GDT 49

A. Scope

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

Use this method to determine the theoretical maximum dry density and optimum moisture of soil aggregate mixtures when the material contains more than 25 percent retained on the No. 10 (2 .00 mm) sieve.

B. Apparatus

The apparatus consists of the following:

1. Mold: Use a cylindrical metal mold approximately 6 in (152.4 mm) diameter and 6 in (152.4 mm) high. This mold is fitted with a detachable base plate and a removable extension approximately 2.5 in (63.5 mm) high (WM-06).
2. Rammer: Use a metal rammer with a 2-in (50 mm) diameter and a flat circular face and that weighs 10 lbs (4.536 kg). The rammer must be able to control the height of drop to a free fall of 18 inches above the soil (WR-1-1).
3. Scales and Balances: Use a scale with at least a 75 to 100 lbs (34 to 46.36 kg) capacity, sensitive to and graduated in 0.1 lbs (0.045 kg), and a 10 lbs (4.5 kg) capacity balance sensitive to 0.001 lb (0.5 g).
4. Drying Device: Use a stove or oven capable of rapidly drying the moisture determination sample.
5. Straightedge: Use a steel bar at least 12 in (304.8 mm) long (WS-13-1).
6. Pans or Dishes: Use pie pans or evaporating dishes suitable for drying soil samples (WD-3).
7. Glass Graduate: Use a glass (Bit-04-100) or plastic (WC-P100) graduate of 3.4 oz (100 ml) capacity used for measuring the mixing water.
8. Container: Use a suitable container for immersing the coarse aggregate.

C. Sample Size and Preparation

1. Ensure that the material meets the graduation requirements of GDT 7.
2. Dry a sample weighing approximately 50 lbs (22.68 kg) until it is friable. Dry the sample in open air or with a drying apparatus that does not cause the material to exceed 140 °F (60 °C).
3. Break up any aggregations to pass through the 3/4 in (19 mm) sieve without reducing the natural size of the individual particles.
4. Grade the material over the 3/4 in (19 mm) sieve.
5. Weigh the amount retained and discard it.
6. Replace the material retained on the 3/4 in (19 mm) sieve with an equal weight of material retained on the No. 4 (4.75 mm) sieve. Take the replacement material from a remaining portion of the material being tested.
7. Select a representative sample weighing approximately 25 lbs (11.34 kg).

D. Procedures

1. Thoroughly mix the selected representative sample with enough water to dampen it approximately 3 percent below optimum moisture content.
2. Form a specimen by compacting the prepared material in the 6 in (152.4 mm) mold (with collar attached).
   a. Compact the material in five equal layers so the total compacted depth is about 5 in (127 mm).
   b. Compact each layer with 56 uniformly distributed blows from the rammer.
3. After compacting the five layers, remove the collar.
4. Carefully trim the compacted material with the straightedge to be even with the top and bottom of the mold.
5. Weigh the mold and moist material.

6. Calculate and record the wet weight in lbs/ft³ (kg/m³) as follows:
   Wet weight = (weight of compacted specimen and mold – weight of the mold) x (13.33).
7. Remove the material from the mold and slice it vertically through the center.
8. Take a representative sample of the material, weighing at least 1 lbs (500 g), and weigh it immediately.
9. Dry the sample at 230 ° ± 9 °F (110 ° ± 5 °C) in the oven.
10. Thoroughly break up the remainder of the compacted material until it will pass a 3/4 in (19 mm) sieve.
11. Add this material to the original portion of the sample that passed the 3/4 in (19 mm) sieve and was not used before.
12. Add enough water to increase the moisture content of the sample by about 1 percent.
13. Repeat Procedures, steps 2 through 12 until there is either a decrease or no change in the wet weight/ft³ (m³) of the compacted material.

E. Calculations

1. Calculate the moisture content and the dry weight of the material as compacted for each trial, as follows:

$$M = \frac{A - B}{B} \times 100$$

and,

$$W = \frac{W_1}{M + 100} \times 100$$

where:

M = Percentage of moisture in the specimen
A = Weight of the wet material
B = Weight of the dry material
W = Dry weight, in lbs per ft³ (kg per m³), of compacted material
W1 = Wet weight, in lbs per ft³ (kg per m³), of compacted material

2. Plot the dry weights as ordinates and the corresponding moisture contents as abscissas.
3. Draw a smooth curve through the resulting points.
4. Read the results from the curve. The peak of the curve corresponds to the optimum moisture content and the theoretical maximum dry density.

F. Report

Report the optimum moisture content and the theoretical maximum dry density on Form 495.

