Field-Composited Soil Core Bulk Density and Stone Volume

Background / Strategy:

Soil Bulk Density (Db) is a determined through dividing the dry weight of soil by a known volume of soil. Typically, Db is measured on the top 3" of soil by pounding a ring (sleeve) of known volume into the soil surface. This intact ring is trimmed to size in the field. The sleeve can be capped and submitted to the lab intact or the sleeve contents can be emptied into a Ziploc bag and analyzed for Db in a laboratory setting. **Multiple rings** can be collected from an area of interest and composited into the same sample bag. Stone may or may not be collected with the intact ring. In the soil lab, all stones over 2 mm will be weighed. Db will be calculated with and without the stone weight included.

Stainless steel ring
wall thickness: 0.16cm
height: 6.1cm
diameter: 3.6cm
ring volume: 248.2cm^3

Field collection:

Field collection of Db samples is done by pounding a steel ring into the top 3" of soil in an area of interest. The ring filled with soil is then careful removed from the soil profile. The soil contained in the ring can be then emptied into a Ziploc bag. Repeat and place the second soil volume into the same bag. Place this bag within a second Ziploc bag to ensure safe arrival to the lab. Upon arrival the sample is signed in and a unique ID is assigned to the soil sample.

NOTE: ***Some soil samples analyzed for Db are from United States Department of Agriculture-Animal and Plant Health Inspection Service (APHIS) designated quarantined areas. For quarantined sample handling see bold and italicized notes within this Standard Operating Procedure (SOP).***

Quarantine soil permit holder must sign in samples according to permit specifications. All other following quarantine procedures may be done by properly trained laboratory technician. Autoclave all packing materials that the quarantined samples arrived in. Place a large "Q" on each quarantined sample bag. All following steps included in determining Db must be done in a secondary container i.e. large bin.

Materials and Equipment:

Analytical Balance
8 mm sieve
2 mm sieve
Wire brush
Indelible marker
Tared aluminum cans (2 sets - one for soils and one for stones)
Plastic bin
Funnel/Acetate sheet
Graduated cylinder

Plastic bin
Sterilization solutions approved for use with Quarantined soil:
Bleach-10% Bleach solution within a labeled spray bottle must be left on contaminated equipment for ½ hour before rinsing.
Ethyl Alcohol 70% within a labeled spray bottle must be left on contaminated equipment for ½ hour before rinsing.

Procedure:

1. Record internal sample ID in column C (Cornell ID) on data sheet (Figure 1).
2. Weigh and record the tare of the second (outside) Ziploc bag in column E (bag weight). Note: If in the outside bag is a different size or brand than the inner Ziploc bag with the sample the inner bag will have to be carefully emptied and weighed in order to determine the bag tare.
   Weigh samples on top of a piece of acetate sheet atop the analytical balance so it can be disinfected upon completion of the batch. Sterilize all quarantine laboratory equipment that comes into contact with quarantined soil with an approved disinfectant.
3. Weigh the entire soil sample plus the inner Ziploc bag, record the weight in column D (bag + wet soil).
   Do all laboratory procedures inside a plastic bin and disinfect with an approved quarantine disinfection solution before rinsing.
4. Record weights of soil cans into column G (can tare), along with can ID (column F) on the data sheet. Note: This should be done ahead of time for efficiency.
5. Open the bag and remove ~2 tablespoons of soil. Place this soil in the soil can. Weigh and record this weight in column H (can + wet soil).
   Sterilize all quarantine laboratory equipment that comes into contact with quarantined soil with an approved disinfectant.
6. Record can IDs and weights of stone cans onto columns J and K respectively.

