BULK DENSITY LAB III

Objective: To determine the bulk density, particle density and porosity of different soil samples

Background:

Bulk density is soil mass divided by unit volume. In its natural state, a soil's volume includes solids and pores, therefore, a sample must be taken without compaction or crumbling to correctly determine bulk density.

As bulk density of a given soil increases soil strength also increases. Bulk density is the oven dry weight of soil divided by the volume or space occupied by the soil. Remember that soil is composed of solids and pores, and the greater the bulk density the greater the amount of solids, and the smaller the amount of pore space. For a particular soil type, as bulk density increases, soil strength increases.

Two examples of management problems caused by increasing soil strength are soil crusts and tillage pans. A soil crust is a thin soil layer that forms at the soil surface following heavy rains. The raindrops compact the soil surface and develop a layer having a high bulk density that hardens upon drying. Soil crusts may prevent seedlings from emerging. Tillage or hard pans are high bulk density (>1.7 g/cm^3) layers that occur within the Ap and E horizons. Tillage pans are formed by compaction produced by tractor wheels and tillage equipment. When dry, tillage pans have high soil strengths and may prevent roots from growing into lower soil horizons.

Compaction caused by traffic of equipment, vehicles, or even foot traffic often increases soil strength to levels that restrict root penetration and plant growth.

Particle density is the volumetric mass of the solid soil. It differs from bulk density because the volume used does not include pore spaces.

Particle density = oven-dry soil weight / volume of soil solids

Porosity is that portion of the soil volume occupied by pore spaces. This property does not have to be measured directly since it can be calculated using values determined for bulk density and particle density.

- 3-inch diameter ring
- Auger
- Hand sledge
- Wood block
- Garden trowel
- Flat-bladed knife
- Sealable bags and marker pen
- Scale (0.1 g precision)
- 1/8 cup (30 mL) measuring scoop
- Paper cups
- 18-inch metal rod
- Access to a microwave oven
- Tape measure
- 25 ml graduated cylinder
- 100 ml graduated cylinder

Procedure:

Collect samples from each of the sites provided by your instructor. For each sampling site, collect at least two samples using different tools (i.e. different metal cores or augers)

Sample Collection:

- Using the an auger, fill the soil core (cylinder) with soil (Use mallet to drive metal core into the soil)
- Use a trowel to remove the core from the soil
- Ensure that the core is completely filled with soil (Use a knife to level off both ends of the core)
- Slowly remove soil from the soil core into a brown bag or newspaper
- Label the soil sample (location & equipment used)
- Repeat steps 1-5 using a different size core or auger
- Collect at least two samples per site
- Repeat steps 1-5 for the remaining sites

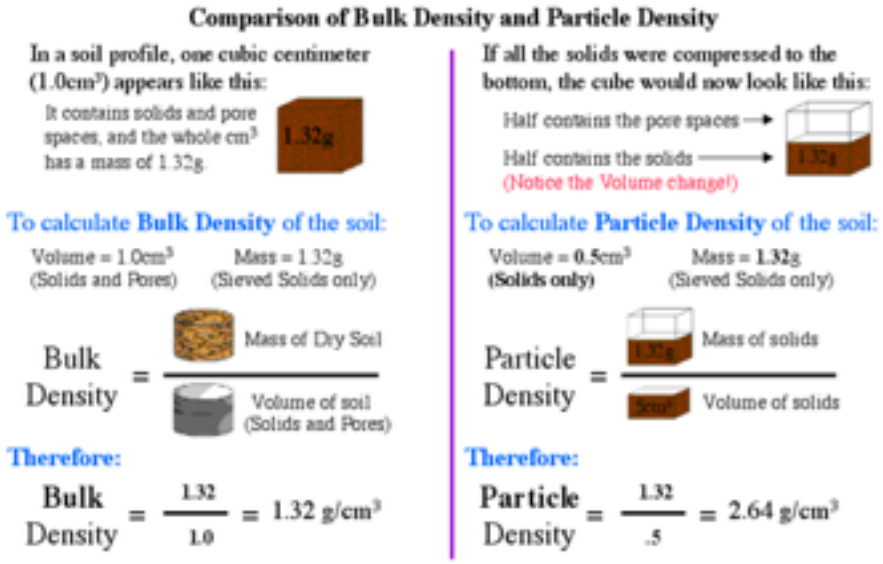
Lab Analysis

- Dry your soil using oven or a microwave (105^0C over a 24 hour period)
- Using a triple beam balance or an electronic balance, determine the mass of each dry soil sample and record the mass in the data table
- Determine the height and internal diameter of the metal core (Remember: D= 2r)
- Determine the volume of each metal core ($V= \pi r^2 h$)
- Record the volume for each soil sample
- Compute the bulk density

Post Lab Questions

1. If the oven dry weight of a soil is 350 g and the volume is 250 cm^3. What is the bulk density?
2. What is the main difference between bulk density and particle density?
3. If bulk density is increased by compaction, does percent pore space increase or decrease?
4. Which soil would have a greater bulk density, one that is sandy or one that is clayey?
5. From the porosity formula, what must the bulk density of a soil be if its porosity is 37% and a particle density of 2.65g/cm^3?
6. What mass, in pounds would the soil in the top six inches of an acre-furrow-slice weigh if it has a bulk density value of 1.47g/cm^3?

Site	Equipment/ Size	Mass of Soil (g)	Volume (cm^3)	Bulk Density (g/ cm^3)	Porosity



PARTICLE DENSITY LAB

- Place 50.0 ml of tap water into 100 ml graduated cylinder
- Carefully weigh a 50.0 gram sample of dry soil. Slowly pour all of the soil into water in the graduated cylinder
- Cover the mouth of the graduated cylinder with the palm of the hand and invert the cylinder back and forth to mix the soil and water thoroughly. Check to see that there are no air bubbles near the bottom of the cylinder.
- Add exactly 10 ml of water to a 25 ml graduated cylinder. Carefully rinse the sides of the cylinder containing the soil with the 10 ml of water. Determine the new water level beneath the floating organic material.

Record your results in the table below:

Site	Mass of dry soil (g)	Total volume (soil + water)	Total volume of water in Cylinder	Volume of Soil particles(cm^3)	Particle density (g/cm^3)

Post Lab Questions

1. How does porosity vary with the amount of clay in the soil?

2. How are air exchanges and water movement in soils related to the amount of pore space?

3. Why is particle density of mineral soils always near 2.65 g/cm^3?