Extension idea from Sri Lanka - -

"Great soil race"

Understand the permeability of soils

This activity has developed based on the Earthlearningidea which was appeared in the website on 28th April, 2008. Second year Earth Science students (age ranging from 21 – 23 years) were engaged with these experiments at the Faculty of Applied Sciences, South Eastern University of Sri Lanka.

Theory :

If there are n number of horizontal sedimentary layers exists in a system (see **Figure 1**) and the water seepage vertically, the overall permeability coefficient (K) can be calculated using the following equation.

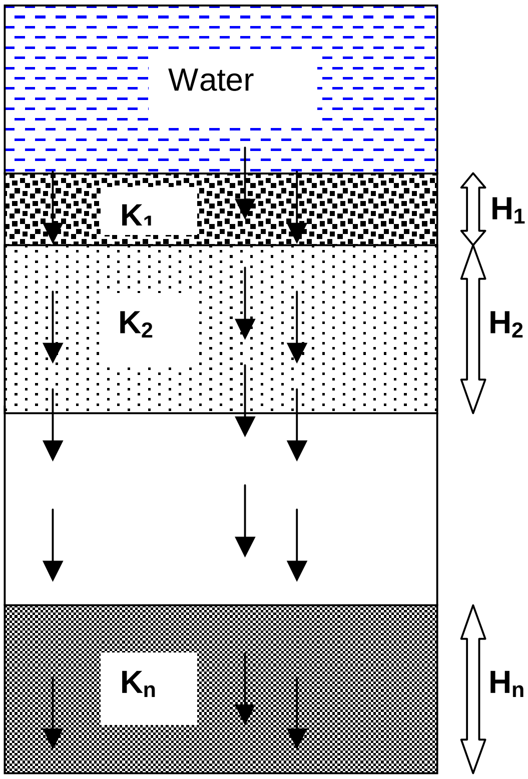

Figure 1

$$K = \frac{(H_1 + H_2 + \dots\dots\dots + H_n)}{\left\{\frac{H_1}{K_1} + \frac{H_2}{K_2} + \dots\dots\dots + \frac{H_n}{K_n}\right\}}$$

K - Overall permeability coefficient , **K_1, K_2**, .., **K_n** - Permeability coefficients of soil layers

H_1, H_2, ……, **H_n** - Thicknesses of soil layers **n** - No of soil layers

Aim : To understand the permeability of different soil types (comparison of clay and gravel) and to determine the overall permeability coefficient of a layered soil profile

Method ;

About 3 kg of an oven dried soil sample has sieved using IS sieve set. Then based on the particle sizes, three different soil samples were separated (Gravel, Sand and Clay size). As explained in the "Grate soil race" Earthlearningidea, six test funnels were prepared using plastic water bottles. From the neck of the bottle, three 3 cm levels and about 14 cm from the neck of the bottle were marked using a permanent marker pen. Tie a piece of filter paper across the neck of each bottle. Then, fit the bottles up side down on top of measuring cylinders. Samples of soil layers representing different thicknesses of three soil categories were arranged as shown in **Figure 2** to **Figure 7**.

Poured water into each bottle until soil samples were got saturated. After the soil samples got saturated, excess water removes from all bottles. Six containers were filled with 300 ml of water. Then, the stop watch had started and added water to each bottle at the same time , up to the "water fill mark" (14 cm from the neck of the bottle). Water level was kept up to the mark in each bottle by adding more water from containers.

The amount of water which had drained through each bottle were measured every five minutes intervals.

Students were record their observations. Some questions were asked before explaining the theory.

1. In which bottle (soil layer) let water flowed faster?
2. What is the reason for such observation?
3. Give few examples for these situations in nature (high permeability and low permeability)
4. Is the seepage of water depending on particle size of a soil sample?
5. Does the rate of water flow depend on the thicknesses of soil layers?
6. Are there any differences in water flowing rate when the clay size layer at the top and the gravel at the top?

Calculations:

Permeability coefficients of Gravel, Sand and Clay size (K_1, K_2 and K_3) were determined using **Constant Head Permeability Test"**. These values were used to calculate the overall permeability coefficients (**K**) of each system using the standard equation mentioned in the above. After they calculated the overall permeability coefficients for different systems of soil layers, they understood the relationship between permeability and the physical properties (specially textural features) of different soil types.

