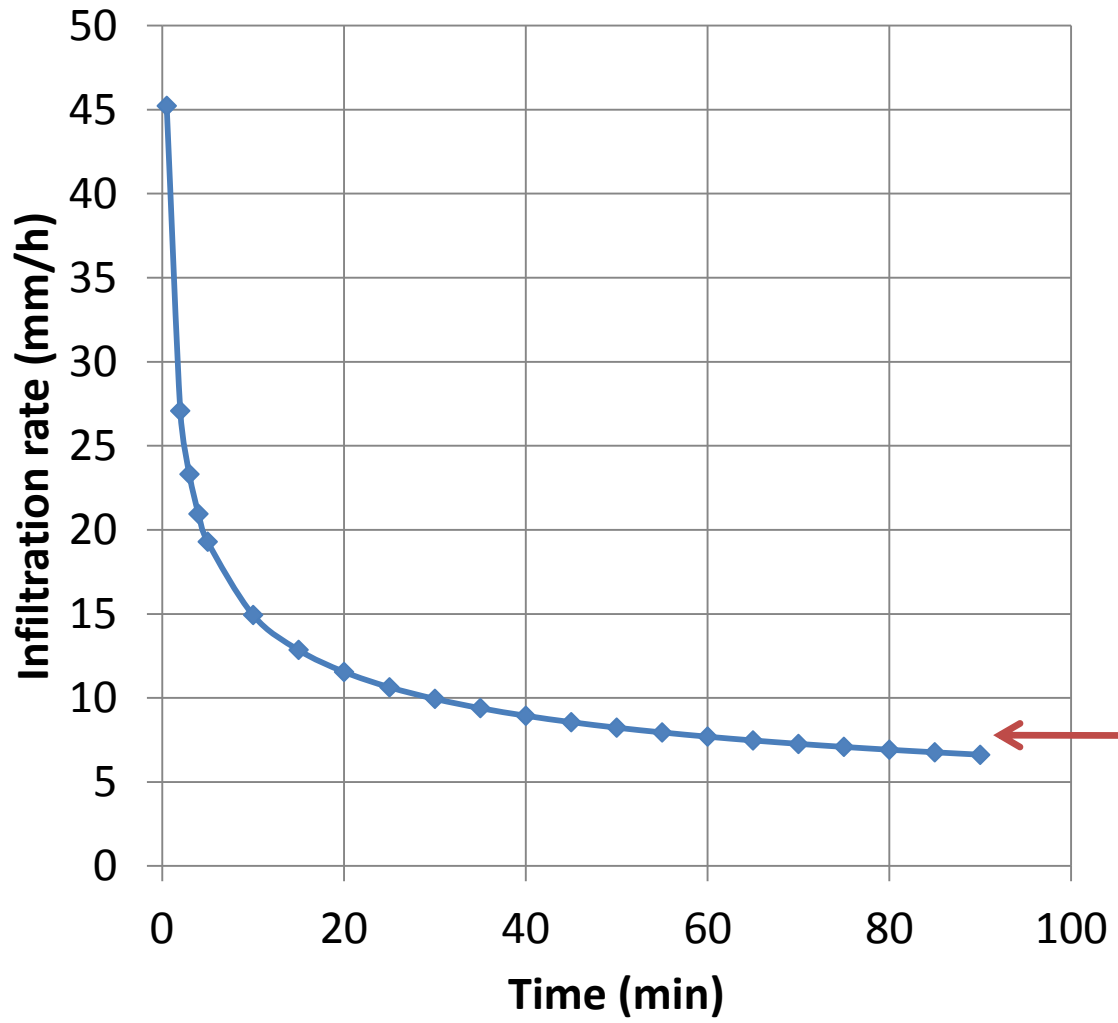# Infiltration

Prof. M.M.M. Najim

- Learning Outcomes:

At the end of this section, the students will be able to

- explain the factors affecting infiltration

- apply the Kostiakov's equation to calculate the infiltration rate

- apply infiltration indices to calculate the depth (amount) of runoff generated from a rainfall

