GDT 4

A. Scope

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

Use this test method to quantitatively determine particle size in soils, soil aggregate, graded aggregate, and similar roadway materials.

B. Apparatus

The apparatus consists of the following:

1. Drying Device: Use any suitable device capable of drying the washed sample at temperatures not exceeding 140 °F (60 °C).
2. Drying Device: Use any suitable device capable of drying the washed sample at a controlled temperature of 230 ° ± 9 °F (110 ° ± 5 °C).
3. Scales: Use scales capable of weighing the total sample with an accuracy of 0.1 percent.
4. Balance: Use a balance capable of weighing 50-g samples with an accuracy of 0.1 g.
5. Sieves: Use sieves that conform to the "Standard Specifications for Sieves for Testing Purposes," AASHTO Designation: M 92 (WS-08).
6. Sieve Shaker: Use a Gilson shaker or other approved device to mechanically agitate the sieves to separate the coarse material into portions of specific sized particles (WS-09).
7. Large Pans: Use pans big enough to thoroughly mix the material passing the No. 10 (2.00 mm) sieve (WP-11) or other suitable device such as a large cloth.
8. Scoop: Use a suitable device for mixing and sampling the material passing the No. 10 (2.00 mm) sieve (WS-03).
9. Pulverizer: Use a mortar and rubber-covered pestle or a mechanical device with a power-driven, rubber-covered muller to break up lumps of soil without reducing the size of the individual grains. Ensure the rotating buckets (WD-4) have lids that close securely, two rubber-covered mullers (placed inside the buckets) and No. 10 (2.00 mm) sieves covering the openings in the sides to allow material finer than No. 10 (2.00 mm) to pass through.
10. Storage Cups: Use pint-sized (0.473 L) cups or other suitable containers identified numerically for storing a sample of the material (OC-14).
11. Plastic Bags: Use quart-sized (0.984 L), reusable plastic bags to thoroughly mix the material before taking the two 50-g samples (WB-01).
12. Spoon: Use a large spoon bent into an approximate "V" shape (WS-14).
13. Funnel: Use a funnel with at least a 3 in (75 mm) intake diameter and at least a 1/2 in outlet diameter to put soil into bottles without spilling.
14. Bottles: a or b
    a. Use 8 oz (237 ml), wide-mouth bottles, approximately 1.3 in (33 mm) inside mouth diameter, 5.35 in (136 mm) high, and 4 in (102 mm) from the bottom to the bottom of the neck. This bottle requires a siphoning wand that has a reach of 3.5 in (89 mm) from the top of the bottle with a clearance from the bottom of the wand to the bottom of the bottle of 1.625 in ± 1/16 in (41.3 mm ± 1.6 mm).The bottles must be clear and free from chips (WB-03).
    b. Use 8 oz (237 ml), wide-mouth bottles, approximately 1.2 in (30 mm)inside mouth diameter, 5.5 in (140 mm) high, and 4 in (102 mm) from the bottom to the bottom of the neck. This bottle requires a siphoning wand that has a reach of 3.7 in (94 mm) from the top of the bottle with a clearance from the bottom of the wand to bottom of the bottle 1.625 in ± 1/16 in (41.3 mm ± 1.6 mm). The bottles must be clear and free from chips (old WB-03).
15. Calgon Solution: Use a mixture of 5 gal (19 L) potable water, and 10 oz (285 g) of Calgon (WC-6).
16. Interval Timer: Use any suitable timer with an alarm (WC-3).
17. Evaporation Dishes: Use dishes to evaporate the water from the minus No. 10 (2.00 mm) sample (WD-3).
18. Water Changing Assembly: Use a reversible-fill siphon assembly for changing the water in the bottle. The device shall consist of 1/4 in (6 mm) copper or stainless steel tubing of such length that when placed into the bottle, the end

reaches 1.625 in ± 1/16 in (41.3 mm ± 1.6 mm) from bottom of the bottle. The water supply should have an aspirator for the fill/empty cycle.

