Lecture 12 **31-January-2013**

Green – Ampts Infiltration

Properties of GA Parameters

The parameters are: → Hydraulic conductivity K

Porosity, ε

Wetting front soil suction head ψ

(Only magnitude)

Various scientists have studied the relationships between moisture content θ and suction head ψ as well as ~~hydra~~ θ and K.

In soils you can define the term

$$\text{Saturation}, \ \sigma = \frac{\text{Volume of water}}{\text{Volume of voids}}$$

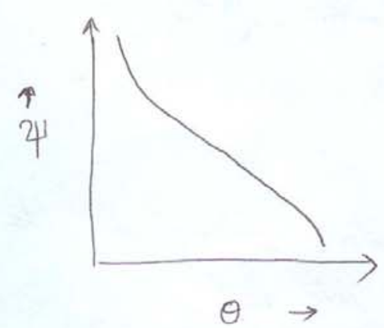
$$0 < \sigma < 1.0$$

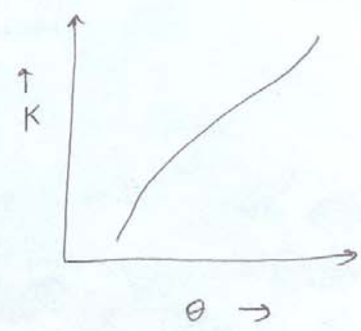
$$\therefore \ \theta = \sigma \varepsilon$$

$$\text{Effective saturation}, \ \sigma_e = \frac{\theta - \theta_r}{\varepsilon - \theta_r} \quad \left(\text{or} = \frac{\sigma - \sigma_r}{1 - \sigma_r} \right)$$

$\theta_r \rightarrow$ Residual moisture content

There are
→ Brooks and Corey relations, etc.
→ Van Genuchten relations, etc





Q: If the soil ~~layer~~ considered for infiltration have multiple layers, how the infiltration equation looks?
→ We are going to ask you in TUTORIAL.

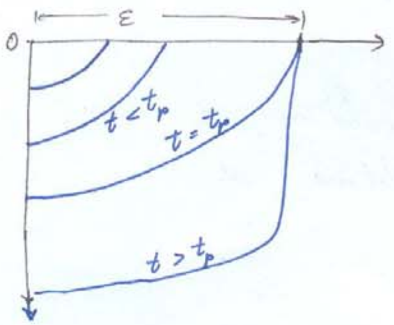
Infiltration due to Ponding

→ Earlier we assumed ponding depth $h_0 \approx 0.0$
→ What happens if it is not negligible?

⑥

* During rainfall, if the intensity of rain > infiltration capacity of soil → ponding occurs.

* Ponding will start only after certain time when the top portion gets completely saturated.
* This time is called ponding time t_p.



Consider a dry soil

We can find an expression for ponding time.
(Mein and Larson, 1973)

We are using G A model.

There are three principles

(i) ~~Bef~~ Before ponding of water occurs, all the rainfall water is infiltrated into soil.

(ii) The potential infiltration rate is function of cumulative infiltration.

(iii) Ponding occurs when potential infiltration < rainfall intensity.

$$f = K\left(\frac{\psi \Delta\theta}{F} + 1\right)$$

$\Rightarrow$ Before ponding, $f = i = K\left(\dfrac{\psi\Delta\theta}{F} + 1\right)$

Now $F = it$, $\quad \therefore \; i = K\left[\dfrac{\psi\Delta\theta}{it} + 1\right]$

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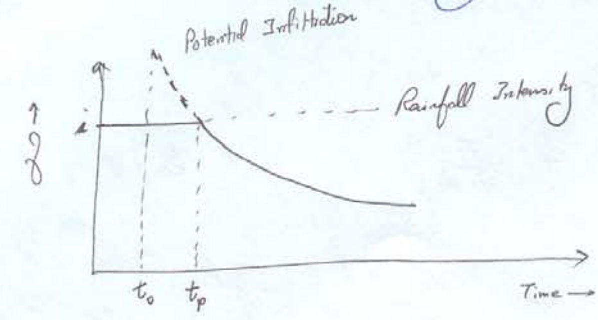

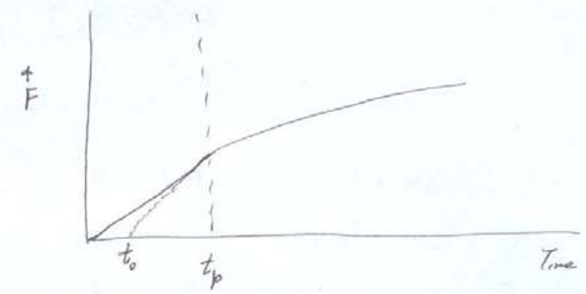

→ From the diagram here

At the ponding time beginning

$$F = i t_p$$

$$\therefore i = K\left(\frac{\psi \Delta\theta}{i t_p} + 1\right)$$

or $$\boxed{t_p = \frac{K \psi \Delta\theta}{i(i - K)}}$$

→ This is ponding time for constant rainfall.

Q: How will you obtain infiltration rate after ponding?

→ Let us extend the cumulative infiltration curve from t_p backwards. It intersects at time $t_o < t_p$.

→ If the infiltration rate curve f vs t is also extended backwards upto time t_o, then the theoretical explanation can be given.

From $t_o < t < t_p$ → Assumed Infiltration occurs at potential infiltration rate of f

→ The amount infiltrated during $t_o < t < t_p$ should be equal to it

$F = F_p$ (ie. within the time t_o to t_p)

$\therefore$ At $\Delta t = t_p - t_o$,

Using the curved infiltration rate f_θ:

$$F_p - \psi \Delta\theta \ln\left(1 + \frac{F_p}{\psi \Delta\theta}\right) = K(t_p - t_o)$$

Note: $F_p = i t_p$

In $t > t_p$,

$$F - 2\psi\Delta\theta \ln\left(1 + \frac{F}{2\psi\Delta\theta}\right) = K(t - t_o)$$

$$\therefore \quad F - F_p - 2\psi\Delta\theta\left[\ln\left(\frac{2\psi\Delta\theta + F}{2\psi\Delta\theta}\right) - \ln\left(\frac{2\psi\Delta\theta + F_p}{2\psi\Delta\theta}\right)\right]$$

$$= K(t - t_p)$$

Note: $\underline{\underline{F_p}} = i t_p$.

$$\text{or} \quad F - F_p - 2\psi\Delta\theta \ln\left[\frac{2\psi\Delta\theta + F}{2\psi\Delta\theta + F_p}\right] = K(t - t_p)$$

$$\sim F = i t_p + 2\psi\Delta\theta \ln\left[\frac{2\psi\Delta\theta + F}{2\psi\Delta\theta + i t_p}\right] + K(t - t_p)$$