- Flow of water through soil surface
- Important in hydrology as it influences the runoff, transpiration, evaporation.
- Rate of infiltration decreases with time and become constant – basic infiltration rate (infiltration capacity)

basic infiltration rate
(infiltration capacity)
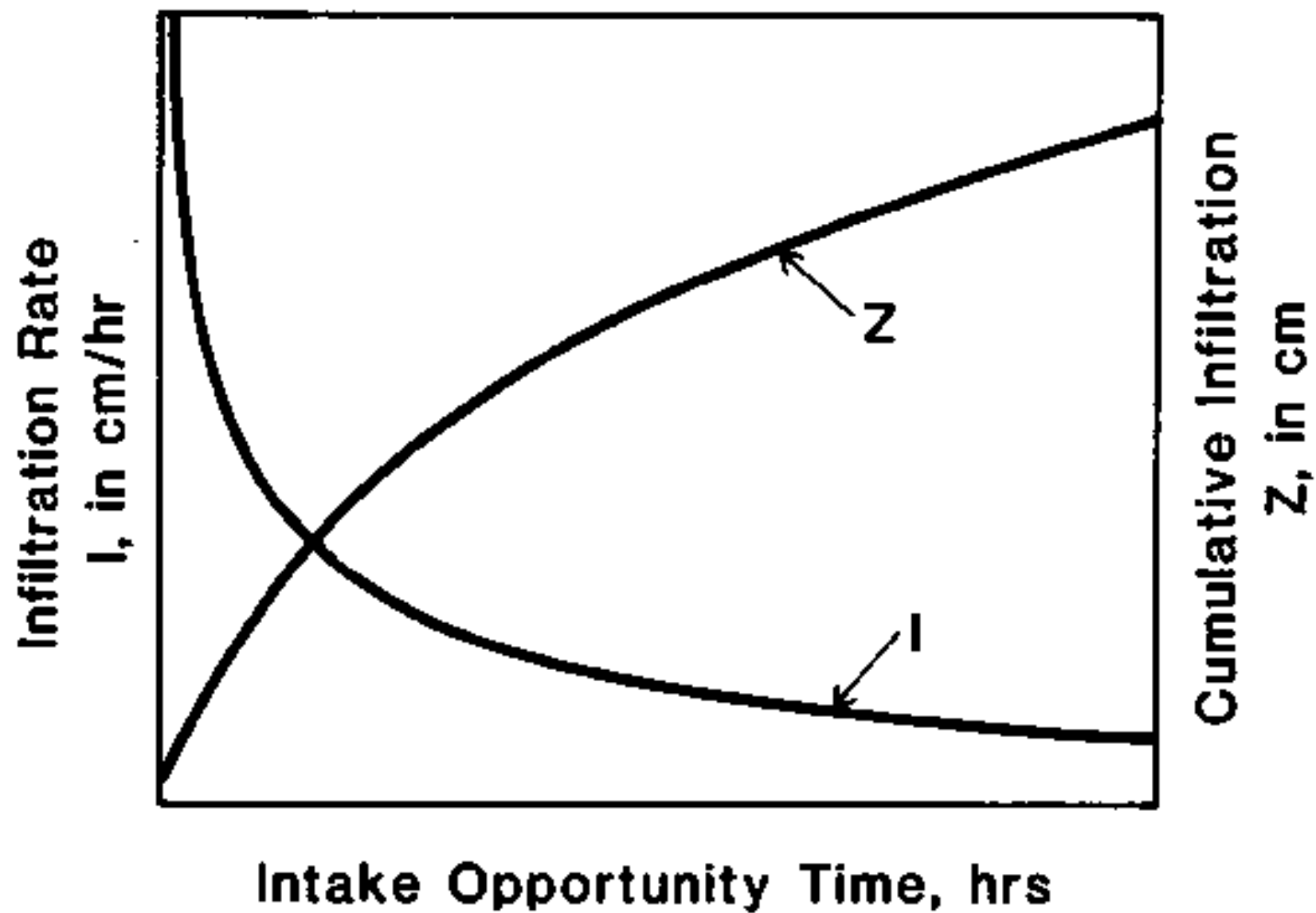
Factors affecting infiltration

- Rainfall
  - Intensity
    - Intensity < infiltration capacity, all the rain infiltrate
    - Heavy intensive rain – bigger raindrops compress soil surface – reduce infiltration
    - Intensity more – more erosion – more clogging of soil – less infiltration
  - Duration
    - More the duration lesser the rate
- Temperature
  - Higher the temperature more infiltration (viscosity of watyer decrease)

- Soil characters
  - Soil type
    - light texture soil (sand) – more infiltration, heavy texture soil (clay) – less infiltration
  - compaction
    - Compacted soil (vehicles, animals, raindrops etc) – less infiltration
  - Depth to water storage
    - Depth more – infiltration more
  - Sun cracks
    - More cracks – more infiltration

- Soil slope
  - Steep slopes – runoff velocity high – less infiltration due to very little time water stay at a place
  - Gentle slopes or flat land – more infiltration
- Soil moisture
  - More moisture in soil – less infiltration (more water stored in soil, swelling of clay)