19. Bottle Flushing Assembly: Use a 3/16 in (4 to 6 mm) copper tube bent into an ogee shape and preferably mounted stationary on a working platform at eye level. The outlet end of the tube should be pointed up, and the middle of the tube should be oriented such that an evaporating dish will fit under it.

    Optional: The copper or stainless steel tube may be hand-held provided all the material is washed into the dish and the dish does not overflow.
20. Bottle: Use a 5 gal (19 L) aspirator bottle (WB-11-1).
21. Glass Stir Rod: (WG-10).

C. Sample Size and Preparation

1. Weigh and record the total weight of the sample.
2. If you see that the sample has coarse material in it, grade the material using the sieves called for in the governing specification. Use AASHTO T-27 to grade the aggregates.
3. Pulverize and reduce to individual grains the portion passing the No. 10 (2.00 mm) sieve, or if aggregations are involved, the portion containing aggregations.
4. Redistribute any coarse material (plus No. 10 (2.00 mm)) remaining in the bucket after pulverizing.
5. Weigh the redistributed material with the appropriate part of the coarse portion of the sample.
6. Weigh and record the cumulative weights retained, beginning at the largest sieve, for the coarse portion (plus No. 10 (2.00 mm)) of the sample.
7. Dump the minus No. 10 (2.00 mm) material from the pulverizer into a large pan or onto a suitable cloth and mix it thoroughly.
8. Scoop a representative amount of the material and dump it into the storage cup.
9. Strike off the excess material so the soil is flush with the top of the cup.
10. Take density, volume change, and any other test samples from the pan of remaining material.

D. Procedures

Grading the Minus No. 10 Material.

Grade the minus No. 10 (2.00 mm) material by elutriation when the governing Standard Specifications call for GDT-4. The process is:

1. Dump the material from the cup into the plastic bag.
2. Close the end of the bag so that air is trapped inside.
3. Thoroughly mix the sample by holding the bag at both ends and vigorously shaking it back and forth in an elliptical motion.
4. After mixing, place the bag on its side.
5. Use the large “V” shaped spoon to carefully weigh out two 50 g samples of material.
6. Place one sample in an evaporating dish.
   a. Dry to a constant weight (generally overnight 20 hours ± 1/2 hour).
   b. Weigh the material. Use this value as the original dry weight to calculate the grading of the minus No. 10 (2.00 mm) material.
7. Use the funnel to place the second sample into a bottle with about 2 in (50 mm) of ammonia solution.
8. Bump the funnel a few times to ensure that the fines clinging to the surface fall into the bottle.
9. Vigorously stir the soil with a glass rod to reduce the cohesive forces of the clay.
10. Let the calgon solution and soil sit for at least 10 minutes.
11. Use the water changing assembly to add water to the bottle in a manner that will vigorously agitate the material. Add water to the height where the bottleneck begins.
12. Let the bottle stand undisturbed for 8 to 10 minutes.

13. Siphon off the fluid until it is about 3/4 in (18 mm) above the soil.
14. Refill the bottle to the neck with water, again to vigorously stir the material.
15. Repeat steps 11 through 14 until the fluid above the sample becomes clear enough after step 12 to read a watch on the opposite side of the bottle.
16. Siphon off the water and pour the soil and remaining water from the bottle into an evaporating dish.
17. Flush the inside of the bottle clean with two or three short spurts of water from the bottle flushing assembly into the evaporating dish. Be careful not to lose any portion of the sample.
18. Let the sample sit in the evaporating dish until the liquid clears.
19. Pour off the excess water without losing any of the sample.
20. Dry the material to constant weight at a temperature of 230 ° ± 9 °F (110 ° ± 5 °C).
21. Sift the dry material over the appropriate sieves.
22. Remove the top sieve and place it over an empty pan and continue to sift until finished.
23. Carefully weigh the material remaining on the sieve and pour the material from the pan onto the next sieve in the nest.
24. Continue this procedure until the material on each sieve and pan has been cumulatively weighed.

