2015 CORNELL SOIL HEALTH TRAIN-THE-TRAINER WORKSHOP

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Wet Aggregate Stability Test

Background / References:

The Wet Aggregate Stability (WAS) Test assesses the extent to which soil aggregates resist falling apart when wetted and hit by rain drops. It is measured using a rain simulation sprinkler that steadily delivers water drops to a sieve containing a known weight of dried soil aggregates. The unstable aggregates slake (fall apart) and pass through the sieve. The fraction of soil that remains on the sieve is used to determine the percent aggregate stability.
Each soil sample is placed on a 20cm diameter soil sieve which receives 1.25cm water depth (as drops) in 5 minutes. About 11,700 drops of 4mm diameter with a total weight of 0.393kg are delivered. These drops reach a velocity of 3.1m/s as they fall the 50cm distance (terminal velocity for this sized drop is 8.8m/s). The total Kinetic Energy (KE) delivered in 5 minutes is:

$$KE = \tfrac{1}{2}\, m * v^2$$

$$KE = \tfrac{1}{2}\, (0.393kg)(3.1m/s)^2$$

$$KE = 1.9 \text{ Joules}$$

Procedure reference: B.N. Moebius, H.M. van Es, R.R. Schindelbeck, O.J. Idowu**,** J.E. Thies, D. J. Clune. (2007) Evaluation of Laboratory-Measured Soil Physical Properties as Indicators of Soil Quality. Soil Science Vol. 172, No. 11, pp. 895-910.

Poster description of the WAS test used in the Cornell Soil Health Assessment (see Figure 1 below): Wet Aggregate Stability Test of Soil Structure in the Cornell Soil Health Assessment 2009. Robert R. Schindelbeck (rrs3@cornell.edu), Bianca N. Moebius-Clune , Omololu J. Idowu, Harold M. van Es

Objective:

The wet aggregate stability of soil health samples is tested on soil dried to constant weight at 40° C (3-4 days in the oven) on the aggregate size fraction 0.25mm-2mm. From the total weight of dry

aggregates tested, the weight of slaked soil and the weight of stones retained on wetted sieve are measured and the difference determines the percent of stable soil as aggregates.

NOTE: For quarantined soils, see labeled procedures in italics at the bottom of each section.

Materials and Equipment:

Cornell Rainfall Simulator
Stopwatch
Filter Paper
16, 0.25mm sieves
Drying oven
Aluminum trays
Plastic cups
Soil sieve brush
Analytical Balance
Two-tablespoon scoop
4-cone portable platform
Sink with sprinkler hose
Squeeze bottles with water
Reverse osmosis system and water storage tank with pump

***Additionally for quarantine soils*:**
2, 5-gallon buckets
Bleach
Spray bottle with 10% bleach solution
Latex or Nitrile gloves to protect hands
Large basin to bleach quarantine sieves

Procedure:

I. Filter preparation:

1. Weigh a series of dried filters and group them in rounded tenths of grams. For example, if a filter weighs 9.32 grams, group it under 9.3 grams, if it weighs 9.26 grams, group it under 9.3 grams. These filters can be stored for future use.
2. Once ready for testing, get out the 4-cone portable platforms and lay them out together on a table.
3. Place the filters into the cones, noting rounded filter weight on the Aggregate Stability data sheet. NOTE: Make sure there are no tears or punctures in the folds of the filter. It may be helpful to squirt a *small* amount of water onto the filters to help them open up - be careful to not over water, as filters are susceptible to failure.
4. The cones and filters are now ready to receive sieves.

II. Sieve/Aggregate preparation:

1. Set out the 16 pre-weighed, numbered, 200mm diameter, 0.25mm mesh sieves on a bench near the analytical balance.
2. Confirm that the weights of the sieves match what is labeled on the data sheet.

3. Aggregate Stability samples should be stored in groups of 16 in deep-dish trays labeled something like “J1”, “N1” or “F2”.
   Quarantined samples should be clearly marked with a “Q” on the lid.

