



Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes¹

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1. Scope

1.1 This test method covers the determination of particle size distribution of putting green and other sand-based rootzone mixes. Particles larger than 0.05 mm (retained on a No. 270 sieve) are determined by sieving. The silt and clay percentages are determined by a sedimentation process, using the pipet method. This procedure was developed for putting green rootzone mixes, those assumed to have sand contents of 80 % by weight or greater. Particle size analysis of soils may be performed by this test method or Test Method D422. This test method also describes a qualitative evaluation of sand particle shape.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Document

2.1 *ASTM Standards:*²

D422 Test Method for Particle-Size Analysis of Soils

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Apparatus

3.1 *Balance*, sensitive to 0.001 g.

3.2 *Stirring Apparatus*, may be either of the following types:

3.2.1 *For Method A—An Electric Mixer*, made for mechanical mixing of soils, or

3.2.2 *For Method B—A Horizontal Reciprocating Shaker*, with holder for 250 mL flasks or bottles.

3.3 *Sedimentation Cylinder*, a glass cylinder marked for a volume of 1000 mL. The height of the 1000 mL must be 36 ± 2 cm from the bottom on the inside.

3.4 *Thermometer*, accurate to 0.5°C.

3.5 *Pipet Rack*, a device for lowering a pipet to a precise depth in the sedimentation cylinder.

3.6 *Pipets*, Lowy or other wide tipped type, 25 mL capacity.

3.7 *Weighing Bottles or Beakers*, glass with a capacity of 100 mL.

3.8 *Sieves*, square mesh with woven wire (brass or stainless steel). The sieves shall conform to the requirements of Specification E11. A full set of sieves shall include the following:

3.8.1 *No. 10*—2 mm,

3.8.2 *No. 18*—1 mm,

3.8.3 *No. 35*—500 μm ,

3.8.4 *No. 60*—250 μm ,

3.8.5 *No. 100*—149 μm ,

3.8.6 *No. 140*—105 μm , and

3.8.7 *No. 270*—53 μm .

3.9 *Sieve Shaker*, type that provides vertical tapping action as well as horizontal shaking.

3.10 *Desiccator*.

3.11 *Dispersing Agent*, a 5 % sodium hexametaphosphate (HMP) solution, made by dissolving 50 g of reagent or technical grade HMP in 1000 mL of distilled or demineralized water.

3.12 *Oven*, capable of maintaining a temperature of $105 \pm 5^\circ\text{C}$.

3.13 *Water*, shall be distilled or demineralized, and brought to the temperature that is expected to prevail during the sedimentation process. If air temperatures are expected to fluctuate, cylinders should be placed in a constant temperature water bath, and the distilled or demineralized water brought to the temperature of the water bath.

¹ This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.64 on Natural Playing Surfaces.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.14 *Dissecting Microscope*, 25 to 50× power.

TEST METHOD 1—PROCEDURE FOR PARTICLE SIZE ANALYSIS

4. Procedure

4.1 Dispersion of Sample:

4.1.1 Weigh 100 ± 5 g of air-dried rootzone mix to the nearest 0.1 g and place in mixing cup (Test Method A) or flask (Test Method B). Place a duplicate sample into a drying oven set at $105 \pm 5^\circ\text{C}$ for correction to oven dried basis.

4.1.2 Add 100 mL of dispersing agent. Stir or swirl until the rootzone mix is thoroughly wet. Allow to stand for 4 h. If using Test Method B, place the flasks or bottles on the shaker and shake for 16 h or overnight.

4.1.3 *Test Method A*—Add about 100 mL of water to the mixing cup and place onto the mixer. Mix for 5 min on low speed.

4.2 Determination of the Sand (2.0 to 0.05 mm) Fractions and Gravel (material >2 mm):

4.2.1 Place a tared No. 270 sieve onto a large funnel held by a stand over a sedimentation cylinder. Pour the suspension onto the sieve. Rinse remaining sand material out of the cup or flask with water onto the sieve. Wash the collected sand and gravel with misted water to wash any remaining silt or clay particles through the sieve into the cylinder.

