TEST METHOD FOR THE ANALYSIS OF TOPSOIL

GEOTECHNICAL TEST METHOD
GTM-25

OCTOBER 2018
# TABLE OF CONTENTS

1. SCOPE ........................................................................................................................................3
2. REFERENCED DOCUMENTS ......................................................................................................3
3. SUMMARY OF TEST METHOD ..................................................................................................3
4. APPARATUS ................................................................................................................................4
5. PROCEDURE ..............................................................................................................................5
6. CALCULATIONS .........................................................................................................................9
   6.1 Rounding Numbers .............................................................................................................9
   6.2 Moisture Content and Weight of Total Dry Inorganic Sample ........................................9
   6.3 Particle Size Distribution of Plus #10 Material ...............................................................10
   6.4 Particle Size Distribution of Minus 1/4" Material .........................................................11
   6.5 Particle Size Distribution of Minus #40 Material ............................................................11
7. CHECKS AND BALANCES ......................................................................................................13
   7.1 Check the Computed Percent Retained ...........................................................................13
   7.2 Check the Computed Percent Passing .............................................................................13
8. REPORT ......................................................................................................................................14

APPENDIX ......................................................................................................................................15

Appendix A: Topsoil Analysis Form .............................................................................................A-1
1. SCOPE

This method describes the determination of organic content, pH, and particle size distribution for the mineral portion of topsoil items stipulated in the Department Specifications. Particle Size is determined by a combination of mechanical separation and light scattering. The method covers materials with particle sizes smaller than 4 in. (100 mm).

2. REFERENCED DOCUMENTS

NYSDOT Standard Specifications
NYSDOT GCP-21 – Procedure for the Control and Quality Assurance of Topsoil
AASHTO T 88 – Particle Size Analysis of Soils
AASHTO T 267 – Determination of Organic Content in Soils by Loss on Ignition
AASHTO T 311 – Grain-Size Analysis of Granular Materials
AASHTO M 231 – Weighing Devices Used in the Testing of Materials
AASHTO T 265 – Laboratory Determination of Moisture Content of Soils
AASHTO T 289 – Determining pH of Soil for Use in Corrosion Testing
ASTM E11 – Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM D4972 – Standard Test Methods for pH of Soils
ISO 13320 – Particle Size Analysis – Laser Diffraction Methods

3. SUMMARY OF TEST METHOD

A sample obtained per GCP-21 is separated on the #10 sieve (2.00 mm). Any identifiable organic material is removed from the retained portion which is then weighed and separated through a series of sieves with progressively smaller openings. Samples are then taken from the portion passing the #10 sieve for determination of moisture content and pH. The dry moisture content sample is then processed per AASHTO T 267. After ignition, the remaining sample is separated on the #40 (0.420 mm) sieve. A portion of the sample passing the #40 is then passed thru the Particle Size Analyzer for determination of particle sizes smaller than the #40 sieve.
4. APPARATUS

Balance - The balance shall have sufficient capacity and conform to M 231, Class G 1.

Crucibles or Evaporating Dishes - High silica, alundum, porcelain, or nickel crucibles of 30- to 50-mL capacity or Coors porcelain evaporating dishes, approximately 100-mm top diameter.

Desiccator - A desiccator of sufficient size containing an effective desiccant.

Liquid or Gaseous Sample Handling System – To transport the dispersed test specimen across the light beam.

Mechanical Sieve Shaker - A mechanical sieve shaker, if used, shall impact a vertical or lateral and vertical motion to the sieve, causing the particles thereon to bounce and turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion for adequacy of sieving is met in a reasonable time-period.

Miscellaneous - Spoons, spatulas, brushes, and containers (noncorroding and not subject to weight change).

Muffle Furnace - The furnace shall be capable of maintaining a continuous temperature of 455 ± 10°C (833 ± 18°F) and have a combustion chamber capable of accommodating the designated container and sample.

Oven - Drying oven capable of maintaining temperatures of 110 ± 5°C (230 ± 9°F).