- Cultivation Practices
  - Closely growing vegetation – protect soil against compaction and erosion
  - Land preparation – increased roughness – increase infiltration; disturbed soil structure increase infiltration

- Surface cover
  - Vegetation type
    - Cover increases infiltration due to increased resistance
    - Vegetation reduces compaction
    - Pasture – more infiltration, row crop – less infiltration
  - Organic matter on surface
    - Dissipate kinetic energy of rain drops
    - Keeps water and allows movement to ward soil
  - Urban paving
    - Impervious layers decrease infiltration

- Climatic factors
  - Temperature
  - Increased microbial activity and reduce surface tension – increased infiltration
- Other factors
  - Water quality
    - Sediments in water clog the pores and reduce infiltration
    - Salts in water affect viscosity and swelling of clays

Infiltration equations

- Kostiakov's equation

$$I = k\,t^{n}$$

I = Cumulative depth of infiltration

t = time

k and n are constants

$$i = \frac{dI}{dt} = n\,k\,t^{n-1}$$

i = infiltration rate

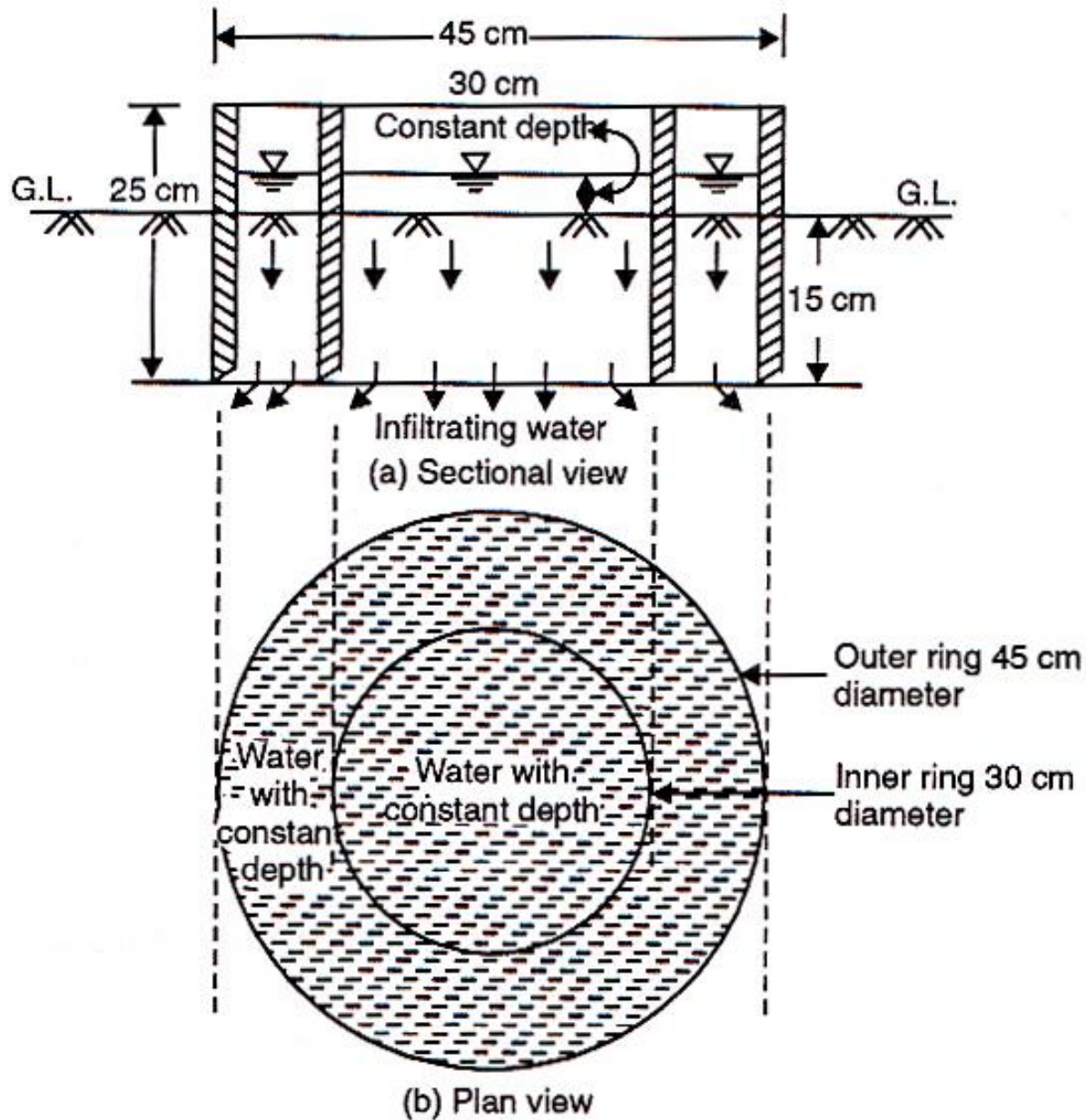# Measurement of infiltration

- Double ring infiltrometer

- Clean the surface vegetation without disturbing soil surface

- Rings driven into 15 cm

- Put a plastic / polythene sheet to inner ring and fill water on that for a particular depth

