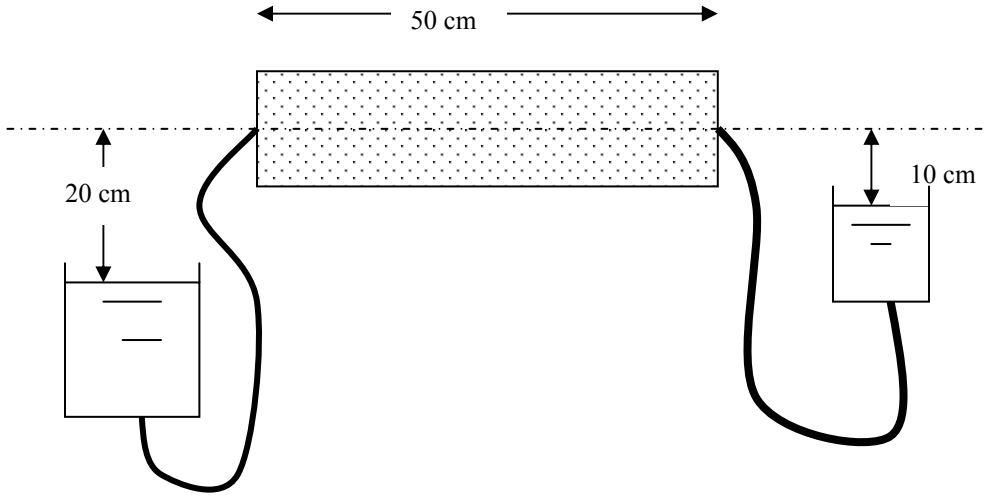
SSC 107
Homework # 4
Date: October 28, 2002
Due date: November 4, 2002

1) The following steady state experimental setup is established in the laboratory. The air entry value of the soil is –30 cm.

a) In which direction is water flowing? Why?
b) Is the total head gradient constant across the column? Why?
c) If the flux through the column is 1.5 cm/day, compute the soil's hydraulic conductivity?
d) How much water is flowing through the soil column in 2 hours? The cross-sectional area of the column is 100 cm^2.
e) If the water level in the left tank drops an additional 30 cm, use a head diagram to graph the approximate change in matric head across the soil column.

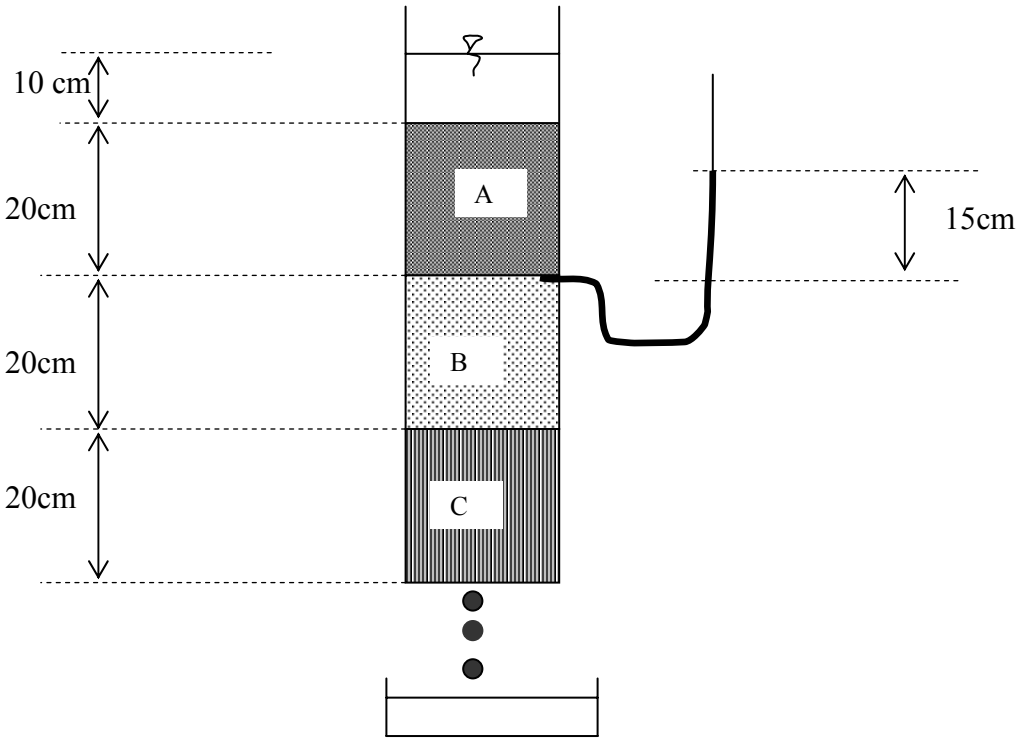


2) Water is applied to the soil surface by sprinklers. The water table is fixed at 1 m below the soil surface. The saturated hydraulic conductivity of the soil is 5 cm/day. At steady state, the sprinkler rate equals the downward flux density everywhere across the soil.

a) Calculate the sprinkler rate in the steady state situation if the depth of the water layer on the soil surface is negligible (h = 0).
b) Under which conditions are H and h linear functions of depth throughout the soil column.
c) Assuming that the air entry value of the soil is not exceeded, draw the head diagram (include h, H and z) for the steady situation with a sprinkler rate of 4 cm/day.
d) Calculate the height of the saturated zone above the groundwater table in the steady situation if the sprinkler rate is 1 cm/day and the air entry value of the soil is –40 cm.

3) The following soil column is prepared in the lab. Water is flowing under steady state conditions. Hydraulic conductivity of soils A and B are 1 cm/day and 0.5 cm/day, respectively. A tensiometer at 20 cm below the top of the soil surface is connected to a water manometer with the reading as indicated.

a. What is the flux through the column?
b. What is the soil water matric head at the boundary between soils B and C?
c. What is the hydraulic conductivity of soil C?
d. How much water will accumulate in the container collecting the effluent in an hour if the cross section of the soil column is 100 cm^2?
e. Plot the matric head, gravitational head and total head as a function of column height.



4) Water is flowing at a steady state rate in a 50 cm long horizontal unsaturated soil column. The soil matric head (h) is 0 cm at the right end and –180 cm at the left end of the soil column. Both heads are maintained throughout the steady state experiment. The saturated hydraulic conductivity (K_{sat}) is 4 cm/day. The unsaturated hydraulic conductivity of the soil at a matric head of –180 cm is one tenth of K_{sat}. The unsaturated hydraulic conductivity, K(h), is given by $K = Ae^{Bh}$

a) Calculate the coefficients A and B
b) Calculate the flux density
c) Find an analytical expression for h as a function of distance x

EXTRA CREDIT QUESTION

A horizontal soil column is connected to a water tank, shaped as a right circular cone (volume is $0.3333\pi r^2 h$, with its radius being a function of height, h). The right end of the soil column is open to the atmosphere, and the soil's saturated hydraulic conductivity is 1.5 cm/hr. The cross sectional area of the soil column is 5 cm^2. How long will it take for the water level in the water tank to drop from point A to point B?