CEE3430 Engineering Hydrology

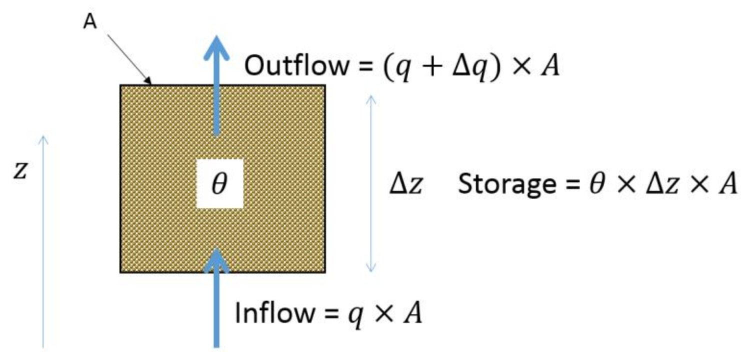
Homework 6. Infiltration

Date: 2/21/14
Due: 2/28/14

Objective.

- Be able to calculate infiltration, cumulative infiltration and time to ponding using the Green-Ampt method as given in Mays Section 7.4

1. The purpose of this question is to lead you through the analytical derivation of Richard's equation so that you understand it to the point where you can derive it on your own. Consider a control volume of unsaturated soil near the surface with cross section area A subject to vertical flow.



(a) Show that the continuity equation determined from rate of change of storage = inflow minus outflow is given by

$$\frac{\partial \theta}{dt} + \frac{\partial q}{dz} = 0 \qquad (1)$$

(b) State the units of θ and q in equation (1).

(c) Darcy's equation gives

$$q = -K \frac{\partial h}{dz} \qquad (2)$$

h may be represented as the sum of suction head, ψ, and elevation head, z, with z measured in the upwards direction,

$$h = z + \psi \qquad (3)$$

Use equation (3) in (2) and equation (2) in (1) to derive the one dimensional form of Richard's equation (Mays 7.4.14 page 313). You will need to introduce $\psi(\theta)$ into your derivation and state what the definition of D is. Refer to pages 311-313, but express this derivation in your own words.

2. Determine the infiltration rate and cumulative infiltration curves (0 to 5 h) at 1-hr increments for a clay loam soil. Assume an initial effective saturation of 20% and continuous ponding. (Mays 7.4.2)

3. Compute the ponding time and cumulative infiltration at ponding for a silty clay soil with a 30 % initial effective saturation, subject to a rainfall intensity of 2 cm/h. (Mays 7.4.5)

4. Mays 7.4.6. Hint: You will need to first determine the time of ponding, then after ponding occurs use a more general form of equation 7.4.22 that accounts for the cumulative infiltration at the time of ponding

$$F - F_p - \psi \Delta\theta \ln\left(\frac{F + \psi\Delta\theta}{F_p + \psi\Delta\theta}\right) = K\left(t - t_p\right)$$

5. Mays 7.4.14. Assume continuous ponding conditions.