DECEMBER, 2000 **GDT NO. 49 WORKSHEET**

PROJECT **COUNTY** **LAB NO.**

TOTAL WEIGHT OF SAMPLE = 10,000 grams

	A.	ACCUMULATED % RETAINED ON 3/4" (19.0 mm) SIEVE
	B.	ACCUMULATED % RETAINED ON 1/2" (12.5 mm) SIEVE
	C.	ACCUMULATED % RETAINED ON 3/8" (9.5 mm) SIEVE
	D.	ACCUMULATED % RETAINED ON NO. 4 (4.75 mm) SIEVE
	E.	ACCUMULATED % RETAINED ON NO. 10 (2.00 mm) SIEVE

	F.	INDIVIDUAL % RETAINED ON 1/2" (12.5 mm) SIEVE (B-A)
	G.	INDIVIDUAL % RETAINED ON 3/8" (9.5 mm) SIEVE (C-B)
	H.	INDIVIDUAL % RETAINED ON NO. 4 (4.75 mm) SIEVE (D-C)
	I.	INDIVIDUAL % RETAINED ON NO. 10 (2.00 mm) SIEVE (E-D)

	J.	TOTAL % RETAINED ON 1/2" (12.5 mm), 3/8" (9.5 mm), & NO. 4 (4.75 mm) SIEVES (D-A)
	K.	% - #10 (-2.00 mm) MATERIAL (100-E)

REDISTRIBUTION OF PLUS 3/4" (19.0 mm) MATERIAL ONTO 1/2" (12.5 mm), 3/8" (9.5 mm), AND NO. 4 (4.75 mm) SIEVES

	L.	-3/4" + 1/2" (-19.0 + 12.5 mm) MATERIAL = A (F/J x 100) + F x 10,000/100
	M.	-1/2" + 3/8" (-12.5 + 9.5 mm) MATERIAL = A (G/J x 100) + G x 10,000/100
	N.	-3/8" + No. 4 (-9.5 + 4.75 mm) MATERIAL = A x (H/J x 100) + H x 10,000/100
	O.	-NO. 4 + NO. 10 (-4.75 + 2.00 mm) MATERIAL = I x 10,000/100
	P.	-NO. 10 (-2.00 mm) MATERIAL = K x 10,000/100

Weigh up these amounts for a 10,000 gram sample

1/2" (12.5 mm) (L)	**3/8" (9.5 mm) (M)**	**#4 (4.75 mm) (N)**	**#10 (2.00 mm) (O)**	**- #10 (-2.00 mm) (P)**

CUMULATIVE WEIGHT

EXAMPLE

DECEMBER, 2000 **GDT NO. 49 WORKSHEET**

PROJECT **COUNTY** **LAB NO.**

TOTAL WEIGHT OF SAMPLE = 10,000 grams

14.0	A.	ACCUMULATED % RETAINED ON 3/4" (19 mm) SIEVE
25.0	B.	ACCUMULATED % RETAINED ON 1/2" (12.5 mm) SIEVE
32.0	C.	ACCUMULATED % RETAINED ON 3/8" (9.5 mm) SIEVE
48.0	D.	ACCUMULATED % RETAINED ON NO. 4 (4.75 mm) SIEVE
59.0	E.	ACCUMULATED % RETAINED ON NO. 10 (2.00 mm) SIEVE

11	F.	INDIVIDUAL % RETAINED ON 1/2" (12.5 mm) SIEVE (B-A)
7	G.	INDIVIDUAL % RETAINED ON 3/8" (9.5 mm) SIEVE (C-B)
16	H.	INDIVIDUAL % RETAINED ON NO. 4 (4.75 mm) SIEVE (D-C)
11	I.	INDIVIDUAL % RETAINED ON NO. 10 (2.00 mm) SIEVE (E-D)

34	J.	TOTAL % RETAINED ON 1/2" (12.5 mm), 3/8" (9.5 mm), & NO. 4 (4.75 mm) SIEVES (D-A)
41	K.	% - #10 (-2.00 mm) MATERIAL (100-E)

REDISTRIBUTION OF PLUS 3/4" (19 mm) MATERIAL ONTO 1/2" (12.5 mm), 3/8" (9.5 mm), AND NO. 4 (4.74 mm) SIEVES

1553	L.	-3/4" + 1/2" (-19 + 12.5 mm) MATERIAL = A (F/J x 100) + F x 10,000/100
988	M.	-1/2" + 3/8" (-12.5 mm + 9.5 mm) MATERIAL = A (G/J x 100) + G x 10,000/100
2259	N.	-3/8" + No. 4 (-9.5 mm + 4.75 mm) MATERIAL = A x (H/J x 100) + H x 10,000/100
1100	O.	-NO. 4 + NO. 10 (-4.75 mm + 2.00 mm) MATERIAL = I x 10,000/100
4100	P.	-NO. 10 (-2.00 mm) MATERIAL = K x 10,000/100

Weigh up these amounts for a 10,000 gram sample

1/2" (12.5	**3/8" (9.5**	**#4 (4.75 mm)**	**#10 (2.00**

mm) (L)	mm) (M)	(N)	mm)(O)	
1553	988	2259	1100	4100
	2541	**4800**	**5900**	**10000**

CUMULATIVE WEIGHT