Bulk Density – Core method

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Introduction

Bulk density is the amount of soil in a given volume. This is an important variable of soil as it influences permeability, porosity, and biological colonization. The amount of space between soil particles governs the movement of water and air. Free flow of water and air allows for nutrients and microbes to travel through the soil media (Hao et al. 2008).

Equipment Needed

Field Equipment:
Soil core sampler
Core sleeves
Plastic bags (core caps can also be used)
Sharpie
Knife or other rigid flat object

Lab Equipment:
Balance
Weighing tins (large enough to fit your sample)
Drying oven at 105°C
Dessicator with fresh dessicant
2 mm sieve
100 mL graduated cylinder
Deionized water (DI)
Ruler

Procedure

Field Procedures:

1. Surface sampling: clear the O horizon from the mineral soil surface. Soil pit: Wall – go straight into the side wall at preferred depth (usually a horizon).
2. Place a core liner in the sampling core and press the sampler into the soil enough to fill with soil. Make sure to not disturb the sample as much as possible (i.e., no rocking or shaking)
3. Remove the sampling core carefully and check to see if the core is intact. If the core isn't completely filled or if a rock or large root is protruding, the core needs to be redone.
4. If the core is pulled away intact, flatten the bottom of the core with a knife so that the soil is flat with the edge of the core.
5. Once the core is trimmed, place the soil sample within the sleeve into a plastic bag.

Lab Procedures:

1. Label and record the weight of a weighing tin.
2. Empty the contents of the soil core into the tin.

    a. Note: You can also calculate the gravimetric water content of a soil by weighing the samples from field wet and using the oven dry weight at the end. (see Soil Processing Protocol for equation)
3. Place the tins carefully into the oven set to 105°C for 48 hours or longer for larger sample sizes.
4. After the samples are fully dried, place them in a dessicator to cool before weighing.
5. Once the total oven dry soil weight is recorded, sieve the soil through a 2 mm sieve.
6. Weigh the amount of coarse fraction (>2 mm) in a tin and then pour the fraction into a 100 mL graduated cylinder filled to 50 mL with DI. Record the new level of the solid and liquid to the nearest mL.
7. Clean the sieve and dump the contents of the graduated cylinder for the next sample.
8. Measure the inside dimensions (radius and height) of the core using the ruler to the nearest 0.1 cm.

Relevant equations and calculations
If all of the cores are identical you only need to calculate the volume of the core once.

Cylinder Volume = $\pi\ r^2\ h$

Make sure to subtract the tin, core, and coarse fraction weights to make sure you are calculating only the soil weight. Also be sure to correct the volume to include only the volume of soil.

$$\rho b = \frac{\text{oven dry soil wt (g)} - \text{tin wt (g)} - \text{core wt (g)} - \text{coarse frac wt (g)}}{\text{core vol } (m^3) - \text{coarse frac vol } (m^3)}$$

References
Hao, X., Ball, B.C., Culley, J.L.B., Carter, M.R., and Parkin, G.W. (2008). Soil Density and Porosity. In Soil Sampling and Methods of Analysis. Boca Raton, FL: CRC Press, pp. 743-749.