Green-Ampt Infiltration 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 7.4.1):

θ_e= 0.486

ψ = 16.68 cm

K = 0.65 cm/hr

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

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

The conditions at ponding are:

$$t_p = \frac{Ky\,\Delta q}{i(i-K)} = \frac{0.65(5.67)}{2(2-0.65)} = 1.366\ \text{hr}$$

$F_p = i\,t_p = (2\ \text{cm/hr})(1.366\ \text{hr}) = 2.732\ \text{cm}$

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

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 cm/hr)(1 hr) = 2 cm

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

$$F(t) = K(t - t_0) + y\,\Delta q\ln\left[1 + \frac{F(t)}{y\,\Delta q}\right]$$

$$6 = 0.65(t - 0.594) + (5.67)\ln\left[1 + \frac{6}{5.67}\right]$$

$$0.65(t - 0.594) = 6 - (5.67)\ln\left[1 + \frac{6}{5.67}\right] = 1.907$$

$$t = (1.907 / 0.65) + 0.594 = 3.528\ \text{hr}$$

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