

Colorado Procedure 21-08

Standard Method of Test for

Mechanical Analysis of Soils

1. SCOPE

- 1.1 This method describes the procedure for the quantitative determination of the distribution of particle size in soils and soil aggregate mixtures.

2. REFERENCED DOCUMENTS

2.1 *AASHTO Procedures:*

- M 92 (ASTM E 11)
- M 145 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

2.2 *Colorado Procedures:*

- CP 20 Dry Preparation of Disturbed Soil Samples for Test

3. APPARATUS

- 3.1 *Balance* – A balance sensitive to within 0.1 gram.

- 3.2 *Container* – A pan or vessel with sufficient capacity to contain the specimen when covered with water.

- 3.3 *Washing Device* (Optional) – Any approved device designed to facilitate the removal of material finer than the No. 200 sieve from the test specimen. The device shall be capable of producing a result equivalent to that described in Subsection 5.2.2 and Note 2.

- 3.4 *Sieves* – A series of sieves of the following sizes conforming to AASHTO M 92: 3-in. (75 mm), 1-in. (25.0 mm), 3/4-in. (19.0 mm), No. 4, No. 10, No. 40, and No. 200.

- 3.5 *Drying Equipment* – Hot plate, stove, or oven.

4. TEST SPECIMEN

- 4.1 The test specimen shall be prepared per CP 20, Subsections 5.1 and 5.2.

5. PROCEDURE

5.1 Sieve Analysis of Plus No. 4 Material – The total fraction of the sample retained on the No. 4 sieve as prepared in CP 20, Subsection 5.1, shall be separated into a series of sizes by the use of the 3-in. (75 mm), 1-in. (25.0mm), 3/4-in. (19.0 mm), 3/8-in. (9.5 mm), and the No. 4 sieves. The sieving operation shall be conducted in such a manner to keep the particles moving continuously over the surface of the sieve. Care shall be taken not to overload the sieves. Sieving shall continue until not more than 1% by weight (mass) of the residue passes any sieve during 1 minute. When mechanical sieving is used, the thoroughness of sieving shall be checked occasionally by using the method as described above.

5.1.1 Weigh and record the portion of the specimen retained on each sieve. It is permissible to record the accumulated weights (masses) as the contents of each successive sieve are added to the fractions previously deposited on the scale pan.

Note 1: For soil classification per AASHTO M 145, material retained on the 3 in. (75 mm) sieve shall not be included in the total weight (mass) of the specimen. The approximate maximum size shall be noted and reported on CDOT Form #219. When there is an appreciable amount of plus 3 in. (75 mm) material the percentage should be estimated and included in the notes on CDOT Form # 219.

5.2 Sieve Analysis of Minus, No. 4 Material – The minus No. 4 specimen for moisture determination, as prepared by CP 20, Subsection 5.2, shall after weighing be dried to a constant weight (mass) at $230^{\circ}\text{F} \pm 9^{\circ}$ ($110^{\circ}\text{C} \pm 5^{\circ}$). When cool (room temperature) and dry, weigh, calculate, and record the percent moisture.

5.2.1 The minus No. 4 specimen for the washed sieve analysis as prepared by CP 20, Subsection 5.2, shall, after weighing, be placed in a container and covered with water for a sufficient length of time to assure complete separation of the material finer than the No. 200 sieve from the coarser particles. A small amount of organic wetting agent may be added to the water to facilitate wetting.

5.2.2 Transfer the soaked specimen from the container onto a nest of two sieves of which the top "breaker" sieve is a No. 8 or No. 10 and the bottom sieve is a No. 200. Wash the specimen over the "breaker" sieve until the material retained on the sieve is clean. Transfer the clean retained material to a suitable container and set aside. Wash the material passing the "breaker" sieve over the No. 200 sieve, using any method or device, which will assure the removal of that portion of the specimen, which is finer than the No. 200 sieve size. When clean, transfer the material remaining on the No. 200 sieve to the container with the material retained on the "breaker" sieve and dry to a constant weight (mass) at $230^{\circ}\text{F} \pm 9^{\circ}$ ($110^{\circ}\text{C} \pm 5^{\circ}$).

Note 2: Washing over the No. 200 sieve by decantation, using a pinched hose, or by mechanical or automatic washing devices, shall be performed in such a manner so as not to reduce the individual particle size. Manipulation of the material on the No. 200 sieve will be permitted, provided direct force or pressure is not applied to the sieve. The specimen shall be considered clean when the water washed through the sieve and caught in a clean white pan shows only a negligible amount of material passing the sieve.

- 5.2.3 When cool (room temperature), separate the specimen into a series of sizes by the use of the No. 10, No. 40, and No. 200 sieves. The sieving shall be conducted as described in Subsection 5.1.
- 5.2.4 Weigh and record the material retained on each sieve. This may be done either individually or accumulatively as in Subsection 5.1.1.

6. CALCULATIONS

- 6.1 Using the percent moisture as determined in Subsection 5.2, correct the original moist weight (mass) of the total minus No. 4 material and the moist weight (mass) of the minus No. 4 specimen selected for the washed sieve analysis to dry weight (mass) as follows:

$$\frac{\text{Dry Weight (Mass)}}{\text{Mass}} = \frac{\text{wet weight (mass)}}{100 + \% \text{moisture in specimen}} \times 100$$

- 6.2 After correcting the total moist weight (mass) of the minus No. 4 fraction to dry weight (mass), calculate the percentage of material retained on each sieve larger than the No. 4 sieve and the total percentage of material passing the No. 4 sieve by dividing each by the total combined dry weight (mass) of both the plus and minus No. 4 fractions. Convert percent retained to percent passing each sieve and total percent passing the No. 4 sieve. (See Note 1)
- 6.3 Calculate the percentages retained on the No. 10, No. 40, and No. 200 sieves from the washed sieve analysis specimen by dividing the weight (mass) retained on each sieve by the total dry weight (mass) of the minus No. 4 sieve analysis specimen before washing. Convert percent retained to percent passing each sieve.
- 6.4 Calculate the percent passing each sieve on a total sample basis by multiplying the percent passing each sieve of the washed sieve analysis specimen by the percent passing the No. 4 sieve of the total sample divided by 100.

7. RECORD

- 7.1 CDOT Form 564, Soils and Aggregates Sieve Analysis When Splitting on the No. 4 Sieve.
- 7.2 CDOT Form 219, Soil Survey of the Completed Roadbed.

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