- Water poured into outer ring and allow it to infiltrate

- Remove the plastic sheet from the inner ring and start recording depth with time
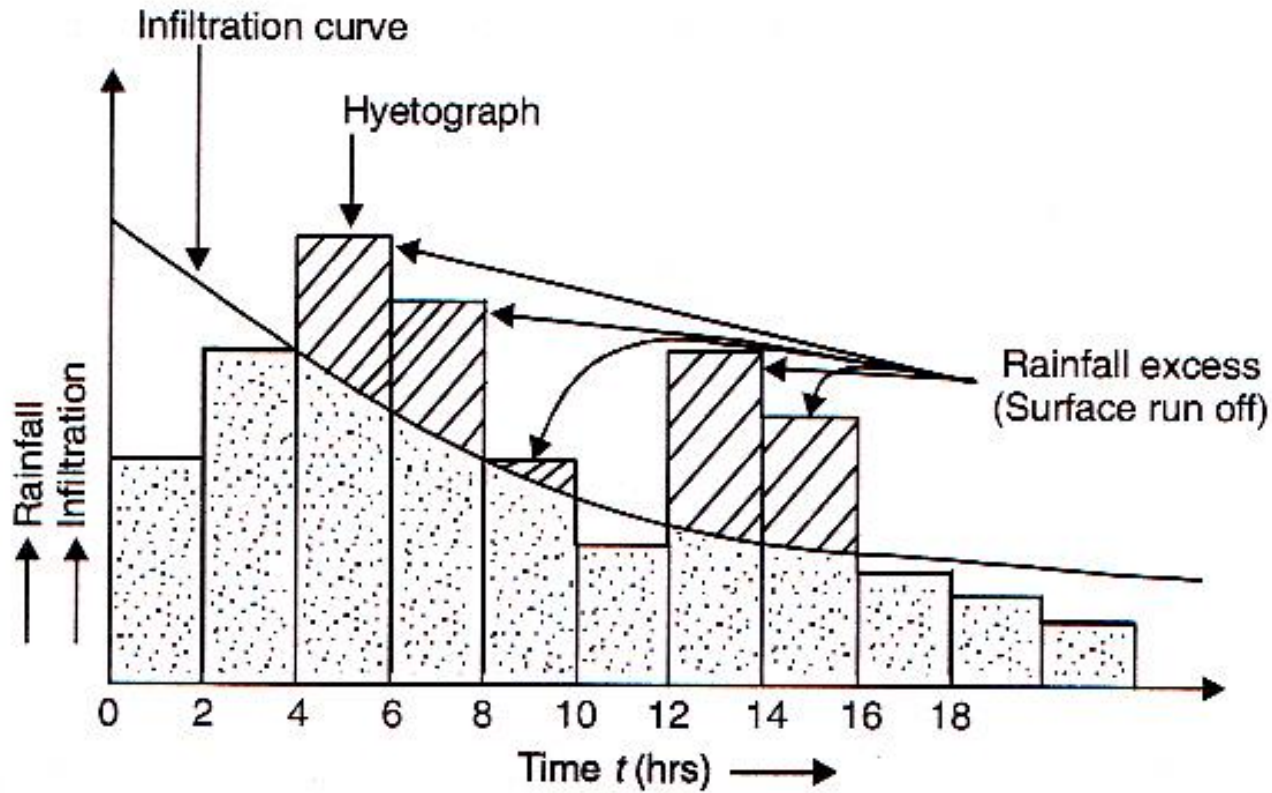
45 cm

30 cm

Constant depth

G.L. 25 cm

G.L.

15 cm

Infiltrating water
(a) Sectional view

Outer ring 45 cm diameter

Water with constant depth

Water with constant depth

Inner ring 30 cm diameter

(b) Plan view

- Double ring infiltrometer

Infiltration indices

- Constant infiltration rate is know infiltration index

Relationship between infiltration, rainfall and runoff.