4. Using a 2-tablespoon sized scoop, spread about 20 grams of 0.25-2.0mm aggregates in a single layer onto the surface of the 0.25m sieve, with order of samples corresponding to numbers labeled on each sieve. Spread the soil evenly on the sieve by shaking the soil scoop about six inches above the sieve.
   Spread soil on sieves inside a bin. Discard any soil into an autoclave bag and autoclave as soon as possible. After using scoop and bin sterilize with a disinfectant solution and let sit for the required time before rinsing.
5. Weigh each sieve and record the total weight of the sieve + aggregates onto the Wet Aggregate Stability data sheet (Table 1 below).
   Weigh sieves on top of a velum paper, and after using apply sterilizing solution and let sit for the required time before rinsing.
6. Place sieves onto the filters that are resting within the 4-cone portable platforms. NOTE: Make sure that sieves are resting within the cone so that any material falling through the sieve will fall into the filter and not behind it, and that the sieves are resting as parallel to the floor as possible
7. **MAKE SURE ALL SIEVES HAVE BEEN WEIGHED BEFORE PLACING THEM UNDER THE SIMULATOR.**
8. Do not disturb the soil on top of the sieve. Try to maintain an even distribution of aggregates across the sieve surface. Samples are ready to be placed under the rainfall simulator.

III. Rainfall Simulator Calibration/Preparation:

1. Make sure the rainfall simulator tank contains enough water to run the amount of samples you will prepare.
2. To fill simulator tank, confirm there is enough deionized (reverse osmosis) water in the storage tank located below the workbench.
3. Through the large opening on top of the simulator tank, insert the clear plastic hose, flip the pump switch over to turn it on. Water should begin to flow.
4. Fill the rainfall simulator tank as much as possible without completely emptying the storage tank. Turn the pump switch upside down to turn off the pump.
5. Cap rainfall simulator with large rubber stopper.
6. You must perform a practice run to check the amount of rainfall delivered in a 5 minute period.
7. DO NOT place samples under the simulator UNTIL AFTER CALIBRATION
8. Pull out the large rubber stopper and let dripper run for a few minutes. (If you have just filled the tank, this step can be avoided).
9. After a few minutes, pull out the small rubber stopper and replace the large rubber stopper. Let water flow for a few more minutes. Ensure that the dripper is suspended 0.5m above the soil on the sieve

10. Make sure the stop-watch is zeroed and press the start button and simultaneously note the water level on the ruler glued to side of simulator tank. This is measurement one.
11. After 5 minutes, note water level. This is measurement two.
12. Record difference between measurement one and two on the Wet Aggregate Stability data sheet (Table 1 below). This difference should be as close to 1.25cm as possible.

13. If substantially higher or lower (should be within + or – 0.1), then the rate may be adjusted by sliding the small diameter tube inside the tank up or down. Get a faster rate by sliding the tube up, and a slower rate by sliding it down.
14. Minor adjustments are only necessary if there has been an extreme difference in temperature between the last testing and the current testing event.

IV. Wet Aggregate Stability Test:

1. MAKE SURE ALL SIEVES HAVE BEEN WEIGHED BEFORE PLACING THEM UNDER THE SIMULATOR.
2. Check to make sure stop watch has been "zeroed".
   Place catch basin out flow tube into 5 gallon bucket with 1.5 liters of bleach to collect all runoff water. When buckets have approximately 4 gallons move out flow tube to another bucket prepared with 1.5 liters of bleach inside. Let buckets sit for 30 minutes before discarding bleach water down the drain.
3. With rainfall simulator running, place the first platform of cones, filters, and sieves 0.5m under the tank, directly under it such that all areas of the sieves are receiving drops.
4. Immediately after placing platform under dripper, start the stopwatch.
5. Throughout a 5-minute period, it is necessary to rotate the tank of the simulator (around its vertical axis) and to allow it to swing very slightly (< 1cm swing) to ensure random delivery of drops to the entire sieve surface. Simulator should be rotated ~90 degrees once every 15-30 seconds.
6. At the 5-minute mark, carefully remove the platform from under the dripper and place sieve rack into bin to trap waste water from the draining sieves.
7. Re-zero stopwatch and repeat the test for the other three 4-cone platforms. Let sieves sit while performing the rest of the tests to allow water in filters to drain, leaving just soil inside the filter.
   Spray any water that may have dripped on the floor with an approved Quarantine disinfectant solution and rinse away after the required time.
8. Carefully remove sieves and gently slide filters sideways so retained water flows through filter and is not 'trapped' by retained soil.

