

GTM-20

**TEST METHOD FOR THE GRAIN-SIZE
ANALYSIS OF GRANULAR SOIL MATERIALS**



GEOTECHNICAL TEST METHOD

GTM-20

Revision #6

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**Department of
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3. EQUIPMENT

The following equipment is required for this test:

Platform Scale

- With a capacity of at least 36 lbs. (16 kg). The scale shall be accurate, and be readable to 0.01 lb (5 g).

Balance

- Triple beam or other with a capacity of at least 5½ lbs. (2500 g). It shall be accurate, and be readable to 0.1 g.

Sieves

- A series of sieves which conform to the requirements of AASHTO M-92-91, page 87 - Table No. 1 (excluding Column 7). See Appendix B.

Containers

- Metal pans of sufficient size to contain at least 1.1 lb. (500 g) of material for moisture content determination.

Large Pans

- Metal pans of sufficient dimension to contain the total sample for mixing and conditioning.

Drying Apparatus

- An infrared dryer, oven, hot plate or stove capable of drying samples without causing alteration of the material's particle size or shape, and without causing the loss of material. Ovens must have a temperature control and be capable of maintaining a temperature of $230^{\circ} \pm 9^{\circ} \text{ F}$ ($110^{\circ} \pm 5^{\circ} \text{ C}$). If a stove or hot plate is used, a bed of sand is required between the sample containers and heat source.

Miscellaneous

- A flat bottom scoop, a wood mallet, an assortment of brushes, a large weighing pan for the platform scale and leveling boards for the platform scale and balance.

5. TEST PROCEDURE

During the entire test, care should be exercised to prevent the loss of sample material. This entails proper labeling and organization of the samples as well as careful transference of material during the test. When the procedure requires several separations (or sievings), be sure to keep each of the sieved portions together for further tests and weighings. Only after all of the tests, checks, and balances have been successfully completed, may any portion of the sample be discarded.

When testing small samples, perform all weighings using the balance rather than the platform scale, as prescribed in the procedure. Record the values to the nearest 0.1 g. Form SM 15b uses US Customary Units (lbs.) for recording the larger weights (weight Plus $\frac{1}{4}$ in. (6.3 mm) material, etc.) and International System of Units (g) for recording the smaller weights (moisture content, weight Minus $\frac{1}{4}$ in. (6.3 mm) material, etc.).

5.1 Initial Separation of the Plus and Minus $\frac{1}{4}$ in. (6.3 mm) Particles.

Screen the moist or dry sample on a $\frac{1}{4}$ in. (6.3 mm) sieve in order to divide it into plus $\frac{1}{4}$ in. (6.3 mm) and minus $\frac{1}{4}$ in. (6.3 mm) portions. If an excessive amount of silt or clay adheres to the plus $\frac{1}{4}$ in. (6.3 mm) material, it should be screened again after additional drying. If the sample does not have any plus $\frac{1}{4}$ in. (6.3 mm) particles, proceed in accordance with Section 5.4.

Note 1. During this initial sieving, care should be exercised to prevent "overloading" the $\frac{1}{4}$ in. (6.3 mm) sieve. This condition exists when an excessive amount of soil is placed on the sieve, leaving an insufficient amount of sieve openings for the material to pass through. To avoid "overloading", the sample must be divided into smaller portions and sieved separately.

Note 2. In some soils a significant amount of the particles will adhere together and form silt and/or clay balls, which may be mistaken for plus $\frac{1}{4}$ in. (6.3 mm) particles. Care must be taken to insure that such balls pass through the $\frac{1}{4}$ in. (6.3 mm) screen. It may be necessary to run a wood mallet over the material on the screen for this purpose, but be careful not to pulverize the actual particles or damage the sieve.

5.2 Weigh the Plus $\frac{1}{4}$ in. (6.3 mm) Portion of the Sample.

Once the plus $\frac{1}{4}$ in. (6.3 mm) portion has fully dried (to the point where there is no visible sign of moisture), weigh the sample to the nearest 0.01 lb. and record this value on Line A of the data sheet.

Note 1. Prior to weighing the plus $\frac{1}{4}$ in. (6.3 mm) portion, check for particles larger than 4 in. (100 mm). Remove such material and weigh it to the nearest 0.01 lb. and make a note of it on the data sheet. These particles should not be included in the test.

