Lesson 14: Green-Ampt Infiltration Equation

Example

A constant rainrate storm (2 cm/hr for 4 hours) falls on a silt loam soil with an effective saturation of 30%. Determine the infiltration rate (f) and cumulative infiltration (F) at time t= 1 hr. Determine the time (t) and infiltration rate (f) when the cumulative infiltration F = 6 cm.

Solution

The appropriate Green-Ampt parameters for a silt loam soil are (Table 4.3.1):

$\theta_e = 0.486$

$\psi = 16.68$ cm

$K = 0.65$ cm/hr

$\Delta\theta = (1 - s_e)\ \theta_e = (1 - 0.3)\ 0.486 = 0.340$

$\psi\Delta\theta = 0.340\ (16.68\text{ cm}) = 5.67$ cm

The conditions at ponding are:

$$t_p = \frac{K\psi\Delta\theta}{i(i-K)} = \frac{0.65(5.67)}{2(2-0.65)} = 1.366\text{ hr}$$

$F_p = it_p = (2\text{ cm/hr})(1.366\text{ hr}) = 2.732$ cm

$$t_0 = 1.366 - \frac{1}{0.65}\left[2.732 - 5.67\ln\left(1 + \frac{2.732}{5.67}\right)\right] = 0.594\text{ hr}$$

Infiltration at t = 1 hr? Since t_p > 1 hour, the infiltration at t = 1hour (before ponding) is:

$f = i = 2$ cm/hr

$F = it = (2\text{ cm/hr})(1\text{ hr}) = 2$ cm

Time (t) and infiltration rate (f) for F = 6 cm? Since F_p < 6 cm (after ponding):

$$t - t_0 = \frac{F}{K} - \frac{\psi\Delta\theta}{K}\ln\left(1 + \frac{F}{\psi\Delta\theta}\right)$$

$$t = 0.594 + \frac{6}{0.65} - \frac{5.67}{0.65}\ln\left(1 + \frac{6}{0.65}\right) = 3.528\text{ hr}$$

$$f(3.528) = K\left[\frac{\psi\Delta\theta}{F(t)} + 1\right] = 0.65\left[\frac{5.67}{6} + 1\right] = 1.264\text{ cm/hr}$$