V. Rinsing the sieves:

1. A sink with a sprinkler hose and regular faucet work best for washing sieves.
2. Set up sprinkler hose and faucet so that they are running simultaneously and hitting the sieve with retained soil in roughly the same area.
   Place bin with a 5 gallon bucket inside it into sink. Catch all water used for sieve rinsing in bucket, add 10% bleach and discard after 30 minutes.

3. Wash any remaining material THROUGH the sieve such that only clean sand too large for the mesh is left behind (do not lose any sand during washing). Use fingers to rub all stable soil particles less than 0.25 mm through the sieve and into sink.
   Catch all water used for sieve rinsing in bucket, add 10% bleach and discard after 30 minutes.
4. Using a squeeze bottle with water, starting with a stream of water at one side of the remaining material, slowly move across the sieve, washing the retained material into a tared and labeled aluminum can to be dried at 105C. Decant excess water from the can.
   Decant water into 5 gallon bucket with 1.5 liters of bleach in it. Bleach any laboratory equipment that comes in contact with quarantined soil.
5. Place the cup in the correct order in a labeled metal tray. Record label of metal tray on the Wet Aggregate Stability data sheet (Table 1 below). Fold drained filters and place into appropriate aluminum cans. These are called soil "tacos" on the data sheet.
6. Wash any remaining rocks and organic matter out of sieves; shake off excess water and place sieves in 105° C oven for 10-20 min. or until dry
   Disinfect sieves with an appropriate solution for the required time period, then rinse and dry in oven
7. Repeat entire procedure for next batch of sieves.
8. MAKE SURE THAT SIEVES START OUT DRY! Use round sieve brush to clean top and bottom area of dry sieves before sprinkling on new aggregates.
9. At the end of the day, put trays into the 105° C oven to dry overnight. Complete analysis at least 2 days later.
   Disinfect any laboratory equipment as well as any surfaces that come in contact with quarantined soil.

VI. Weighing rocks and slaked soil:

1. After drying to constant weight in the 105° C oven, remove trays from the oven one at a time.
   Place into bin.
2. Weigh filter and aluminum can together on the analytical balance, record weight in the "filter and oven dry soil and taco can" column of the Wet Aggregate Stability data sheet (Table 1 below).
   Weigh sub-samples on a weigh boat on top of a sheet of velum to catch crumbs.
3. Weigh aluminum can with stones, record weight in "sand can and oven dry stones" column of the Wet Aggregate Stability data sheet (Table 1 below).
   Weigh sub-samples on a weigh boat on top of a sheet of velum to catch crumbs.
4. Discard filter and stones into compost bucket after they are weighed and recorded.
   Discard sub-samples into autoclave bags and autoclave as soon as possible. Bleach any laboratory equipment as well as any surfaces that come in contact with quarantined soil.
5. Continue with all filters and cups in tray and repeat for other dried trays.
   Discard sub-samples into autoclave bags and autoclave as soon as possible. Bleach any laboratory equipment as well as any surfaces that come in contact with quarantined soil.

VII. Data Collection Sheet and Calculations:

After all data is recorded on the Wet Aggregate Stability data sheet in the laboratory, transcribe into an Excel spreadsheet (Table 1 below). In each set of 16 samples that are run, sample 16 is a soil standard which is run as a check or quality control. Columns are dedicated to identifying the samples

and their locations during the testing. Other columns list the sieve used and the tare weight of the sieve that occupies each location. Record the collected laboratory data into the blank cells (columns 2-5) in each row for the automatic calculation of percent stability of soil aggregates. Note that column 5 will be completed before testing. Columns 6 and 7 are completed during the data analysis stage from a saved file of tare weights of the aluminum cans. Highlighting the cell in column 8 of each row in an Excel table would reveal the formula used in the calculation:

Percent Stability of Aggregates =

((initial dry material on sieve (g) – sieve wt (g)) – (dry rock and organic material in can

(g) – can wt (g)) – (dry filter and failed soil (g) – filter wt (g) – can wt (g))) / ((initial

dry material on sieve (g) – sieve wt (g)) – (dry rock and organic material in can (g) – can

wt (g))) * 100