E. Calculations

1. Retained (percent) = 100 (B ÷ A)

   Passing (percent) = 100 (A - B) ÷ A

   Check: percent retained + percent passing = 100.0 percent

   Where:

   A = the total sample weight if the sieve is No. 10 (2.00 mm) or larger, or

   A = the weight of the 50.0 g sample after it was dried to a constant weight if the sieve is smaller than the No. 10 (2.00 mm)

   B = cumulative weight retained on the specific sieve

2. Adjust the gradation of the minus No. 10 (2.00 mm) portion to represent the total sample as follows:

   C = D x E ÷ 100 where:

   C = percent of the total sample smaller than the specific sieve

   D = percent passing the No. 10 (2.00 mm) sieve

   E = percent of the minus No. 10 (2.00 mm) portion that passed the specific sieve

3. Examples of Calculations:

Total Sample Weight = 28,650 g			
Gradation of Plus No. 10 (2.00 mm)			
Sieve	Accumulative Weight Retained	Percent of Total Sample	
		Retained	Passing
1-1/2 (37.5 mm)	0	0	100.0
3/4 (19.0 mm)	5,850	20.4	79.6
10 (2.0 mm)	17,450	60.9	39.1

Accumulative percent retained on and passing the 3/4 in (19.0 mm) sieve:

Retained on 3/4 in (19.0 mm) sieve = 100 (B ÷ A)

= 100 (5,850 ÷ 28,650) = 100 (0.204)

= 20.4 percent retained

Passing 3/4 in (19.0 mm) sieve = 100 (A - B) ÷ A

= 100 (28,650 – 5,850) ÷ 28,650

= 100 (0.796) = 79.6 percent passing

Check: percent retained + percent passing = 100.0 percent

20.4 percent + 79.6 percent = 100.0 percent

Gradation of Minus No. 10 (2.00 mm)				
Weight of 50 g sample after drying = 49.1 g				Adjusted for Total Sample Percent Passing
Sieve	Accumulative Weight Retained	Retained	Passing	
40 (425 µm)	19.5	39.7	60.3	23.6
60 (250 µm)	27.1	55.2	44.8	17.5
200 (75 µm)	40.0	81.5	18.5	7.2
Total	44.1	89.8		
Clay (effluent) =			10.2	4.0

Retained on No. 60 (250 µm) = 100 (B ÷ A)

= 100 (27.1 ÷ 49.1)

= 100 (0.552)

= 55.2 percent retained

Passing No. 60 (250 µm) = 100 (A - B) ÷ A

= 100 (49.1 - 27.1) ÷ 49.1

= 100 (22.0) ÷ 49.1 = 44.8 percent passing

Minus No. 60 (250 µm) in total sample = (D x E) ÷ 100

= (39.1 x 44.8) ÷ 100

= 1751.68 ÷ 100

= 17.5 percent

Clay is the material washed from the 50 g sample; therefore, it is not in the washed sample.

Clay (percent) in minus No. 10 (2.00 mm)

= 100 (A - B) ÷ A

= 100 (49.1 - 44.1) ÷ 49.1 = 100 (0.102)

= 10.2 percent

Clay (percent) in total sample = (D x E) ÷ 100

= (39.1 x 10.2) ÷ 100

= 3.988 or 4.0 percent

F. Report

1. Report the percent that passes the appropriate sieves to the nearest 0.1 percent on the form appropriate for the material and Specification involved, as follows:

   a. Use Form 408 for subgrade, embankment, and backfill.
   b. Use Form 495 for soil cement base and sand clay base.
2. Send the completed original form to the Office of Materials and Research in Forest Park.
3. Send copies of the form to the Branch Lab and the Area Engineer.
4. Notify the department head of any material that fails.