Soil System 1

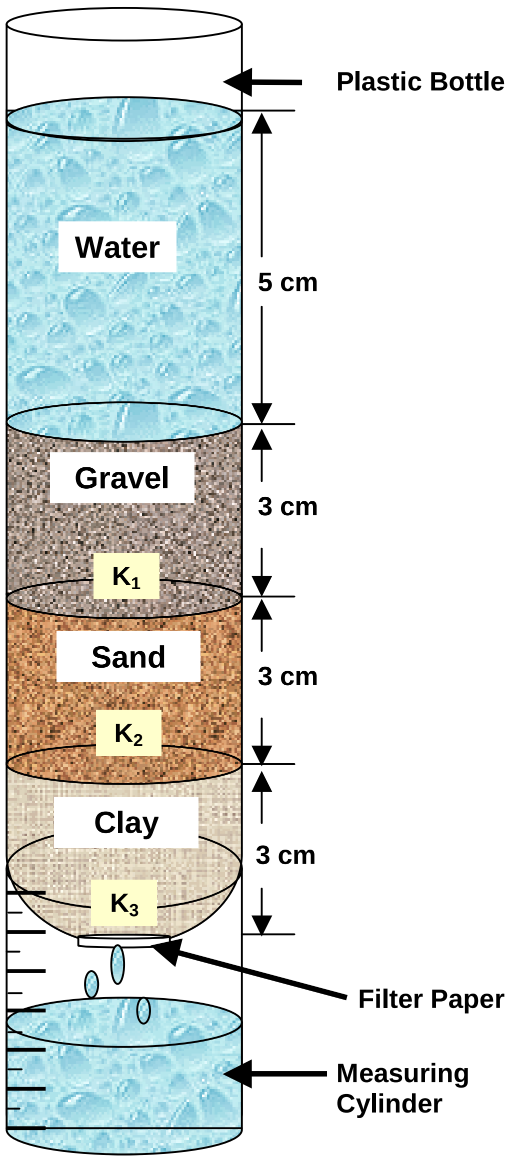

Figure 2

Soil System 2

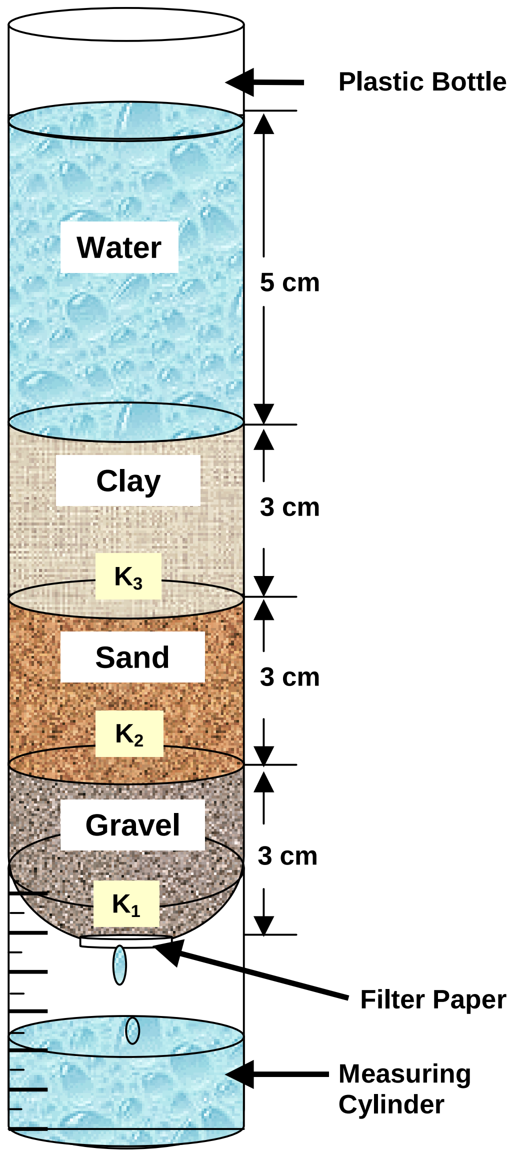

Figure 3

$\mathbf{K_1}$, $\mathbf{K_2}$ and $\mathbf{K_3}$ are permeability coefficient of Gravel. Sand and Clay size respectively.

$$K = \frac{(3\,cm + 3\,cm + 3\,cm)}{\{\frac{3\,cm}{K_1} + \frac{3\,cm}{K_2} + \frac{3\,cm}{K_3}\}}$$

$$K = \frac{(3\,cm + 3\,cm + 3\,cm)}{\{\frac{3\,cm}{K_1} + \frac{3\,cm}{K_2} + \frac{3\,cm}{K_3}\}}$$