Particle Size Analyzer (PSA) – Based on Fraunhofer diffraction or Mie scattering, or a combination of both models. Care must be taken to ensure that the analyzer system is optimum for the size range being tested.

pH Meter – Potentiometer equipped with an electrode system with a readability to the nearest 0.1 pH unit and an accuracy of ±0.1 pH unit or better. A silver/silver chloride electrode system or similar is also acceptable. A Thermometric device readable to 0.5°C and accurate to ±0.5°C is required if pH meter does not automatically compensate for temperature.

Pulverizing Apparatus - A mortar and rubber-covered pestle or a mechanical device consisting of a power-driven, rubber-covered muller suitable for breaking up the aggregations of soil particles without reducing the size of the individual grains.

Sieves - A series of sieves which conform to the requirements of ASTM E11
5. Procedure

**Note 1** – Fields and calculations within this test method reference data sheet SM 16 (9/18); contained in Appendix A, if a different data sheet is utilized references may not apply

**Note 2** – Alternate sieve sizes may be used for separation depending on equipment capabilities or ease of operation. When alternate sieve sizes are used, a new Data Sheet must be developed for the alternate sieve size utilized.

5.1. Air dry the entire sample until it is in a friable state.

5.2. Screen the sample on a #10 sieve to divide it into plus #10 and minus #10 portions. If an excessive amount of silt or clay adheres to the plus #10 material, it should be screened again after additional drying.

5.3. Remove and discard any organic material retained on the #10 sieve.

5.4. Dry the plus #10 portion until it is saturated surface dry (to the point where there is no visible sign of moisture), weigh the sample to the nearest 0.1 g and record this value on line A.

5.5. Sieve the material retained on the #10 sieve during initial separation. The series of sieves used shall, at a minimum, comply with the particle size requirements of the material being tested. The sieves shall be arranged such that the largest opening sieve is on top, with the sizes progressively decreasing. The last sieve shall be the #10, followed by a “pan.”

**Note 3** - If the sieving is performed using a mechanical shaker, the sieves shall be shaken no less than 3 min and no more than 5 min. If performed manually, the sieve shall be shaken no less than 5 min. Very often particles will get stuck in the openings of a sieve. Such material shall be removed from the openings and weighed as being retained on that sieve. Do not force particles through the sieves.

5.6. Weigh the material retained on each sieve to the nearest 0.1 g and record these (column 1). During the sieving process, some additional material will pass through the #10 sieve into the “pan.” Weigh this “pan” material to the nearest 0.1 g (line B).

5.7. Incorporate the “pan” material into the minus #10 material obtained in Section 5.2.

5.8. Thoroughly mix the minus #10 portion of the sample, weigh to the nearest 0.1 g (line D).
5.9. Immediately obtain a minimum of 100 g of minus #10 material and place it into a container of predetermined weight for a moisture content determination. The weight of container and the weight of the soil and container should be recorded, to the nearest 0.1 g (line H and F). Retain the remaining sample for use in pH determination.

5.10. Dry the sample overnight (15 h minimum) at a temperature of 110 ± 5°C or until a constant mass (mass loss of the sample after 1 h of additional drying is less than 0.1 percent), Allow the sample to cool. Weigh dry sample and container to the nearest 0.1 g (line G).

**Note 4** – If a hotplate or stove is used, place the container holding the sample on a pan containing a thin layer of sand to prevent spattering and/or fracturing of the soil particles during the drying process. Sample shall be dried until the mass loss of the sample after 1 hour of additional drying is less than 0.1 percent (constant mass).

5.11. Obtain 10 to 40 g of the dry moisture content sample (from Section 5.10), place into tared crucibles or porcelain evaporating dish (line P), and determine the mass to the nearest 0.01 g (line N).

**Note 5** – Aggregations of soil particles should be broken up in a pulverizing apparatus in such a way as to avoid reducing the natural size of individual particles.