4.2.2 An alternative for collecting sand and gravel is to separate following the sampling for clay (4.3). In this case the suspension is poured and washed onto a No. 270 sieve after pipeting has been completed. The sample is then washed until only sand and gravel remain on the sieve. Then continue the procedure at 4.2.3. If this alternative method is used, the volume of silt plus clay suspension at pipeting time is less than 1000 ml due to the presence of sand and gravel. Thus the clay percentage as calculated in 6.1 must be corrected. Assuming a particle density of 2.65 g/cc for sand and gravel, conversion factors for various sand plus gravel weights in the cylinder are as follows:

Sand and Gravel in Cylinder, g	Conversion Factor to Correct % Clay in 6.1
68 to 92	0.97
93 to 100	0.96

4.2.3 Wash the material retained on the No. 270 sieve into a tared beaker, and place into an oven at $105 \pm 5^\circ\text{C}$ until dry and weigh.

4.2.4 Transfer the dried sand to a nest of sieves. Shake the sieves on a shaker for 5 min. Check thoroughness of sieving in each sieve by the hand method of sieving and continue sieving until not more than 1 mass % of the residue on a sieve passes that sieve during 1 min of sieving (see Test Method D422). Weigh gravel [material retained on No. 10 (2 mm) sieve] and each sand fraction to the nearest 0.1 g.

4.3 Determination of Clay (<2 μm):

4.3.1 Add distilled or demineralized water to the sedimentation cylinder to bring up to the 1000 mL volume. Cover the cylinder with waxfilm, a stopper, or watch glass. Place the cylinder into a water bath, or allow it to stand until the

temperature of the suspension is the same as the water bath or the air temperature, respectively.

4.3.2 After the temperature is constant, resuspend the silt and clay by one of the two following methods: (a) stir thoroughly with a hand stirrer, using an up and down motion for at least 30 s; or (b) stopper the cylinder and shake end over end for 1 min.

4.3.3 Use Tables 1 and 2 or appropriate calculations using Stoke's Law to determine sampling depths and times for the suspension temperature.

4.3.4 Turn on the vacuum and withdraw a 25 mL sample in about 12 s. Rate of withdraw is important.

4.3.5 Discharge the sample into a tared beaker or drying dish.

4.3.6 To wash out any residual material in the pipet draw 25 mL of water into the pipet, and discharge into the same drying dish.

4.3.7 Evaporate the water and dry the clay at $105 \pm 5^\circ\text{C}$.

4.3.8 Cool in a desiccator and weigh to the nearest 0.001 g.

5. Determination of Correction for Dispersing Solution

5.1 Dispense 100 mL of dispersing solution into 1 L container.

5.2 Add distilled or demineralized water to 1 L volume, stir or swirl until thoroughly mixed.

5.3 Draw 25 mL and dispense into a tared beaker or drying dish.

5.4 Draw 25 mL of water and dispense into same dish.

5.5 Evaporate in an oven at $105 \pm 5^\circ\text{C}$.

5.6 Weigh the sediment in the beaker (W_D) to the nearest 0.001 g.

6. Calculation for Test Method 1

6.1 Calculate percent clay as follows:

$$\% \text{ clay} = \frac{40(W_C - W_D)}{W_S} \times 100$$

TABLE 1 Settling Velocities and Settling Times (at 10-cm depth) for 5 g/L HMP Solutions and Particle Density of 2.65 g/cc when Sampling for Clay (<2 microns) at Various Temperatures

Temperature, °C	Settling Velocity, cm/h	Time for 10-cm Depth, h
14	1.084	9.23
15	1.112	8.99
16	1.142	8.76
17	1.172	8.53
18	1.203	8.31
19	1.233	8.11
20	1.264	7.91
21	1.295	7.72
22	1.327	7.54
23	1.358	7.36
24	1.390	7.19
25	1.423	7.03
26	1.455	6.87
27	1.488	6.72
28	1.521	6.57
29	1.555	6.43
30	1.588	6.30