonplastic soils will bulk noticeably.
2. When the soil is a heavy-textured clayey material, compact the mixture of soil, cement, and water in the container to a depth of about 2 in (50 mm) using the rammer described in GDT 7 or a similar hand tamper. Cover, and allow to stand for not less than 5 minutes but not more than 10 minutes to aid dispersion of the moisture and to permit more complete absorption by the soil-cement.
3. After the absorption period, thoroughly break up the mixture, without reducing the natural size of individual particles, until it will pass a No. 10 (2 mm) sieve, and then remix.
4. Form a specimen by compacting the prepared soil-cement mixture in the mold, with the collar attached, in 3 equal layers so as to give a total compacted depth of about 5 in (125 mm). Compact each layer by 25 blows from the rammer dropping free from a height of 12 in (304.5 mm) above the elevation of the soil-cement when using a sleeve-type rammer, or from ½ in (12.7 mm) above the approximate elevation of each finally compacted layer when using a stationary-mounted type rammer. Uniformly distribute the blows over the surface of the layer being compacted. During compaction, rest the mold on a uniform, rigid foundation such as provided by a cube of concrete weighing not less than 200 lbs (90 kg).
5. Following compaction, remove the extension collar, carefully trim the compacted mixture even with the top of the mold by means of the spatula and straightedge, and weigh.
6. Multiply the weight of the compacted sample and cylinder minus the weight of the cylinder by the multiplication correction factor for the mold as determined according to OMR-CVP-7-A or ASSHTO T-19 (unit weight and voids in aggregate) Section 7-7.5 (calibration of measure) and the results recorded as the wet weight, pounds per cubic foot (kilograms per cubic meter), of the compacted soil-cement mixture.
7. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material, weighing not less than 0.22 lbs(100 g), from the full height of one of the cut faces, weigh immediately, and dry in an oven at 230 ° ± 10 °F (110 ° ± 5 °C) for at least 12 hours or to constant weight. Calculate the moisture content of the sample as directed in Calculations.

8. Thoroughly break up the remainder of the material as before until it will pass a No. 10 (2 mm) sieve, as judged by eye, and add all other material remaining after obtaining the moisture sample. Add water in sufficient amount to increase the moisture content of the soil-cement mixture by 1 or 2 percentage points, mix, and repeat the procedure given in paragraphs 2, 3 and 4 for each increment of water added. Continue this series of determinations until there is either a decrease or no change in the wet weight per cubic cubic foot (meter) of the compacted soil-cement mixture.

NOTE: This procedure is satisfactory in most cases. However, in instances where the soil material is fragile in character and will reduce significantly in grain size from repeated compaction, use a separate and new sample for each moisture-density determination.

E. Calculations

Calculate the moisture content and density (dry weight per cubic foot [kg/m^3]) of the compacted soil-cement mixture for each trial as follows:

$$M = \frac{A-B}{B}$$

$$W1 = \frac{W}{1\ 00 + M}$$

where:

A = weight of wet soil-cement,

B = weight of dry soil-cement,

W = weight in pounds per cubic foot (kilograms per cubic meter) of compacted wet soil-cement

M = moisture content, in percent, at which the wet weight was determined.

W1 = weight in pounds per cubic foot (kilograms per cubic meter) of compacted dry soil-cement

F. Report

Report the results of the test as the “theoretical” or laboratory maximum dry density and the optimum moisture content.

Moisture-Density Relationship—Make the calculations in Calculations to determine the moisture content and corresponding density for each of the compacted soil-cement samples. Plot the densities of the soil-cement mixture as ordinates and the corresponding moisture contents as abscissas. Draw a smooth curve through the resulting points. The peak of the curve represents the maximum dry density and the moisture content at this point represents the optimum moisture content.