5.3 Sieve the Plus $\frac{1}{4}$ in. (6.3 mm) Material.

The series of sieves used shall comply with the particle size requirements of the material being tested or as requested by the Engineer or Laboratory Supervisor. The sieves shall be arranged

Note 3. If an oven is used, the sample should be maintained at a temperature of $230 \pm 9^\circ \text{F}$ ($110 \pm 5^\circ \text{C}$) for a minimum of 12 hours or until it maintains a constant weight.

Note 4. When a sample contains less than 1 lb. (500 g) of minus $\frac{1}{4}$ in. (6.3 mm) particles, moisture content and gradations (Sections 5.5, 5.6 & 5.7) may be performed on the smaller amount only if the sample is considered to be representative by the requestor.

5.6 Wash the Minus $\frac{1}{4}$ in. (6.3 mm) Sample.

Obtain a 300 ± 5 g portion of the moisture content sample (from Section 5.5) and record this weight to the nearest 0.1 g on Line N of the data sheet. Wash this sample on a No. 200 (0.075 mm) sieve to remove all fines from the sample. It is suggested to wash the sieve sample over a white basin to make it easier to see when the wash water is clean. After the sample is thoroughly washed, carefully transfer the sample from the sieve to a container for drying. Dry the sample in accordance with the provisions of Section 5.5. Weigh the dried sample to the nearest 0.1 g and record this value on Line O of the data sheet.

Note 1. Examine the No. 200 (0.075 mm) sieve prior to each washing to determine its condition. Replace the sieve if any holes or cracks are noticed in the solder or mesh, or if the sieve's mesh is stretched excessively. A new No. 200 (0.075 mm) sieve must be washed with soap and water prior to initial use.

Note 2. Place sample directly on wash sieve and, while sample is under stream of water, agitate back and forth using motion similar to hand sieving dry material.

Note 3. The No. 200 (0.075 mm) sieves are delicate. Fingertips may be used to agitate the sample to breakdown soil aggregations during washing, but do not apply pressure to the mesh itself.

Note 4. Do not allow water to overflow or splash out of the sieve. This may cause a loss of material and lead to inaccurate results. Tapping the side of the sieve will help break the surface tension as well as eliminate clogging.

5.7 Sieve the Minus $\frac{1}{4}$ in. (6.3 mm) Sample.

Sieve the dry washed sample remaining from Section 5.6. The series of sieves used shall comply with the particle size requirements of the material being tested or as requested by the Engineer or Laboratory Supervisor. The sieves shall be arranged such that the largest mesh sieve is on top, with the mesh sizes progressively decreasing. The last sieve should be the No. 200 (0.075 mm) followed by a "pan". Weigh the material retained on each sieve and the "pan", and record the weights to the nearest 0.1 g in Column 5 of the data sheet. Sum the values in Column 5 and record this value at the bottom of that Column.

6. COMPUTATIONS

6.1 Rounding Numbers.

For all computed results, round the values in the following manner: Compute the values to one place beyond the required significant figures. If the extended value is less than 5, leave the last required digit unaltered. If it is greater than 5, round the last required digit up one unit. If the extended value equals 5, round the last required digit to the nearest even number.

6.2 Correct the Weight of Minus ¼ in. (6.3 mm) Material for Moisture Content.

6.2.1 Determine the moisture content.

Compute the weight of water by subtracting Line I from Line H and record this value on Line K. Compute the weight of dry material by subtracting Line J from Line I and record this value on Line L. Compute moisture content by dividing weight of water (Line K) by the weight of the dry material (Line L) and multiply this value by 100 and record to the nearest 0.1% on Line M.

$$\% \text{ Moisture Content, } M = \frac{H - I}{I - J} \times 100$$

6.2.2 Compute the dry weight of the minus ¼ in. (6.3 mm) material.

Divide the total weight of minus ¼ in. (6.3 mm) material (Line D) by the quantity 1 plus the moisture content (Line M) divided by 100 and record this value on Line E.

$$\text{Weight of dry minus } 1/4 \text{ in (6.3 mm), } E = D \div (1 + (M \div 100))$$

6.3 Compute the Total Dry Weight of the Sample.

Compute the total dry weight by adding the dry weight of the plus ¼ in. (6.3 mm) material (Line C) to the dry weight of the minus ¼ in. (6.3 mm) material (Line E) and record this value on Line F.

$$\text{Total Dry Weight, } F = C + E$$

6.4 Compute the Particle Size Distribution of Plus ¼ in. (6.3 mm) Material.

6.4.1 Compute the percent retained.

Divide the weight retained on each sieve (in Column 1) by the total dry weight of the sample (Line F). Multiply each value by 100 and record the results to the nearest 0.1% in Column 2 opposite the respective sieve. Sum the values in Column 2 and record this value at the bottom of Column 2.