Soil System 3

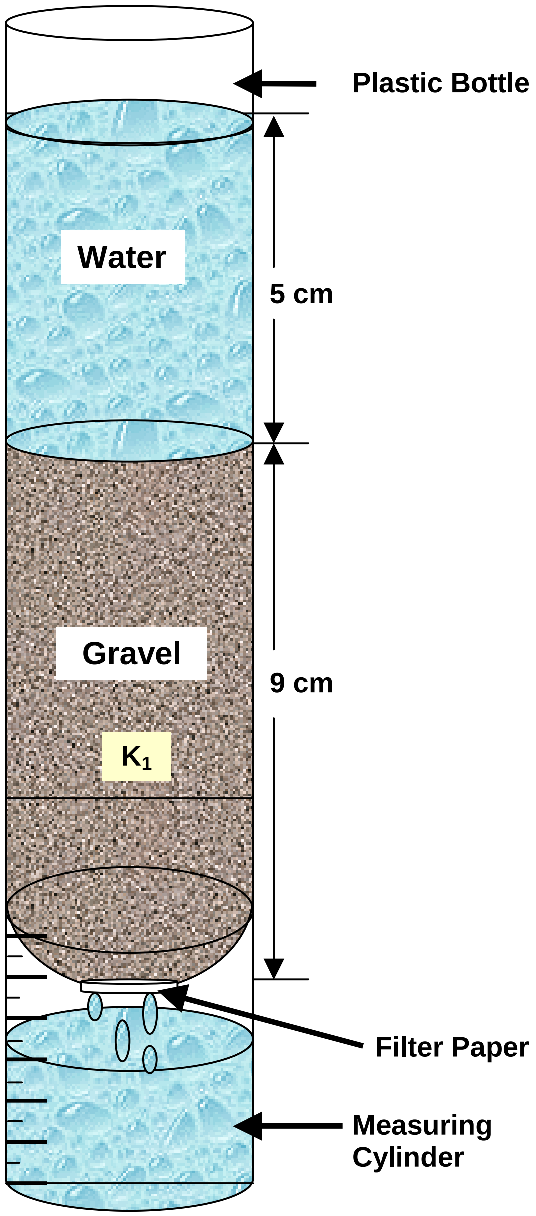

Figure 4

$$K = \frac{(9\ cm)}{\{\frac{9\ cm}{K_1}\}}$$

Soil System 4

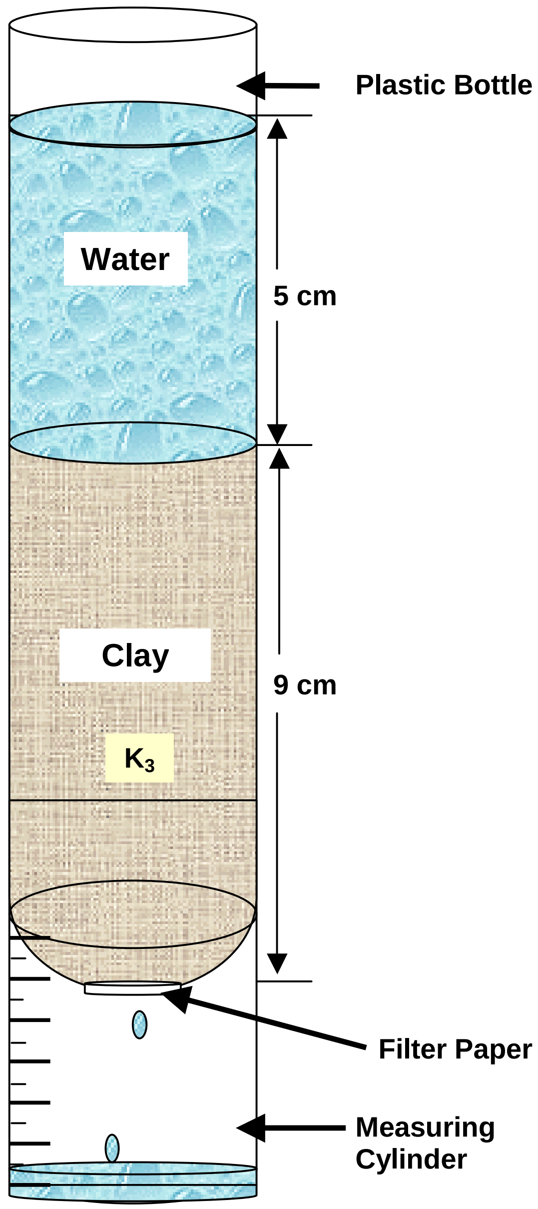

Figure 5

$$K = \frac{(9\ cm)}{\{\frac{9\ cm}{K_3}\}}$$

Soil System 5

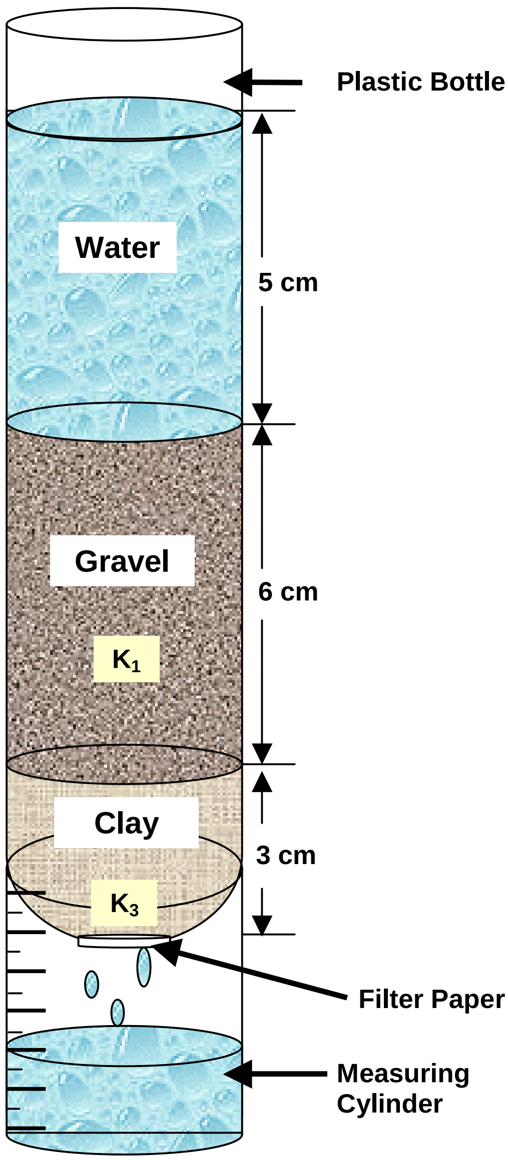

