3.3 Bulk Density

3.3.1 Field-State

3.3.1.4 Soil Cores

After Soil Survey Staff (2004)

Application

Bulk density by the core method offers the opportunity to obtain bulk density information without the expense incurred to obtain water retention. Field-state bulk density by the core method is particularly useful if the soil layers are at or above field capacity and/or the soils have low extensibility (shrink-swell potential) and do not exhibit desiccation cracks even if below field capacity. This method is not intended for weak or loose soil material. The procedure described herein is after the Soil Survey Staff (2004, method 3B6a).

This method is alternatively adapted to measure satiated bulk density in subaqueous soils collected with vibracores. Vibracoring is a soil-coring technique used to collect subaqueous samples by vibrating a core barrel into the soil. Vibracore sampling is the most effective approach to obtain minimally disturbed samples having fluidity class of nonfluid through moderately fluid.

Summary of Method

A metal cylinder is pressed or driven into the soil. The cylinder is removed, extracting a sample of known volume. *Alternatively*, for subaqueous samples taken as vibracores and opened by cutting, a plastic syringe with the end removed is used to collect a mini-core. The plunger can be fixed at the 10-ml volume mark and the syringe gently pushed into the split vibracores sample to collect a known volume of sample. The moist sample weight is recorded. The sample is then dried in an oven and weighed.

Interferences

During the coring process, compaction of the sample is a common problem. Compression can be observed by comparing the soil elevation inside the cylinder with the original soil surface outside the cylinder. If compression is excessive, the soil core may not be a valid sample for analysis. Rock fragments in the soil interfere with core collection. Dry or hard soils often shatter when the cylinder is hammered into the soil. Pressing the cylinder into the soil reduces the risk of shattering the sample. If soil cracks are present, select the sampling area so that crack space is representative of the sample, if possible. If this is not possible, make measurements between the cracks and determine the areal percentage of total cracks or of cracks in the specimen.

Safety

Be careful when using oven or microwave. Avoid touching hot surfaces and materials. Follow standard field and laboratory safety precautions.

Equipment

1. Containers, air-tight, tared, with lids
2. Electronic balance, ±0.01-g sensitivity. Refer to Appendix 9.9.
3. Sieve, no. 10 (2 mm-openings)
4. Coring equipment. Sources described in Grossman and Reinsch (2002).
5. Oven, 110 ±5 °C, or microwave. Refer to Section 3.5.1 of this manual for information on drying soils in a standard laboratory oven or microwave.
6. First-aid kit
7. Alternative equipment (for satiated bulk density) as follows:
   - 7.1 Vibracore equipment (available commercially)
   - 7.2 Beaker, heat durable, 50 ml
   - 7.3 Plastic syringe, 50 ml with the end removed

Reagents

None.

Procedure

1. Record empty core weights (CW).
2. Prepare flat surface, either horizontal or vertical, at required depth in sampling pit.
3. Press or drive core sampler into soil. Use caution to prevent compaction. Remove core from inner liner, trim protruding soil flush with ends of cylinder, and place in air-tight container for transport to laboratory. If soil is too loose to remain in the liner, use core sampler without the inner liner and deposit only the soil sample in air-tight container. Water content cans can also be pushed directly into a prepared face. For fibrous organic materials, trim sample to fit snugly into moisture can.
4. Dry core in oven at 110 °C or in microwave until weight is constant. Refer to Section 3.5.1 of this manual for information on drying soils in a standard laboratory oven or microwave.
5. Measure and record cylinder volume (CV).
6. If sample contains rock fragments, wet sieve sample through a 2-mm sieve. Dry and weigh the rock fragments that are retained on the sieve. Record weight of rock fragments (RF). Determine density of rock fragments (PD).
7. *Alternatively*, determine satiated bulk density as follows:
   - 7.1 For samples taken as vibracores and opened by cutting, fix the plastic syringe at 10-ml volume mark.
   - 7.2 Gently push the syringe into the split vibracore sample to collect a known volume of sample.
   - 7.3 For samples taken from peat samplers, collect a sample of known volume.
   - 7.4 Empty the sample into a 50-ml beaker.
   - 7.5 Measure and record the moist sample weight.
   - 7.6 Dry the sample in oven at 110 °C or in microwave until weight is constant. Refer to Section 3.5.1 of this manual for information on drying soils in a standard laboratory oven or microwave.
   - 7.7 Measure and record the oven-dry sample weight.

Calculations

$$Db = (ODW - RF - CW)/[CV - (RF/PD)]$$

where:
Db = Bulk density of <2-mm fabric at sampled, field water state (g cm^{-3})
ODW = Oven-dry weight
RF = Weight of rock fragments
CW = Empty core weight
CV = Core volume
PD = Density of rock fragments

Report

Bulk density is reported to the nearest 0.01 g cm^{-3} (g cc^{-1}).