**Note 6** – Sample masses should be of sufficient amount to fill the crucible to at least three-quarter depth. A cover may initially be required over the crucible during the initial phase of ignition to decrease the possibility of sample loss.

5.12. Place the crucible or dish containing the sample for ignition into the muffle furnace for 6 hours at a temperature of 455 ± 10°C. Remove the ignited sample from the furnace, place into the desiccator, and allow to cool.

5.13. Remove the cooled sample from the desiccator and determine the mass to the nearest 0.01 g (line O).

5.14. Sieve the ignited sample through the #40 sieve. The series of sieves used shall, at a minimum, comply with the particle size requirements of the material being tested. The sieves shall be arranged such that the largest opening sieve is on top, with the sizes progressively decreasing. The last sieve shall be the #40, followed by a "pan". Weigh the material retained on each sieve, and in the pan, to the nearest 0.1 g and record these values (column 5).

**Note 7** – An alternate to the #40 sieve may be used based on the capability of the Particle Size Analyzer.
Note 8 – If no Particle Size Analyzer is available additional sample should be processed per section 5.12. Sufficient sample should be ignited as to provide inorganic material to proceed following AASHTO T 88. An alternate data sheet is required.

5.15. Initialize the Particle Size Analyzer (PSA) and perform a Background measurement per manufactures instruction.

Note 9 – Inorganic particles typically found in topsoil provided to NYSDOT have an Index of Refraction of 1.55.

5.16. Place a representative sample of the minus #40 material into the PSA. Refer to the instrument manufacture’s recommendations to optimize sample size and light scattering conditions. Required sample size depends on median particle size and density.

Note 10 – For typical NYS topsoil samples an obscuration level of 10-15% is recommended.

5.17. Select the appropriate test parameters and method of dispersant for the sample. Sample should be run until the D50 particle size is stable over 3 measurements taken at 1 minute intervals. D50 is the median particle size.

Note 11 – Sample is considered stable when the D50 Residual Standard Deviation (RSD) is less than 1.0% when D50 is larger than 0.02mm or D50 RSD is less than 2.0% when D50 is smaller than 0.02mm.

5.18. Drain and rinse the system as necessary to obtain background values as specified by manufacturer.

5.19. Repeat Section 5.16 using the parameters set in Section 5.17 until the RSD of the three stable measurements of any two repeat samples is less than 1.5%. These six measurements will be averaged and the relevant percent passing’s reported (column 10).

5.20. For determination of pH: From the sample retained in 5.9 place a mass of 30.0 ± 0.1 g of soil into a mixing container and add 30.0 ± 0.1 g of distilled water. Stir to obtain a soil slurry.

Note 12 – This sample may also be tested for Electrical Conductivity (EC) to be used in determining Total Dissolved Solids (TDS). To test for EC, substitute the standardized EC meter for the pH meter in section 5.23.
5.21. Let slurry stand for a minimum of 1 hour, mixing every 10-15 minutes.

5.22. Following the manufacturer’s instructions, standardize the pH meter using buffer solutions. Select buffer solutions that will bracket the expected pH value of the soil.

5.23. Fully submerge the pH electrode into the aqueous part of the slurry. Do Not push the electrode into the soil.

5.24. When stabilized, record the pH value to the nearest tenth.
6. CALCULATIONS

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 figure. 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. Calculate the Moisture Content & Weight of Total Dry Inorganic Sample

6.2.1. Determine the weight of Dry material greater than #10. Record on Line C.

\[ \text{Wt. of dry Plus #10 Material, Line C = Line A - Line B} \]

6.2.2. Determine the moisture content.

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

\[ \text{Moisture Content, } K = \frac{F - G}{G - H} \times 100 = \frac{I}{J} \times 100 \]

6.2.3. Compute the dry weight of the minus #10 material.

Divide the total weight of moist-minus #10 material (Line D) by the quantity 1.0 plus the moisture content (Line K) divided by 100 and record this value on Line L.

\[ \text{Weight of dry minus #10, } L = \frac{D}{(1 + \frac{K}{100})} \]
6.2.4. Compute the Organic Content of the Sample.