7. Sieve remaining soil through 8 mm sieve placing stones separated into the stone can that corresponds with that unique sample.
   Sterilize all quarantine laboratory equipment that comes into contact with quarantined soil with an approved disinfectant.
8. Sieve remaining soil through 2 mm, placing any stones into the >8 mm stones can.
   Sterilize all quarantine laboratory equipment that comes into contact with quarantined soil with an approved disinfectant.
9. Weigh and record wet stone weight plus can weight into column L.
10. Upon completion of a batch of samples place the soil cans and the stone cans into a 105°C oven until constant weight is reached (usually 12-24 hours).
11. Weigh out soil cans recording weight in column I (can + dry soil).
    Sterilize all quarantine laboratory equipment that comes into contact with quarantined soil with an approved disinfectant.
12. When constant weight is reached for the stone cans, weigh and record weight in column M (can + dry stones).
    Sterilize all quarantine laboratory equipment that comes into contact with quarantined soil with an approved disinfectant.
13. Prepare a 1000 ml graduated cylinder by placing inside 300 ml of water. If you have a very small volume of stones use a 100 ml graduated cylinder and start with 30 ml of water. If you determine the soil sample has less than .05 ml in stone volume do not record weight and instead record no stones on data sheet. Note: If you have a very high percentage of stones (over 1 cup) in a sample you should start with a higher volume of water.
    Do this step inside of a bin. Note additional steps (outlined below) must be taken to safely dispose of the contaminated water.
14. Using a funnel carefully drop all stones from one sample into the graduated cylinder.
15. Record rise in water i.e. volume of stone into column N (volume stones).
    For Quarantined samples save all water used for volumetric measurement into a 5 gallon bucket. Upon filling the bucket or upon completing the day's work add 10% bleach for ½ hour. After ½ hour water can safely be disposed of down a drain. Bleached stones should be autoclaved.

Quarantine soil handling procedures:

- ***All excess soil must be autoclaved.***
- ***All water that comes into contact with soil must be bleached with a 10% bleach solution for ½ hour before disposing of bleach water down drain.***
- ***Any area or material that has come into contact with quarantined soil must be disinfected using sterilization solutions approved for use with Quarantined soil:***
  1. ***Bleach- 10% bleach solution within a labeled spray bottle must be left on contaminated equipment for ½ hour before rinsing. Note, this is the only approved method for handling water contaminated with quarantined materials.***
  2. ***Ethanol solution (70%) (stored in a labeled spray bottle) must be left on contaminated equipment for ½ hour before rinsing.***

Data Collection and Calculations:

Table 1. Soil bulk density datasheet and with parameter calculator

I. Columns A-N. Record data here. Use different lab constants as appropriate

lab apparatus constants

volume soil (two core composite) 645cm^3

column A	column B	column C	column D	column E	column F	column G	column H	column I	column J	column K	column L	column M	column N
					bulk soil (in g)				STONES (in g)				
order	ID	Cornell ID	bag + wet soil (g)	bag wt (g)	can ID	can tare	can + wet soil	can + dry soil	can ID	can tare	can + wet stones	can + dry stones	volume stones (cm^3)
1	dummy	SH-1	1108.72	15.6	a12	31.35	71.5	64.23	b12	50.36	228.1	218.19	60

II. Columns O-U. Calculations shown of soil weights and water contents to arrive at bulk density based on 1) the entire soil as collected with stones and 2) using only the < 2mm soil. The stone volume percent in the bagged sample is also determined.

column O	column P	column Q	column R	column S	column T	column U
					w/o stones	
wet soil (g)	soil Theta M	dry material in bag (g)	Bulk Density (as sampled) (g/ cm^3)	dry stone wt (g)	Bulk Density (only <2mm soil) (g/ cm^3)	stone volume %
D6-E6	(H6-I6) / (I6-G6)	O6 * (1/(1+P6))	Q6/645	M4-K4	(Q4-S4) / (645-N4)	(N4/645) * 100
1093.12	0.23	886.56	1.37	195.23	1.22	12.40

**Note: the sample volume of 645cm^3 used in the above calculations corresponds to (*in this example*) the total volume of all of the replicate sample cores that were collected into the bag.

References:

R. B. Grossman and T. G. Reinsch, 2.1 Bulk Density and Linear Extensibility, SSSA Book Series, Methods of Soil Analysis: Part 4 Physical Methods, 5.4:201-228 doi:10.2136/sssabookser5.4.c9