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APPENDICES

APPENDIX 10

METHOD: ASTM D422
STANDARD OPERATING PROCEDURE
FOR PARTICLE SIZE ANALYSIS OF SOILS
Applicable Matrix or Matrices: Soil, Sediment, Sludge
Standard Compound List and Reporting Limits: NA

Approvals and Signatures

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1.0 SCOPE AND APPLICATION

1.1 This method determines the particle size distribution in soil. Particles greater than 75um (gravels to fine sands) are determined by sieving and particles less than 75um (silts and clays) are determined by sedimentation using an hydrometer.

1.2 Minimum quantity of sample depends on subsequent analyses to be performed. Typical range is 150 to 350 grams of dry soil. Larger amounts (from 500 to 5000 grams) are specified for particle size analysis of soils with appreciable gravel component.

1.3 This preparation is amenable to samples containing sand, silt, clay and gravel.

2.0 SUMMARY OF METHOD

2.1 Soils for particle size analysis are prepared according to ASTM D421 or D2217. The soils are sieved in two steps. The particles greater than 2.00mm (retained on the No. 10 sieve) are sieved after the soil has been prepared. A portion of the soil passing the No. 10 sieve is prepared for hydrometer measurements. Seven hydrometer readings are made over a 24 hour time frame. The soil in the hydrometer is rinsed on a No. 200 (75 um) sieve and dried for sieve analysis of material less than 2.00mm (No. 10 sieve). Calculations are made to determine the percent finer of soil for each sieve and hydrometer reading. These calculations are dependent on percent solid, which is determined during the drying process, and the specific gravity that is assumed to be 2.65 (unless separate analysis is requested for specific gravity).

3.0 DEFINITIONS

N/A

4.0 INTERFERENCES

N/A

5.0 SAFETY

5.1 The toxicity or carcinogenicity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Cautions are included for known extremely hazardous materials or procedures.

5.2 STL Burlington maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. Material Safety Data Sheets (MSDS) are made available to all personnel involved in the chemical analysis. STL Burlington also has a written environmental health and safety plan.

5.3 Please note chemicals that have the potential to be highly toxic or hazardous, the appropriate MSDS must be reviewed by the employee before handling the chemical.

6.0 EQUIPMENT AND SUPPLIES

6.1 Balance sensitive to 0.01 grams

6.2 Mixer and dispersion cup

6.3 1000 ml sedimentation cylinder

6.4 Soil test hydrometer meeting specification E 100

6.5 Mortar and rubber tipped pestle for breaking up soil aggregates

6.6 Sieves of the following size:

3.0 in (75.00mm)	No. 20 (850.0um)
2.0 in (50.00mm)	No. 40 (425um)
1.5 in (37.50mm)	No. 60 (250.0um)
1.0 in (25.00mm)	No. 80 (180.0um)
3/4 in (19.00mm)	No. 100 (150.0um)
3/8 in (9.50mm)	No. 200 (75.0um)
No. 4 (4.75mm)	
No. 10 (2.00mm)	

6.7 Oven with temperature range of 60° C to 110° C

6.8 Thermometer accurate to 0.5° C

6.9 Timer with second hand and capable of counting up to 25 hours

6.10 Mixing utensils, metal and bristle brushes for sample recovery.

6.11 Rototap machine

7.0 REAGENTS AND STANDARDS

7.1 Sodium Hexametaphosphate (dispersion reagent)

8.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

8.1 Typical sample of 150 to 350 grams is used for analysis. Larger amounts (from 500 to 5000 grams) are specified for particle size analysis of soils with appreciable gravel component. The sample container must remained sealed to maintain natural water content.

8.2 There are no holding time requirements.

9.0 QUALITY CONTROL

9.1 Check balance daily with Class S weight, yearly manufacturer calibration.

9.2 Oven temperature is checked daily prior to start of work.

9.3 Thermometer is checked against similar or more accurate temperature device.

9.4 Duplicate samples are recommended every 20 samples.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Sieves calibrated twice a year using the National Bureau of Standard, Certificate of Calibration, standard reference materials 1017a, 1018a and 1019a calibrated glass beads.

10.2 Hydrometers are calibrated twice a year, and checked prior to each use.

10.3 Thermometer calibrated against NIST certified thermometer.

11.0 PROCEDURE

11.1 Large Sieve (dry): The soil retained on the No. 10 sieve is used in this step. Rinse the particles on a No. 10 sieve and then place the material in an oven until dry.

