Procedure for Wet Aggregate Stability

Procedure Overview:

This protocol describes a procedure for the determination of percent soil wet aggregate stability in soil samples. The original method was reported by Yoder (1936) and uses nested sieves submerged in water to disaggregate soil through slaking. Soils that are sieved to <8mm and air-dried are typically used.

Sample Analysis

50 grams of air-dried soil → Dunk 10 min @ 30 osc/min (no pre-wet) → Dry @ 100^{o}F for 7 days → Weigh and record

Instrumentation and Materials:

Machine Preparation

- Dunking machine assembly
- Sieve hangers
- 8-inch soil sieves (2000, 500, 250 and 53 μm)

Sample Preparation

- Aluminum soil tins
- Analytical balance

Sample Reaction and Analysis

- Funnels and stand
- High pressure air hose
- High pressure sink sprayer
- Sieve bottom
- Wash bottle
- 500 mL square soil tins
- Shallow tins/weigh boats
- Soil dehydrator oven
- Analytical balance

Detailed Procedure:

I. Machine Preparation

1. Attach dunking machine to soil trap and check for leaks.
2. Ensure machine is level using bubble levels and casters.
3. Close all bucket valves, add deionized water to fill line. Fill a carboy with deionized water to be used for wash bottles.

4. Stage funnels and funnel stand within reach of a high-pressure air hose.
5. Ensure soil sieves are mostly dry by quickly wiping with a paper towel. Stack sieves in sieve hangers in order with largest sieve on top and smallest on bottom: 3 sieve = 2000, 250 and 53 µm; 4 sieve = 2000, 500, 250 and 53 µm.
6. Plug the machine into electrical outlet and turn main red switch to "ON".
7. Verify default program settings.

II. Sample Preparation

1. Dry all soil samples completely before analysis. Previously-dried soil samples should be put in the soil dehydrator overnight to drive off any excess moisture.
2. Weigh approximately 50 g (± 0.05 g) of unknown sample into a tared weighing boat/tin and record actual weight.

III. Sample Reaction and Analysis

3. Pour soil over 2000 µm sieve (with other sieves already stacked) as uniformly as possible. Note some sample may pass through all sieves including 53 µm. This is acceptable if the <53 µm fraction will be calculated by difference (see below). If this fraction will be captured and quantified, care should be taken to retain sample in this step.
4. Hang sieve stack on the arm of the dunker, over the corresponding bucket, noting sample ID and position. Repeat for all samples.
5. Turn toggle switch to 'Run' position to start the cycle.
6. While machine is running through cycle (or ahead of time), record square soil tin labels and weights. Match labels to sample ID's.
7. After the cycle is complete, transfer wet samples to square soil tins:
   a. After all sieve stacks have drained completely, remove sieve stack from sieve hangers.
   b. ***Separate rocks from 2mm fraction.*** Remove 2mm sieve from stack and nest in a sieve pan. Use a sink sprayer to force soil through sieve and into nested sieve pan. Remove sieve from nested pan and transfer rocks (>2 mm) on top of the sieve to a labeled square tin lid.
   c. Use a wash bottle to transfer <2 mm soil mixture in the sieve pan to the corresponding square tin.
   d. ***Transfer remaining size fractions to square tins.*** Place remaining square tins directly under corresponding funnels.
   e. Disassemble sieve stack one at a time; invert each sieve and place into funnels in corresponding order.
   f. Use compressed air hose to transfer as much soil from sieve to the funnel as possible.
   g. Rinse sieve and funnel completely with DI water in wash bottle, ensuring labelled square tin is under funnel to capture all of the wash. If more than 500 mL of water is required for this step, separate mixture into a second, labeled tin and make note.
   h. Set sieves aside and place square tins containing rocks, soil and wash in order on drying oven sheets. Note positions.
8. Place samples in dehydrator at 105° F for at least seven days. Some samples may require less drying time depending on volume of water and soil type.
9. Once moisture is completely evaporated from all tins, remove from oven and let cool down to room temperature.
10. Weigh all tins and record. Subtract tin weights from soil or rock weights for final calculations.

IV. Calculating Percent Wet Stable Aggregates (%WSA)

1. **Adjust initial soil weight for rocks**
   a. Initial soil weight minus rock weight.

2. **Calculate dry soil weight for each fraction**
   a. Fractions other than <53 µm: Tin + dry soil weight minus tin weight
   b. <53 µm fraction: Adjusted initial soil weight minus sum of all other fractions

3. **Calculate %WSA for each fraction**
   a. Dry soil weight (step 2) divided by adjusted initial soil weight (step 1) times 100

Example Calculation:

Initial Soil Weight: 49.97g

Aggregate Fraction	Tin ID	Tin Weight	Tin + Dry Soil/Rocks	Dry Soil/Rocks	Wet Stable Aggregates (WSA)	Mean Weight Diameter
µm	#	g	g	g	%	µm
Rock	101a	63.36	64.55	1.19	-	823
>2000	101b	55.42	64.55	9.13	18.72	
250-2000	101c	55.05	71.86	16.81	34.46	
53-250	101d	55.15	72.92	17.77	36.43	
<53				5.07	10.39	

Mean Weight Diameter. With multiple size classes, the aggregate stability of the soil can also be reported as mean weight diameter (MWD, µm, after Kemper & Rosenau, 1986). Mean weight diameter is calculated by 1) multiplying the mean diameter of each size class by the relative proportion of aggregates in that size class, 2) summing the products from step 1.

All calculations can be performed in the accompanying calculation template.

Clean-up and Disposal:

Thoroughly rinse all funnels, tins, sieves, and sieve hangers. Open all valves on dunker and rinse buckets. For final flush, fill two buckets furthest from the soil trap with water, then simultaneously open the valves to wash drainpipe. Detach from soil trap and move to storage location.

References:

Kemper, W.D., and R.C. Rosenau. 1986. Aggregate stability and size distribution. Methods of Soil Analysis. John Wiley & Sons, Ltd. p. 425–442

Yoder, R.E. 1936. A direct method of aggregate analysis of soils and a study of the physical nature of eroson lossess. J Am Soc Agron 28:337-351

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