MODULE 2

LOSSES FROM PRECIPITATION

The hydrological equation states that ‗Runoff = Rainfall – Losses'. Hence the runoff from a watershed resulting due to a storm is dependent on the losses. Losses may occur due to the following reasons

1. Evaporation
2. Evapotranspiration
3. Infiltration
4. Interception
5. Watershed leakage

The first three contribute to the major amount of losses.

2.1 EVAPORATION

2.1.1 INTRODUCTION

It is the process by which a liquid changes to gaseous state at the free surface through transfer of heat energy. In an exposed water body like lakes or ponds, water molecules are in continuous motion with arrange of velocities (faster at the top and slower at the bottom). Additional heat on water body increases the velocities. When some water molecules posses' sufficient kinetic energy they may cross over the water surface. Simultaneously the water molecules in atmosphere surrounding the water body may penetrate the water body due to condensation. If the number of molecules leaving the water body is greater than the number of molecules arriving or returning, difference in vapour pressure occurs, leading to evaporation.

2.1.2 EVAPORATION PROCESS

When the external thermal energy supplied to surface of water body, the kinetic energy of water molecules will be increased. When the molecules near the free surface attain enough kinetic energy, they escape from the water body they eject themselves in to the atmosphere. Out of total atmospheric pressure on the free surface there will be some contribution from the vapour molecules present in the free surface. This partial pressure exerted by the vapour is called vapour pressure. Continued supply of heat energy causes accumulation of more and more vapour molecules and thus gaseous medium can no longer accommodate and reject vapour molecules in the form of condensation at the same rate as vaporization. At this stage the air is said to be saturated. At saturation the partial pressure exerted by water vapour is called the saturation vapour pressure and denoted by (e_s) which increase with temperature.

Thus if vapour pressure of air above free surface of water is already equal to the saturation vapour pressure (e_s) neither evaporation no condensation takes place and then it is called as equilibrium state.

From the above explanation for evaporation to occur it is necessary to have:

(1) A supply of water
(2) A source of heat
(3) Vapour pressure deficit, i.e difference b/w saturated vapour pressure of water correspond to water temperature.

2.1.3 FACTORS AFFECTING EVAPORATION

1. Vapour pressure difference: The number of molecules leaving or entering a water body depends on the vapour pressure of water body at the surface and also the vapour pressure of air. Higher water temperature leads to high vapour pressure at surface and tends to increase the rate of evaporation. High humidity in air tends to increase vapour pressure in air and in turn reduces rate of evaporation.

2. Temperature of air and water: The rate of emission of molecules from a water body is a function of its temperature. At higher temperature molecules of water have greater energy to escape. Hence maximum evaporation from water bodies takes place in summer. It has been estimated that for every 1o C rise in atmospheric temperature increases 5 cm of evaporation annually.

3. Wind Velocity: When wind velocity is more the saturated air (humid air) is drifted away and dry air comes in contact with water surface which is ready to absorb moisture. Hence rate of evaporation is dependent on wind velocity. It has been estimated that 10% increase in wind velocity increases 2 – 3% of evaporation.

4. Quality of water: The rate of evaporation of fresh water is greater than saline water. (Specific gravity of saline water is greater than that of fresh water. It is established that saline water has lesser vapour pressure and it is observed that evaporation from fresh water is 3 – 4% more than sea water.

5. Atmospheric pressure and Altitude: Evaporation decreases with increase in atmospheric pressure as the rate of diffusion from water body into the air is suppressed. At higher altitude the atmospheric pressure is usually lesser and there by evaporation rate is higher.

6. Depth of water body: Evaporation shallow water bodies is greater when compared to deep water bodies as the water at lower levels in deep water bodies is not heated much and vapour pressure at lower levels is also reduced.

7. Humidity: If the humidity of the atmosphere is more the evaporation will be less because during the process of evaporation, water vapour, moving from the point of higher moisture content to lower moisture content and rate of this movement is grounded by this difference of their moisture content or moisture gradient existing in air.

8. Radiation: Since the evaporation requires continuous supply of energy which is derived mainly from solar radiation. The radiation will be a factor of considerable importance. Evaporation increase and the radiation increases and vice versa.

2.1.4 DALTONS LAW OF EVAPORATION

The rate of evaporation is function of the difference in vapour pressure at the water surface and the atmosphere. Dalton's law of evaporation states that ―Evaporation is proportional to the difference in vapour pressures of water and air.

i.e. $E \alpha (e_w - e_a)$ or $E = k (e_w - e_a)$

Where, E = daily evaporation

e_w = saturated vapour pressure of water at a given temperature

e_a = vapour pressure of air

k = proportionality constant

Considering the effect of wind Dalton's Law is expressed as $E = k^l (e_w - e_a)(a+b*V)$

Where, V = wind velocity in km/hour k^l, a & b are constants for a given area.

