13. DETERMINATION OF SOIL PHYSICAL PROPERTIES

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1. Soil Texture by Feel Method

Introduction

Many times it is necessary to estimate the textural class of a soil. Soil textural class can be determined in the field by the feel method. Much can be judged about the texture of a soil by merely rubbing it between the thumb and fingers. For example, a soil containing large quantities of sand will fee gritty when rubbed between your fingers. Silt has been described as having the feel of flour. The amount of clay can be estimated by feeling the stickiness; by making a ball and ribbon. Soils with higher amounts of clay form longer ribbons. Feeling of grittiness and smoothness of wet soil samples indicate amounts of sand and silt respectively.

Procedure:

a. Take about 25 g of soil in the palm, add water and moisten it. Knead the soil to break down all aggregates. The soil is at proper consistency when plastic and mouldable.

b. Try to form a ball and squeeze it. If the soil does not remain in a ball when squeezed, the textural class of the sample is SAND

c. Place the ball of soil between the thumb and the forefinger of your hand and gently push the soil with the thumb against the forefinger. Squeeze it upward and form a ribbon (1mm thick). If it does not form a ribbon, the textural class of the sample is LOAMY SAND.

d. If the soil forms a ribbon, then determine the size of the ribbon into either a short (5 cm long).

e. Place a pinch of the soil ribbon on the palm of one hand. Add water to intake it wet. Gently rub it with the forefinger of another hand to feel the grittiness or smoothness.

Class of Soil

Sand, Loamy Sand

- Almost all sand
- Individual grains easily seen and felt

- Moist soil forms a cast that crumbles when squeezed

Sandy Loam

- Sand dominates noticeably
- Moist silt forms a cast that can be gently handled

Loam

- Can feel all three soil separates but none dominates
- Moist soil forms a cast that can be freely handled
- Cast may be squeezed to form short, broken ribbons

Silt Loam

- Dry soil has both a smooth and gritty feel
- Forms a stable cast when moist
- Short, broken ribbons (<2.5 cm) may be formed

Sandy Clay Loam

- Feels very gritty yet moist soil will form a cast
- Medium ribbons (2.5 to 5.0 cm) may be formed

Clay Loam

- Moderate grittiness
- Medium ribbons (2.5 to 5.0 cm) may be formed

Silty Clay Loam

- Feels smooth, little grittiness
- Medium ribbons (2.5 to 5.0 cm) may be formed

Clay, Silty Clay, and Sandy Clay

- Often sticky, however, stickiness varies with clay type
- Long ribbons (>5.0 cm) may be formed
- Cast is often very tough to work between thumb and finger

2.Determination of Soil Moisture Content

Gravimetric Method (Direct Method):

Gravimetric method is the simplest and most widely used direct method. It is frequently used for the calibration of other indirect methods.

Principle

Disturbed or undisturbed wet soil samples are weighed, dried to constant weight in an oven at 105°C and reweighed. From these measurements, the water content on dry mass

basis is calculated. It can be expressed on a volume basis by multiplying it with the bulk density.

Apparatus

A sampling tool – auger, Soil cores or some other suitable device, Moisture box, oven and desiccators with an active desiccant (calcium chloride).

Procedure

1. Place the moist soil sample in a moisture box and weight it immediately.
2. Place the box with lid off in an oven (105°C) and dry the soil to a constant weight.
3. Remove the sample from the oven, replacing the lid, and place the box in the desiccators until it is cool.
4. Weigh it and also determine the mass of the empty moisture box. Determine the mass of the moisture.

Observations

Mass of empty moisture box = M1 gm.

Mass of moisture box + Moist soil = M2 gm.

Mass of moisture box + oven dry soil = M3 gm.

Calculations

Mass of water in the soil = (M2 – M3) gm.

Mass of the oven dry soil = (M3 – M1) g.

Percentage moisture content on dry mass basis (θg) = (M2 – M3) 100 / (M3 – M1)

Percentage moisture content on volume basis = (θg) x Db / Dw

Where Db is the bulk density of soil & Dw is the density of water

3.Determination of Soil Bulk Density (Core method)

The bulk density or apparent density of soil may be defined as the mass of oven dry soil per unit volume of soil in its natural undisturbed condition

Bulk density (Db) = weight of oven dry soil / bulk volume of soil gram per cm^3 or Mega gram per m^3

Apparatus required: Balance, aluminum moisture box, hot air oven, desiccator, cylindrical core sampler (thin walled brass tube), knife, plastic tray, marker etc.

Procedure

1. On a flat soil surface, core sampler is hammered or pressed to insert it into the soil.
2. The core sampler is taken out of the soil.
3. The content of the sampler is transferred completely in a previously weighted moisture

box.

4. Dry the contents in an oven at 105°C for 10-18 hours to get a constant weight.

5. Cool in a desiccator and record the oven-dry weight of the soil core.

6. Calculate the volume of the core sampler. (Volume = $\pi r^2 h$)

7. Calculate the bulk density of your soil and record the value (Bulk density = weight of oven dry soil / bulk volume of soil)

Observations to be recorded

a. Internal radius of cylindrical core sampler (r) = ...cm

b. Length of core sample (h) = ...cm

c. Wt. of empty moisture box =.....gm

d. Wt. of oven dry soil + moisture box =.....gm

Calculations

A. Volume of cylindrical soil core =$\pi r^2 h$ = ...cm^3

B. Weight of oven dry soil (d-c) = ...gm

C. Bulk density (B/A) = ... g cm^3 or Mg m^3

4.Determination of Particle Density of Soil

Particle density (Dp) is the mass per unit volume of the soil solids.

D p = Weight (g) of oven dry soil/ Solid volume (cm^3)

The Dp value for most of the mineral soil ranges between and 2.70 g/cm3 with an average of 2.6 2.65 g/cm3. The knowledge of Dp is important to calculate volume weight relationships of soil, like porosity, and void ratio. Particle density is also used in calculating settling velocity of particles of different sizes during mechanical analysis.

Equipment

Pycnometer

Procedure

a. Weigh a clean dry pycnometer in the air.

b. Put into it 10 g of oven dry soil.

c. Using a pipette, fill the bottle about half-full with distilled water with a stream washing any soil particles sticking to the inside of the neck into the bottle.

d. Remove the entrapped air by gently boiling the contents.

e. Leave the soil overnight in case of heavy clay.

f. Cool the contents to room temperature and fill the pycnometer with boiled, distilled water, cooled to room temperature.

g. Insert the stopper and seat it carefully.

h. Wipe dry the outside of the pycnometer with a blotter.

i. Weigh it and also note the temperature.

J. Empty the pycnometer, clean it and fill it with boiled, cooled water at the same temperature as before.

k. Replace the stopper and dry the outside of the pycnometer with a piece of cloth or blotter and weigh it.

Calculation

Particle Density, Dp = (Ws - We) X dw / (Ws- We) - (Wsw -Ww) where

We =wt of the empty and dry pycnometer,

Ws = Wt of pycnometer +Wt of soil sample,

Wsw=Wt of Pycnometer filled with soil and water,

Ww = Wt of pycnometer filled with water.

dw =density of water (g/cm3) at the observed temperature.

Total Porosity and % Pore space

% Solid space = Db/Dp X 100

% Pore space + % Solid space =100

% Pore space = 100 - % Solid space =100- Db/Dp X100

Total porosity (e) = 1 -- Db/Dp Where: Db = bulk density Dp = particle density