Figure 6

$$K = \frac{(6\ cm + 3\ cm)}{\left\{\frac{6\ cm}{K_1} + \frac{3\ cm}{K_3}\right\}}$$

Soil System 6

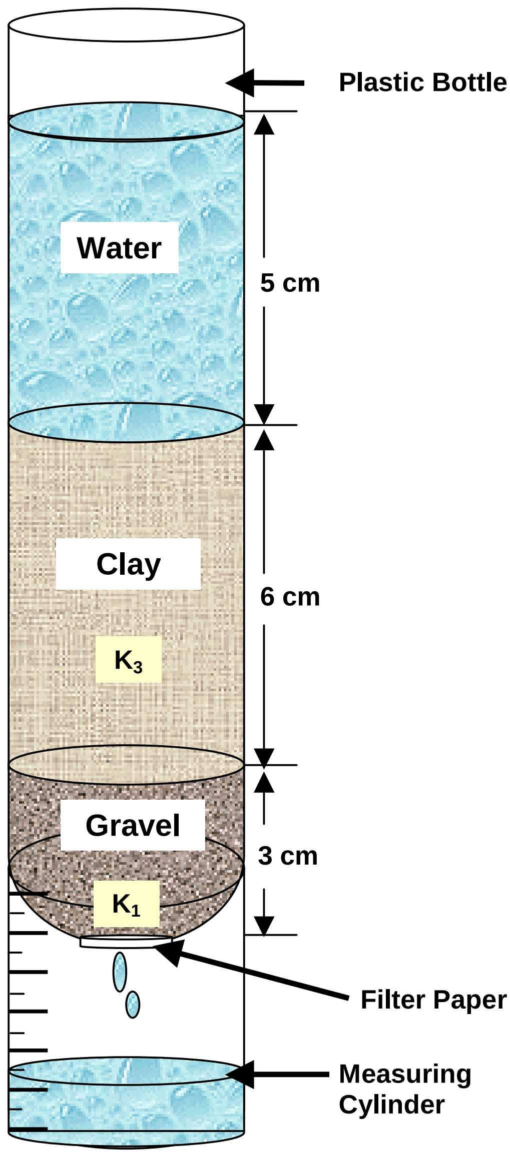

Figure 7

$$K = \frac{(6\ cm + 3\ cm)}{\left\{\frac{6\ cm}{K_3} + \frac{3\ cm}{K_1}\right\}}$$