Compute the weight of organic by subtracting Line O from Line N and record this value on Line Q. Compute the weight of inorganic material by subtracting Line P from Line O and record this value on Line R. Compute the organic content by dividing the weight of organic (Line Q) by the weight of the inorganic material (Line R) and multiply this value by 100 and record to the nearest 0.1% on Line S.

\[
\text{Organic Content, } S = \frac{N - O}{O - P} \times 100 = \frac{O}{R} \times 100
\]

6.2.5. Compute the weight of dry inorganic minus #10 material.

Divide the weight of dry minus #10 material (Line L) by the quantity 1.0 plus the organic content (Line S) divided by 100 and record this value on Line T.

\[
\text{Weight of dry inorganic minus #10, } T = \frac{L}{(1 + (S/100))}
\]

Compute the total dry inorganic weight by adding the dry weight of the plus #10 material (Line C) to weight of dry inorganic minus #10 material (Line T) and record this value on Line U.

\[
\text{Total Dry Inorganic Weight, } U = C + T
\]

6.3. Compute the Particle Size Distribution of Plus #10 Material

6.3.1. Compute the percent retained.

Divide the weight retained on each sieve (in Column 1) by the total dry weight of the sample (Line U). 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 the column.
6.3.2. Compute the percent of total sample passing.

The smallest sieve size in which all of the sample passes will have 100% total sample passing. For the rest of the sieve sizes, compute the percent total sample passing by subtracting the percent retained (in Column 2) from the percent of total sample passing computed for the previous sieve size. This makes it necessary to work from the top down. Record each of the values computed to the nearest 0.1% in Column 3 of the data sheet.

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

6.4.1. Compute the percent retained.

Divide the weight retained on each sieve (in Column 5) by the weight of the sample after ignition (Line R). Multiply each value by 100 and record the results to the nearest 0.1% in Column 6. Sum the values in Column 6 and record this value at the bottom of the Column.

6.4.2. Compute the percent passing based on minus #10 material.

Subtract the percent retained on the largest sieve used on the minus #10 material from 100% to determine the percent passing for that sieve. For the rest of the sieves, compute the percent sample passing by subtracting the percent retained from the percent sample passing computed for the previous sieve size. Record these values to the nearest 0.1% in Column 7.

6.4.3. Compute the percent passing based on total weight.

Multiply the percent’s passing, (Column 7), by the percent of the total sample passing the #10 sieve (last value in Column 3), for each sieve size. Divide each value by 100 to get the percent and record to the nearest 0.1% in Column 8.

6.5. **Particle Size Distribution of Minus #40 Material**

6.5.1. Compute the percent passing based on minus #10 material.

Multiply the percent’s passing given by the PSA, (Column 10), by the percent of the total sample passing the #40 sieve (last value in Column 7), for each sieve size. Divide each value by 100 to get the percent and record to the nearest 0.1% in Column 11.
6.5.2. Compute the percent passing based on total weight.

Multiply the percent’s passing based on minus #10, (Column 11), by the percent of the total sample passing the #10 sieve (last value in Column 3), for each sieve size. Divide each value by 100 to get the percent and record to the nearest 0.1% in Column 12.
7. CHECKS AND BALANCES

7.1. Check the Computed Percent Retained

7.1.1. For the plus #10 material.

The total weight retained (Total of Column 1) divided by the total dry weight of the sample (Line U) and multiplied by 100 should be within ± 0.2% of the sum of the percent’s retained (Total of Column 2).

\[ \sum \text{of Column 2} = \left( \frac{\sum \text{of Column 1}}{\text{Line U}} \right) \times 100 \pm 0.2\% \]

7.1.2. For the minus #10 material.

The total weight retained (Total of Column 5) divided by the weight of dry inorganic minus #10 material (Line R) and multiplied by 100 should be within ± 0.2% of the sum of the percent’s retained (Total of Column 6).

