GDT 4

A. Scope

For a complete list of GDTs, refer to the STI (Sampling, Testing and Inspection) section of "The Source", which is the Georgia Department of Transportation's online reference for contractors.

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. Oven: A thermostatically controlled drying oven capable of maintaining temperatures of 230 ± 9 °F (110 ± 5 °C) for drying the sieve analysis samples.
2. Balance: The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirement of AASHTO M 231.
3. Sieves: A series of sieves consisting of the #40, #60 and #200, constructed with a square mesh woven cloth, conforming to the requirements of ASTM E11.
4. Mechanical Sieve Shaker—A mechanical sieving device, if used, shall create motion of the sieves to cause the particles to bounce, tumble, or otherwise turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion for adequacy of sieving described in Section D, Step No. 23, is met in a reasonable time period.
5. Large Pan: Suitable large pan made of material resistance to corrosion and subject to change in mass or disintegration from repeated use or other suitable device such as a large cloth.
6. Scoop: Suitable device for mixing and sampling the material.
7. Sample Splitter—A suitable riffle sampler or sample splitter for proportional splitting of the sample and capable of obtaining representative portions of the sample without appreciable loss of fines. The width of the container used to feed the riffle sample splitter should be equal to the total combined width of the riffle chutes. Proportional splitting of the sample on a canvas cloth is also permitted.

   Note—The procedure for proportional splitting is described in R 76.
8. Storage Cups: Use pint-sized (0.473 L) cups or other suitable containers identified numerically for storing a sample of the material.
9. 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.
10. 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.
    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.
11. Sodium Hexametaphosphate Solution: Use a mixture of 5 gal (19 L) potable water, and 10 oz (285 g) of Sodium Hexametaphosphate.
12. Timing Device: A watch or clock readable to the nearest second.
13. Evaporation Dishes: Use dishes to evaporate the water from the minus No. 10 (2.00 mm) sample.
14. 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.

15. 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.
16. Bottle: Use a 5 gal (19 L) aspirator bottle.
17. Stirring Device: Any nonporous device suitable for stirring the sample mixture without loss of material.

C. Sample Size and Preparation

1. Prepare the sample received from the field in accordance with AASHTO R 58, Standard Practice for Dry Preparation of Disturbed Soil and Soil-Aggregate Samples for Test.
2. Separate the materials retained on the No. 10 (2.00 mm) sieve into a series of sizes 3 in., 2 in., 1 in., 3/8in., and the No. 4 (75, 50, 25, 9.5 and 4.75-mm) sieves and using other sieves as may be needed depending on the sample or on the specification for the material being testing.
3. Weigh and record the cumulative weights retained, for the coarse (plus No. 10) materials, in accordance with AASHTO T-27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregate.
4. Transfer the portion of material passing the No. 10 (2.00 mm) sieve, obtained from the portion of the sample selected for particle analysis in step No. 1, into a large pan or onto a suitable cloth and mix it thoroughly.
5. Using a sampler, or by splitting or quartering, obtain representative portions, from the thoroughly mixed materials prepared in step No. 4, having the following masses: (1) for GDT 6 – volume change of soils, 1000 +/- 1g; (2) for GDT 7 – maximum dry density and optimum moisture, 3000g; and (3) for grading the minus No. 10 (2.00 mm) material by elutriation, a pint-sized storage cup.

D. Procedures

Grading the Minus No. 10 (2.00 mm) Material by elutriation.

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

1. Using a sampler, or by splitting or quartering, obtain two 50g samples from the material in the pint-sized storage cup.
2. Place one sample in an evaporating dish.
3. Dry the sample to a constant mass at a temperature of 230 ± 9 °F (110 ± 5 °C).
4. Weigh the sample and determine its mass to the nearest 0.1g. Record this mass as Sample No. 1. Use this value as the original dry weight to calculate the grading of the minus No. 10 (2.00 mm) material.
5. Fill a test bottle to approximately 2 in. (50mm) of sodium hexametaphosphate solution.
6. Use the funnel to place the second sample into the test bottle containing hexametaphosphate solution.
7. Bump the funnel a few times to ensure that the fines clinging to the surface fall into the test bottle.
8. Vigorously stir the soil with a suitable nonporous stirring device(e.g.) to reduce the cohesive forces of the clay.
9. Allow the test bottle, containing sodium hexametaphosphate solution and soil, to stand for a minimum of 10 minutes.
10. Using the water change assembly, add water to the test bottle in a manner that will vigorously agitate the material. Continue to add water, using the agitating action, until the test bottle is filled to the height where the bottleneck begins.
11. Allow the test bottle, water, and sample to stand undisturbed for 8 to 10 minutes.
12. Using the water change assembly, siphon off the fluid level to about 3/4 in. (18 mm) above the soil.
13. Using the water change assembly, refill the test bottle in a manner that will vigorously agitate the material. Continue to add water, using the agitating action, until the test bottle is filled to the height where the bottleneck begins.
14. Allow the test bottle, water, and sample to stand undisturbed for 8 to 10 minutes.
15. Repeat steps No. 10 through No. 14 until the fluid above the sample becomes clear enough, after step No. 14, to read a watch on the opposite side of the test bottle.

16. Using the water change assembly, siphon off the water and transfer the soil and remaining water from the test bottle into an evaporating dish.
17. Flush the inside of the test 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. Allow the sample to stand in the evaporating dish until the liquid clears.
19. Decant excess water with care not to lose any of the fine material.
20. Dry the material to constant mass at a temperature of 230 ± 9°F (110 ± 5°C).
21. Weigh the sample and determine its mass to the nearest 0.1g. Record this mass as Sample No. 2.
22. Sieve the dry sample over a nest of sieves, the No. 40, No. 60, and No. 200, arranged in order of decreasing size from top to bottom.
23. Continue sieving for a sufficient period and in such manner that, after completion, not more than 0.5 percent by mass of the sample No. 2, as determined in step No. 21, passes any sieve during 1 min of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute, turn the sieve about one sixth of a revolution at intervals of about 25 strokes.
24. Determine the mass of each size increment to the nearest 0.1g.
25. The total mass of the material after sieving shouldn't differ by more than 0.3 percent of the total original dry mass of the sample placed on the sieves, sample No. 2. If the two amounts differ by more than 0.3 percent, based on the total original dry sample mass, the results should not be used for acceptance purposes.
26. Calculate percentages passing, total percentages retained, and clay percentage to the nearest 0.1 percent on the basis of the total mass of Sample No. 1, determined in step No. 4. These test results shall be used to classify soils, as established in GDOT Standard Specifications, Section 810-Materials, Table 1.
27. When required, compute the sieve analysis and clay percentage, of materials passing the No. 10 (2.00 mm) sieve, to represent the total sample as determined in Section E., Step No. 2 and Step No. 4.

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 (Sample No. 1) 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

4. 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 passing each sieve to the nearest 0.1 percent.
2. Report the percent clay to the nearest 0.1 percent.