7. CHECKS AND BALANCES

7.1 Check the Computed Percent Retained.

- 7.1.1 For the plus ¼ in. (6.3 mm) material.

The total weight retained (Total of Column 1) divided by the total dry weight of the sample (Line F) and multiplied by 100, should be no more than $\pm 0.2\%$ from the sum of the percents retained (Total of Column 2).

$$\Sigma \text{ of Column 2} = \frac{\Sigma \text{ of Column 1}}{\text{Line F}} \times 100 + _ 0.2\%$$

- 7.1.2 For the minus ¼ in. (6.3 mm) material.

The total weight retained (Total of Column 5) minus the "Pan" material, divided by the weight of dry minus ¼ in. (6.3 mm) material before wash (Line N) and multiplied by 100, should be no more than $\pm 0.2\%$ from the sum of the percents retained (Total of Column 6).

$$\Sigma \text{ of Column 6} = \frac{(\Sigma \text{ of Column 5} - \text{Pan})}{\text{Line N}} \times 100 + _ 0.2\%$$

7.2 Check the Computed Percent Passing.

- 7.2.1 For the plus ¼ in. (6.3 mm) material.

The sum of the percent retained (Total of Column 2) plus the percent of total sample passing the ¼ in. (6.3 mm) sieve (last value of Column 3) must equal 100%.

$$\Sigma \text{ of Column 2} + \text{last value of Column 3} = 100\%$$

- 7.2.2 For the minus ¼ in. (6.3 mm) material.

The sum of the percent retained (Total of Column 6) plus the percent passing the No. 200 (0.075 mm) sieve, based on minus ¼ in. (6.3 mm), (last value of Column 7), must equal 100%.

$$\Sigma \text{ of Column 6} + \text{last value of Column 7} = 100\%$$

APPENDIX A - Sieve Analysis Data

GEOTECHNICAL ENGINEERING BUREAU SIEVE ANALYSIS DATA									
Project		Contract No.		<div style="border: 1px solid black; padding: 10px; min-height: 100px;">PROJECT STAMP</div>					
PIN		County							
Region		Material Source							
Location		Offset							
Item No.		Depth							
Sample No.									

LINE			SAMPLE WEIGHTS (lbs.)		LINE			MOISTURE CONTENT (Grains)	
A			Wt. of Dry Plus 6.3 mm After Separation	lbs	G			Container Number	
B			Wt. of "Pan" Material from Plus 6.3 mm	lbs	H			Wt. of Sample & Container Before Drying	g
C			Wt. of Dry Plus 6.3 mm Material (A + B)	lbs	I			Wt. of Sample & Container After Drying	g
D			Wt. of Moist Minus 6.3 mm Material	lbs	J			Wt. of Container	g
E			Wt. of Dry Minus 6.3 mm (D + 1 * (MC * 100))	lbs	K			Wt. of Water (H - I)	g
F			Wt. of Total Dry Sample (C + E)	lbs	L			Wt. of Dry Sample (I - J)	g
					M			Moisture Content (K / L) * 100%	

SIEVE		1	2	3	4	SPECIFICATION REQUIREMENT
mm	in.	WEIGHT RETAINED (lbs)	% RETAINED	% OF TOTAL SAMPLE PASSING	WHOLE NO. % PASSING	
100	4					
75	3					
50	2					
37.5	1 1/2					
25.0	1					
19.0	3/4					
12.5	1/2					
9.5	3/8					
6.3	1/4					
TOTAL						

N. Wt. of Dry Minus 6.3 mm Before Wash (gms)		_____ g	P. Plasticity Indicator 0.075 mm / 0.425 mm = _____
O. Wt. of Dry Minus 6.3 mm After Wash (gms)		_____ g	

SIEVE DESIGNATION		5	6	7	8	9	SPECIFICATION REQUIREMENT
mm	No.	WEIGHT RETAINED (gms)	% RETAINED	% PASSING BASED ON MINUS 6.3 mm	% OF TOTAL SAMPLE PASSING	WHOLE NO. % PASSING	
4.75	4						
2.00	10						
0.850	20						
0.425	40						
0.250	60						
0.150	100						
0.075	200						
PAN							
TOTAL							

REMARKS

TESTED BY: _____	DATE: _____	CHECKED BY: _____	DATE: _____
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