- Area above the infiltration curve is runoff
- In order to simplify the infiltration rate, infiltration indices with constant infiltration rate is used
- infiltration rate is assumed to be constant throughout the rain
- Φ-index – average rainfall intensity above which rainfall volume is equal to runoff volume (Φ = Phi)

Definition sketch of φindex
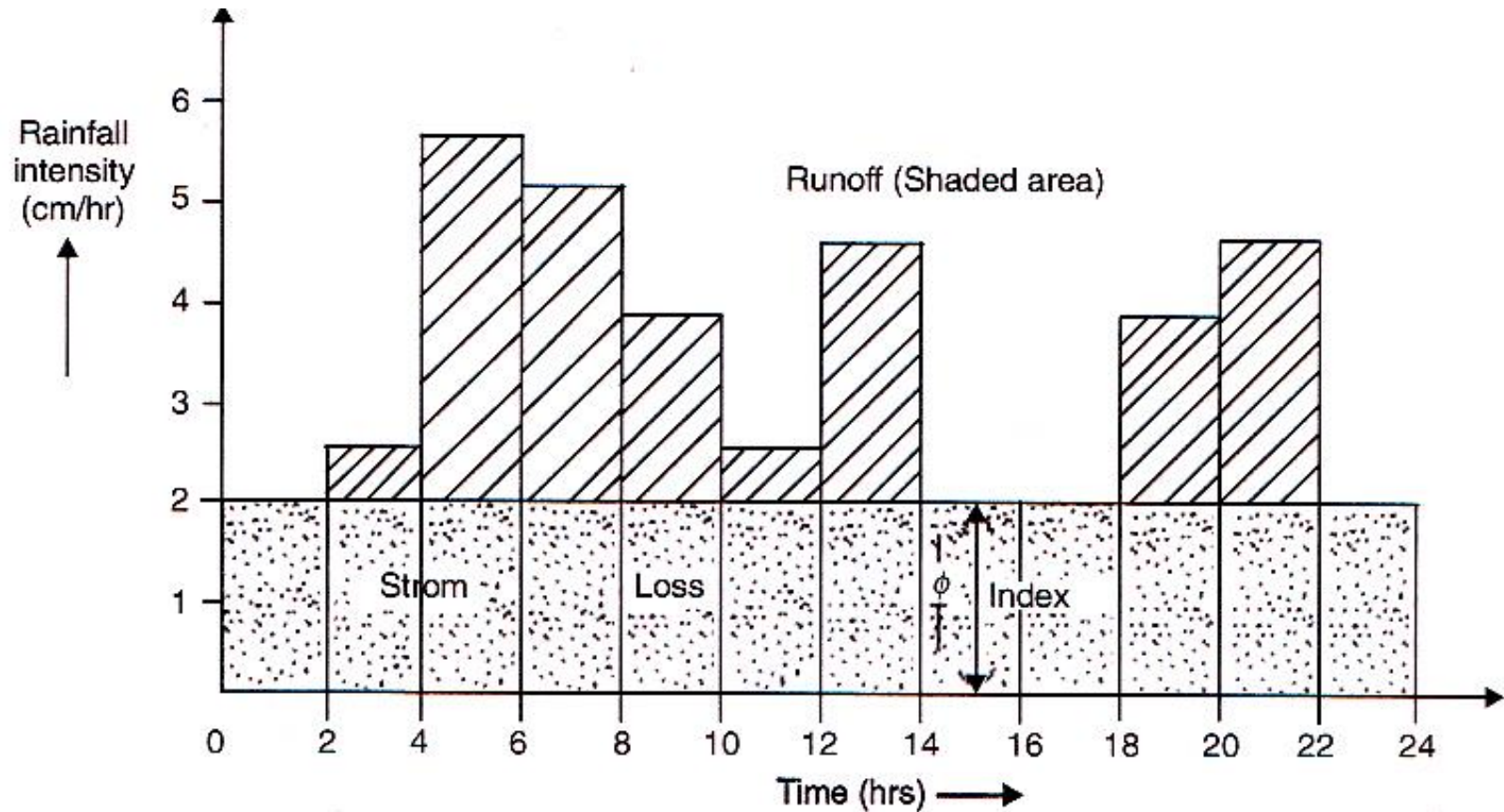
$$\phi \ index = \frac{\text{All losses due to infiltration}}{\text{Duration of rainfall}}$$

$$= \frac{\text{Area under the line}}{\text{Duration of rainfall}}$$

- W-index

$$W - index = \frac{P - Q - S}{t_r}$$

- P – total rainfall, Q = surface runoff, S – effective surface retention, t_r – duration of rainfall

- Example calculations : 4.1 (Page 50), 4.2 (Page 51), 4.4 (Page 52) – Hydrology by Das and Saikia