

Measurement of soil moisture content by gravimetric method

The soil moisture content may be expressed by weight as the ratio of the mass of water present to the dry to the dry weight of the soil sample, or by volume as ratio of volume of water to the total volume of the soil sample. To determine any of these ratios for a particular soil sample, the water mass must be determined by drying the soil to constant weight and measuring the soil sample mass after and before drying. The water mass (or weight) is the difference between the weights of the wet and oven dry samples. The criterion for a dry soil sample is the soil sample that has been dried to constant weight in oven at temperature between 100 – 110 °C (105 °C is typical). It seems that this temperature range has been based on water boiling temperature and does not consider the soil physical and chemical characteristics

Materials

- Oven with 100 – 110 °C temperature
- Aluminum weigh tins
- A balance of precision of ± 0.001 g.
- auger or tool to collect soil samples

Procedure

1. Weigh an aluminum tin, and record this weight (tare”).
2. Place a soil sample of about 10g in the tin and record this weight as (wet soil + tare).
3. Place the sample in the oven 105°C, and dry for 24 hours or over night.
4. Weigh the sample, and record this weight as weight of (dry soil + tare).
5. Return the sample to the oven and dry for several hours, and determine the weight of (dry soil +tare).
6. Repeat step 5 until there is no difference between any two consecutive measurements of the weight of (dry soil+tare).

Computations

The moisture content in dry weight basis may be calculated using the following formula:

$$\theta_d = \frac{(wt\ of\ wet\ soil\ +\ tare) - (wt\ of\ dry\ soil\ +\ tare)}{(wt\ of\ dry\ soil\ +\ tare) - (tare)}$$

In some literature the moisture content is expressed in wet weight basis that is defined as the ratio between water mass and the mass of wet soil (θ_w). The conversion from θ_d to θ_w or visa versa can be carried out as follows:

$$wt\ of\ water = wt\ of\ wet\ soil - wt\ of\ dry\ soil$$

$$\theta_d = \frac{wt\ of\ water}{wt\ of\ dry\ soil}$$

$$\theta_d = \frac{(wt\ of\ wet\ soil) - (wt\ of\ dry\ soil)}{(wt\ of\ dry\ soil)}$$

$$\theta_d = \frac{(\text{wt of wet soil})}{(\text{wt of dry soil})} - 1$$

but :

$$\frac{\theta_d}{\theta_w} = \frac{(\text{wt of wet soil})}{(\text{wt of dry soil})}$$

thus:

$$\theta_d = \frac{\theta_d}{\theta_w} - 1$$

which result in the following formulas:

$$\theta_w = \frac{\theta_d}{\theta_d + 1}$$

And:

$$\theta_d = \frac{\theta_w}{1 - \theta_w}$$

Water content in volumetric basis is expressed as:

$$\theta_{vd} = \frac{\text{Volume of water}}{\text{Volume of soil}}$$

but:

$$\text{Volume of water} = \frac{\text{wt of water}}{\text{water density}}$$

And:

$$\text{Volume of soil} = \frac{\text{wt of dry soil}}{\text{bulk density}}$$

Thus:

$$\theta_{vd} = \frac{\text{wt of water}}{\text{wt of dry soil}} \times \frac{\text{bulk density}}{\text{water density}}$$

$$\theta_{vd} = \theta_d \times \frac{d_b}{d_w}$$

Reference

Black C.A. 1965. "Methods of Soil Analysis: Part I Physical and mineralogical properties".
American Society of Agronomy, Madison, Wisconsin, USA.