Large Sieve (wet): Take the equivalent of 200 grams of dry soil (use the percent solid table). Place soil on a No. 10 sieve and wash the soil. Take the soil retained on the No. 10 sieve and place in an oven until dry.

11.1.1 Record the weights of the sieves greater than No. 10. Take the dry soil and pour into the sieve stack. Place the sieve stack on the Rototap machine and shake sample for ten minutes.

11.1.2 Weigh and record the contents of each sieve.

11.1.3 Record the maximum particle size. Determine the hardness of the particles by dropping a hammer on the particle from a height or approximately one foot. Record the hardness as hard, soft or brittle. Save the soil particles.

11.2 Hydroscopic Moisture (dry prep. only): The soil passing the No. 10 sieve is used in this step. Take a small tin, label it and record the weight. Place approximately 10 to 15 grams of soil in the tin. Place the tin in the oven at 110°C for at least 16 hours. Remove the tin and record the weight.

11.3 Hydrometer Test: The soil passing the No. 10 sieve is used in this step.

11.3.1 Sample Preparation:

- Dry Prep: Tare a 250 ml beaker. Place and record approximately 50 grams for silt or clay particles or 100 grams for same particles into the beaker. Add 125 ml of a 40g/l sodium Hexametaphosphate solution to sample and allow to soak overnight

  Wet Prep: Tare a 500 ml beaker. Place and record the dry equivalent (use the percent solid table) of approximately 50 grams for silt or clay particles into the beaker. Add 125 ml of a 40g/l sodium Hexametaphosphate solution to sample.

- Dry Prep: Rinse the sample with DI water into a dispersion cup. Fill the cup to the halfway mark with DI water and place cup on the blender. Mix sample for approximately one minute. Pour content of cup into a 1000 ml sedimentation cylinder. Rinse cup with DI water to wash all the sample into cylinder. Fill the cylinder to the 1000 ml line and cover with a sheet of paraffin wax.

  Wet Prep: Rinse the sample with DI water into a dispersion cup. Fill the cup to the halfway mark with DI water and place cup on the blender. Mix sample for approximately five minutes. Pour content of cup through a No. 10 sieve into a 1000 ml flask. Rinse cup with DI water to wash all the sample into the flask. Fill the flask to the 1000

ml line and cover the flask with a sheet of paraffin wax. Take the material on the No. 10 sieve, dry it in the oven and record the weight.

11.3.2 After preparing up to 12 flasks, begin setup for hydrometer readings. The following paperwork is needed: hydrometer data sheet, hydrometer reading table, and temperature table if conversion from Fahrenheit to Celsius is necessary. Initiate timer to indicate the elapsed time, counting up from zero. Check readings of hydrometer and temperature probe in a DI water rinse bath. Get the rubber stopper to shake flask and prepare staging and test areas.

11.3.3 Initiate timer to indicate the elapsed time. The hydrometer reading table is used to perform activities as indicated (shake, place or read) for each 1000 ml cylinder.

A reading consists of inserting the hydrometer gently into the cylinder, (after the cylinder has been shaken for 1 minute), about 20 seconds before the actual reading. Read the hydrometer to the nearest 0.0005 at the top of the meniscus. Remove the hydrometer and insert a temperature sensor into the cylinder to the depth to which the hydrometer reached. Read the temperature meter to the nearest 0.1°C and remove the temperature sensor. The hydrometers and temperature sensor are rinsed in a DI bath between each reading.

After each cylinder is read, the hydrometer reading, temperature, and time (from table) is entered on the hydrometer data sheet at the corresponding cylinder (test) number and time portion on the data sheet; deviations from the table schedule are noted on the sheet. The readings are taken at 2, 5 and 15 minute and at 30, 60, 240 and 1440 minutes.

11.4 Small Sieve: Soils from the hydrometer test are rinsed on the No. 200 sieve. The soil retained on the No. 200 sieve is placed in an oven and dried over night.

11.4.1 Record the weights of the sieves used between No. 10 and No. 200. Take the dry soil and pour into the sieve stack. Place the sieve stack on the Rototap machine and shake sample for ten minutes.

