Solution for homework # 2

1. A cylindrical soil sample of 3.85 cm diameter and 10.00 cm height weights 201.13 g. The sample is then oven dried at 105 ^{o}C until a constant weight, being 177.75 g, is reached. Assuming the particle density of 2.65 g/cm^3 and a density of water 1.00 g/cm^3:

Calculate

- The bulk density of the soil sample
- Gravimetric and volumetric moisture content
- Porosity
- Equivalent depth of water contained in the soil sample

Solution

Volume of soil sample, V_t

$$V_t = \frac{\pi * D^2}{4} = \frac{\pi * (3.85)^2}{4} * 10.00cm = 116\ cm^3$$

Bulk density of soil sample, ρ_b

$$\rho_b = \frac{M_s}{V_t} = \frac{177.75\ g}{116\ cm^3} = 1.53\ {}^{g}/_{cm^3}$$

Gravimetric water content, ω

$$\omega = \frac{M_w}{M_s} = \frac{(201.13\ g - 177.75\ g)}{177.75\ g} = \frac{23.38\ g}{177.75\ g} = 0.1315\ {}^{g}/_{g}$$

Volumetric water content, θ

$$\theta = \omega * \frac{\rho_b}{\rho_w} = 0.1315\,{}^{g}/_{g} * \frac{1.53\,{}^{g}/_{cm^3}}{1.00\,{}^{g}/_{cm^3}} = 0.201\,{}^{cm^3}/_{cm^3}$$

Porosity, f

$$f = \left(1 - \frac{\rho_b}{\rho_s}\right) * 100\ \% = \left(1 - \frac{1.53\,{}^{g}/_{cm^3}}{2.56\,{}^{g}/_{cm^3}}\right) * 100\ \% = 42.3\%$$

Equivalent depth of water,

$$= \theta * z = 0.201\,{}^{cm^3}/_{cm^3} * 10.00cm = 2.01cm = 20.1\ mm$$

2. From the previous question, before oven drying how much water do we need to bring the soil water content to $0.35 m^3/m^3$?

   Solution

$\theta_i = 0.201 \, {cm^3}/{cm^3}$; And $\theta_f = 0.35 \, {cm^3}/{cm^3}$

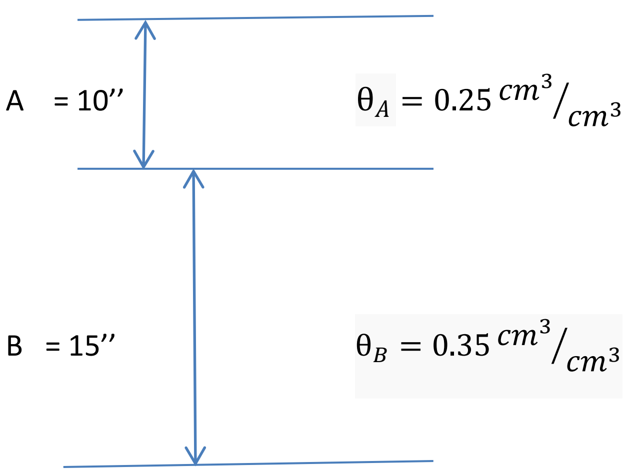
$\Delta\theta = 0.15 \, {cm^3}/{cm^3}$

Change in equivalent depth of water = $0.15 \, {cm^3}/{cm^3}$ * 10.00 cm = 1.5 cm = 15 mm

Total amount of water needed = $1.5 \, cm * \frac{\pi * D^2}{4}$ = $17 \, cm^3$ (= 17 ml of water)

3. Calculate the soil water storage in mm for a 25" deep soil profile in which the A horizon is 10" thick and has a volumetric water content of 0.25 $cm^3 \, cm^{-3}$ and the B horizon is 15" thick and has a volumetric water content of 0.35 $cm^3 \, cm^{-3}$.

Solution:



Soil water storage in the soil profile, S

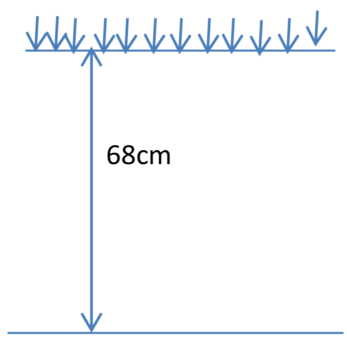
$S = (\theta_A * Z_A) + (\theta_B * Z_B)$

$$S = \left(0.25 \, {cm^3}/{cm^3} * 10 * 25.4\right) + \left(0.35 \, {cm^3}/{cm^3} * 15 * 25.4\right)$$

$S = 64mm + 130mm = 194mm$

4. Calculate the average volumetric water content after rainfall event for a 68 cm deep soil profile which had an average volumetric water content of 0.27 cm^3 cm^{-3} before getting 6.4 cm of rain. Assume 28% of the rain was lost to interception and there were no other losses.

Solution



$$\theta_f = 0.27\, {cm^3}/{cm^3} + \frac{(1-0.28) * 6.4cm}{68\ cm} = 0.34\, {cm^3}/{cm^3}$$