BYJU'S EXAM PREP

Infiltration Indices

Infiltration indices are the parameters for measuring the various infiltration losses that occur through various means. The process of water entering the soil is called infiltration. The infiltration occurs on the ground surface. Below the surface, the penetration further is called percolation. Whatever rainfall occurs on the surface of the earth, some quantities infiltrate.

The topic of Infiltration indices comes in the topic of Infiltration and Runoff chapter of the GATE CE syllabus. The infiltrated quantities may further penetrate as percolation. If the voids in the soil are only partially filled by water during this percolation, it is called unsaturated flow. You have studied unconfined and confined flows in aquifers. Those flows are saturated, and these flows have all voids occupied by water. The water table is the interface between the saturated and unsaturated flow.

Horton's Equation for the Measurement of Infiltration Indices

Horton observed that the infiltration capacity reduced exponentially from an initial maximum rate f_0 to a final constant rate f_c. Horton expressed the decay of infiltration capacity with time as an exponential decay given by

$$f = f_c + (f_o - f_c)\, e^{-kt}$$

Where,

- f = infiltration capacity at any time t from the start of the rainfall
- f_o = initial infiltration capacity at t = 0
- f_c = final steady-state value
- t_d = Duration of rainfall
- k_h = Horton's constant depending on the soil.

Types of Infiltration Indices

In hydrological calculations involving floods, it is found convenient to use a constant value of filtration rate for the storm's duration. The defined average infiltration rate is called the infiltration index. Also, this is the average infiltration rate during the time when the rainfall intensity exceeds the infiltration rate. Based on these parameters, infiltration indices can be classified as the W-index and the φ - index.

The W – index can be derived from the observed rainfall and runoff data. It differs from the φ - index because it excludes surface storage and retention.

(i) **W-index**

In an attempt to refine the φ-index, the initial losses are separated from the total abstractions, and an average value of infiltration rate, called W-index, is defined as

W-index = $(P-R-I_a)/t_e$

Where

- P = Total storm precipitation (cm)
- R = Total storm runoff (cm)
- I_a = initial losses (cm)
- t_e = Duration of rainfall excess

W-index = Avg. rate of infiltration (cm/hr)

(ii) **φ-index**

The φ index is the average rainfall above which the rainfall volume equals the runoff volume. The φ index is derived from the rainfall hyetograph with the edge of the resulting run-off volume.

φ-index = $(I-R)t_e$

Runoff and its Affecting Factors

Runoff can be described as the part of the water cycle that flows over land as surface water instead of being absorbed into groundwater or evaporated. It thus represents the output from the catchment in a given unit of time. There are a variety of factors that affect runoff. Some of those are explained below.

Amount of Rainfall

The amount of rainfall directly affects the amount of runoff. As expected, if more rainfall hits the ground, more rainfall will turn into a runoff. The same can be said about snowmelt. If a large amount of snow melts quickly, there will be a large amount of runoff.

Permeability

The ability of the ground surface to absorb water will affect how much surface runoff occurs. If you have ever poured water onto the sand, you may have noticed it sinks into it almost instantaneously. On the other hand, if you pour water on the street, the water will not sink but run off to the gutter or a ditch. The less water the ground can absorb, the more runoff on the surface there will be. This is called permeability.

A surface with high absorption ability has high permeability, and a surface with low absorption ability has low permeability.

Vegetation

Vegetation needs water to survive, and a plant's root system is designed to absorb water from the soil. There is less runoff in highly vegetated areas because the water is used by the plants instead of flowing off the ground's surface.

Slope

The surface slope is also important to the amount of runoff. The steeper a surface is, the faster it will flow down the slope. A flat surface will allow the water time to absorb.

Base Flow and Direct Runoff

Base flow and direct runoff are the water present in the river streams after the losses. These are explained below.

Direct Runoff

The part of runoff which enters the stream quickly after the rainfall or snow melting. To design a soil conservation structure with proper capacity, it is necessary to estimate the peak runoff rate. It includes surface runoff, prompt interflow and rainfall on the stream's surface. In the case of snow melt, the resulting flow entering the stream is also a direct runoff; sometimes, terms such as direct storm runoff are used to designate direct runoff.

Base Flow

Base flow (also called drought flow, groundwater recession flow, low flow, low-water flow, low-water discharge and sustained or fair-weather runoff) is the portion of stream flow that comes from "the sum of deep subsurface flow and delayed shallow subsurface flow. Also, the delayed flow reaches a stream essentially as groundwater flow is called base flow.

(i) Direct runoff = surface runoff + Prompt interflow

(ii) Direct runoff = Total runoff- Base flow

(iii) Form Factor A/l^2 where A = Area of the catchment and l is the axial length of the basin.

(iv) Compactness coefficient = $P/2\pi r_e$; and $r_e = \sqrt{(A/\pi)}$

r_e = Radius of an equivalent circle whose Area is equal to the area of the catchment (A)

(v) Elevation of the watershed, (z)

$$Z = \frac{A_1Z_1 + A_2Z_2 + ... + A_nZ_n}{A_1 + A_2 + ...A_n}$$

Where, A_1, A_2 … Area between successive contours.

Z_1, Z_2 … mean elevation between two successive contours.

Methods of Computing Runoff

Various methods are developed to calculate runoff generated for a particular storm. These include theoretical methods and analytical methods. Some of these are discussed below.

(i) By Runoff coefficient

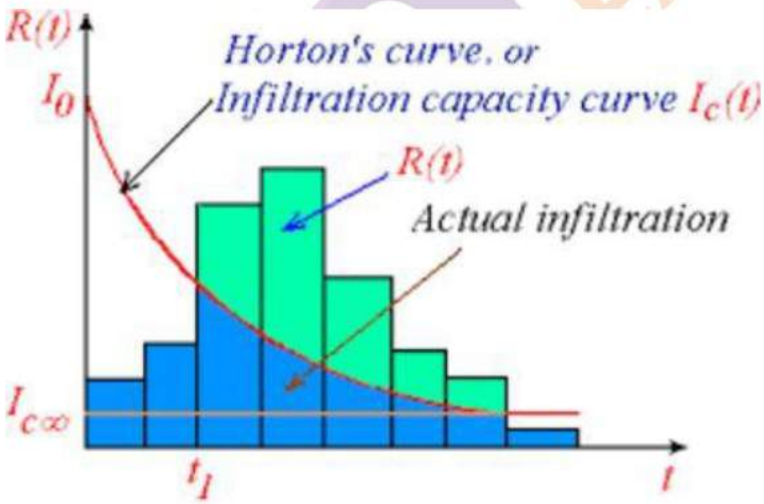
Q = KP where, p = precipitation

K = Runoff coefficient

Q = Runoff

(ii) By infiltration Capacity Curve

Runoff due to a particular storm can also be determined with the help of Horton's curved method. These are explained below.



(iii) By Rational Formula

$Q_P = (1/36)\ kP_CA$