\[ \sum \text{of Column 6} = \left( \frac{\sum \text{of Column 5}}{\text{Line R}} \right) \times 100 \pm 0.2\% \]

7.2. Check the Computed Percent Passing

7.2.1. For the plus #10 material.

The sum of the percent retained (Total of Column 2) plus the percent of total sample passing the #10 sieve (last value of Column 3) must equal 100.0%.

\[ \sum \text{of Column 2} + \text{last value of Column 3} = 100.0\% \]

7.2.2. For the minus #10 material

The sum of the percent retained (Total of Column 6) plus the percent passing the #40 sieve, based on minus #10 (last value of Column 7), must equal 100.0%.

\[ \sum \text{of Column 6} + \text{last value of Column 7} = 100\% \]
8. REPORT

8.1. At a minimum, the report will contain the following:

8.1.1. Percent of total sample passing required sieves

8.1.2. Percent sample passing based on minus #10 sieve

8.1.3. Particle Size Analysis details:

8.1.3.1. The instrument name and model number

8.1.3.2. The method of dispersion

8.1.3.3. The measurement run time

8.1.3.4. Refractive indices used

8.1.4. Percent Organic Content

8.1.5. pH
APPENDIX
## Appendix A

### GEOTECHNICAL LABORATORY

#### TOPSOIL ANALYSIS

<table>
<thead>
<tr>
<th>LINE</th>
<th>SAMPLE WEIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Wt. of Dry Plus #10 After Separation</td>
</tr>
<tr>
<td>B</td>
<td>Wt. of &quot;Pan&quot; Material from Plus #10</td>
</tr>
<tr>
<td>C</td>
<td>Wt. of Dry Plus #10 Material (A - B)</td>
</tr>
<tr>
<td>D</td>
<td>Wt. of Moist Minus #10 Material</td>
</tr>
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<table>
<thead>
<tr>
<th>LINE</th>
<th>MOISTURE CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Container Number</td>
</tr>
<tr>
<td>F</td>
<td>Wt. of Sample &amp; Container Before Drying</td>
</tr>
<tr>
<td>G</td>
<td>Wt. of Sample &amp; Container After Drying</td>
</tr>
<tr>
<td>H</td>
<td>Wt. of Container</td>
</tr>
<tr>
<td>I</td>
<td>Wt. of Water (F - G)</td>
</tr>
<tr>
<td>J</td>
<td>Wt. of Dry Sample (G - H)</td>
</tr>
<tr>
<td>K</td>
<td>Moisture Content ( \left( \frac{I}{J} \right) \times 100 )</td>
</tr>
<tr>
<td>L</td>
<td>Wt. of Dry Minus #10 ( \frac{D}{(1 + (K/100))} )</td>
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<table>
<thead>
<tr>
<th>LINE</th>
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<tr>
<td>M</td>
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<td>Wt. of Sample &amp; Crucible Before Ignition</td>
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<td>O</td>
<td>Wt. of Sample &amp; Crucible After Ignition</td>
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<tr>
<td>P</td>
<td>Wt. of Crucible</td>
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<tr>
<td>Q</td>
<td>Wt. of Organic ( (N - O) )</td>
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<tr>
<td>R</td>
<td>Wt. of Inorganic Sample ( (O - P) )</td>
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<td>S</td>
<td>Organic Content ( \frac{Q}{R} \times 100 )</td>
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<tr>
<td>T</td>
<td>Wt. of Dry Inorganic Minus #10 ( \frac{L}{(1 + (S/100))} )</td>
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<td>U</td>
<td>Wt. of Total Dry Inorganic Sample ( (C + T) )</td>
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<thead>
<tr>
<th>WEIGHT</th>
<th>% RETAINED</th>
<th>% OF TOTAL SAMPLE PASSING</th>
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<td></td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
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</tr>
<tr>
<td>4</td>
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</tr>
<tr>
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| pH        |

**EB 18-037**

**Page A-1**