11.4.2 Weigh and record the contents of each sieve.

12.0 CALCULATIONS

12.1 Percent Solids (PS) and Hydroscopic Moisture Correction Factor (HMCF)

12.1.1 HMCF is used for air dried samples (dry prep.)

*HMCF = (pan and baked sample - pan)/(pan and dry sample -pan)*100*

12.1.2 Wet Method:

*PS = (pan and dry sample- pan)/(pan and wet sample - pan)*100*

Dry Method:

*PS = HMCF * (pan and dry sample -pan)/(pan and wet sample - pan)* 100*

12.2 Sample Used (SU):

12.2.1 Wet Method:

SU = (pan and wet sample - pan) PS*

Note: for hydrometer SU, subtract the dry weight of any material retained on the No. 10 sieve.

12.2.2 Dry Method:

*SU = ((pan and dry sample - pan) - (pan and non-soil material - pan)) * HMCF*

12.3 Sieve Analysis (Percent Finer = PF)

12.3.1 Large Sieves:

- 3 inch: PF = 100-100* (Sieve and Sample (3 inch) - Sieve (3 inch))/SU
- 2 inch: PF = PF (3 inch) - 100*(Sieve and Sample (2 inch) - Sieve (2 inch))/SU and so on through the #10 Sieve.

12.3.2 Small Sieves

- #20: PF = PF(#10) - 100*(mass passing #10/sample mass (Hyd))*(sieve and sample (#20) - sieve(#20))/sample used
- #40: PF = PF (#20) - 100*(mass passing #10/sample mass (Hyd))*(sieve and sample (#40) - sieve (#40))/sample used and so on up through #10 sieve.

12.4 Hydrometer Analysis

12.4.1 Particle size, Micron

*1000*sqrt [930*viscosity/980*(SG-1))*(effective depth/time)]*

Viscosity at sample temperature, poises

- Effective Depth, cm = 16.29-264.5*(actual Hydrometer reading - 1) above equation for effective depth based on equation found with table 2 in method, in which 16.29 = 0.5*(14.0-67.0/27.8)+10.5 and 264.5 = (10.5-2.3)/0.031
- Time, minutes = Time of hydrometer reading from beginning of sedimentation

Sqrt - square root
SG - Specific Gravity of soil
Viscosity - is the resistance of a liquid to flow

12.4.2 Percent Finer (PF):

PF = Constant(actual hydrometer reading - hydrometer correction factor - 1)*

Where:
Constant = (100,00/W)*SG/(SG-1)
W = (Total sample used *sample used for hydrometer analysis*HMCF)/Amount of total sample passing #10 sieve
Hydrometer Correction = slope*sample temperature + Intercept
Slope = ((low temp. reading -1)-(high temp. reading -1)/(low temp. - high temp.))
Intercept = (low temp. reading -1) - (low temp. * slope)

13.0 METHOD PERFORMANCE

N/A

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The USEPA has

established a prevention hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the agency recommends recycling as the next best option.

14.2 The quantity of chemical purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

14.3 For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036; (202) 872-4477.

15.0 DATA ASSESSMENT AND CRITERIA AND CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

15.1 Data is initially reviewed by the analyst in the lab. Following this, the data is secondarily reviewed by QC personnel before being put into its final data package form (where the data is thirdly reviewed before being sent to the client).

15.2 Data that is out of control is marked as such and slated for re-analysis. Any corrective action undertaken is documented on a corrective action form (detailing the client information, problem, investigation findings and solution). This form is kept together with the project.

16.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

16.1 Generally, any data that is out of control is considered unusable. There are, however, cases in which laboratory supervisor will be made aware of the issue and, if the data is used, it will be thoroughly narrative noted.

17.0 WASTE MANAGEMENT

17.1 The USEPA requires that laboratory waste management practices conducted be consistent with all applicable rules and regulations. Excess reagents, samples, and

method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water and land by minimizing and controlling all releases from hoods, and bench operations, complying with the letter and spirit of any waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel", available from the American Chemical Society at the address listed in Section 14.3.

18.0 REFERENCES

18.1 Annual Book of ASTM Standards, volume 04.08 Soil and Rock (I): D 420 - D4914, Section 4, Construction edition; American Society for Testing and Materials, Philadelphia, Pa., 1994.

19.0 TABLES, DIAGRAMS, FLOWCHARTS AND VALIDATION FORMS