2.1.5 MEASUREMENT OF EVAPORATION

In order to ensure proper planning and operation of reservoirs and irrigation systems estimation of evaporation is necessary. However exact measurement of evaporation is not possible. But the following methods are adopted as they give reliable results.

- Pan measurement methods
- Use of empirical formulae
- Storage equation method
- Energy budget method

PAN MEASUREMENT METHOD

Any galvanized iron cylindrical vessel of 1.2 m to 1.8 m diameter, 300 mm depth with opening at the top can be used as an evapometer or evaporation pan. During any interval of time evaporation is measured as the drop in water level in the pan. Rainfall data, atmospheric pressure data, temperature, etc should also be recorded. It has been correlated that evaporation from a pan is not exactly the same as that taking place from a water body. Hence while using a pan measurement data for measuring evaporation from a lake or a water body, a correction factor has to be applied or multiplied by a pan co-efficient.

Pan co-efficient = (actual evaporation from reservoir / measured evaporation from pan)

The evaporation pans adopted in practice have a pan coefficient of 0.7 to 0.8.

The popularly used evaporation pans are:

1. ISI standard pan or Class A pan
2. US Class A pan
3. Colorado sunken pan
4. US Geological Survey floating pan

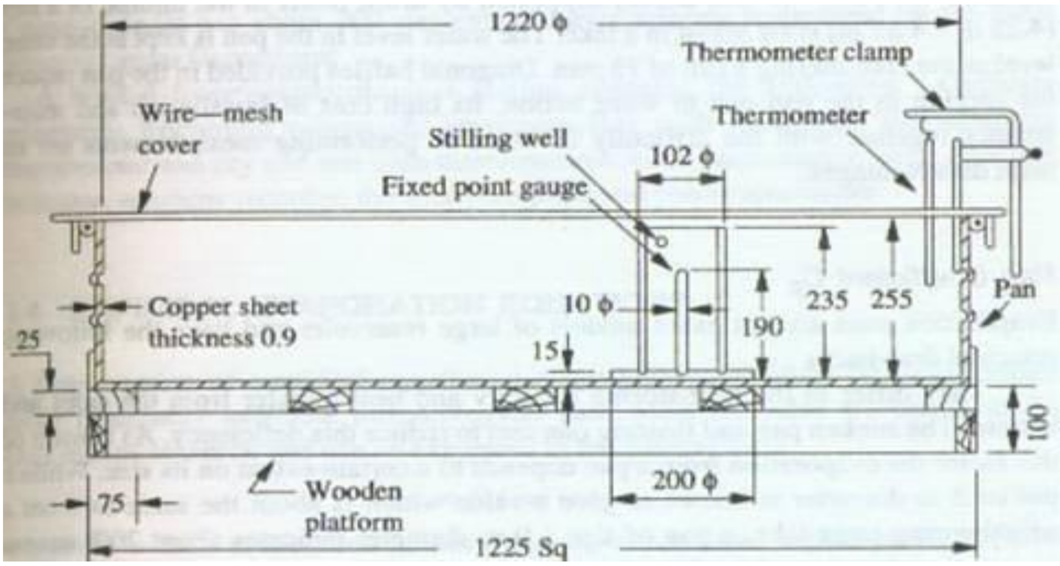


Fig: ISI standard pan or Class A pan

This evaporation pan should confirm to IS – 5973:1976 and is also called Class A pan. It consists of a circular copper vessel of 1220 mm effective diameter, 255 mm effective depth and a wall thickness of 0.9 mm. A thermometer is assembled to record the variation in temperature. A wire mesh cover with hexagonal openings is provided at the top to prevent entry of foreign matter. A fixed gauge housed in a stilling well as shown in figure is provided. During evaporation measurement a constant water level is maintained at the top level of fixed gauge. For this purpose water has to be added or removed periodically. The water level measurements are done using micrometer hook gauge. The entire assembly is mounted on a level wooden platform.

PAN CO-EFFICCIENT

Evaporation pans are not exact models of large reservoirs or lakes, because of the exposure conditions which are not identical in both the cases. Specially the heat storing capacity and the heat transformed from the side & bottom of pan are quite different from those of large lake are reservoir, also the height of the rim above the water surface in the pan effects the wind action over the surface and creates a shadow of variable magnitude over water surface which effects radiation incident to the water surface. In view of the above evaporation measured from the pans has to be corrected to get the evaporation from the lake under a similar climatic exposure condition. Thus a co-efficient called pan co-efficient is introduced and is given by:

Pan Co-efficient (Cp) = (Actual evaporation from the lakes or reservoirs/ Measured evaporation from the pan)

The pan co-efficient for different types of pans are tabulated below:-

Type of Pan	Range of Cp	Average Cp
ISI Pan	0.65-1.0	0.80
Class A load pan	0.60-0.80	0.70
Colorado Sunken pan	0.75-0.86	0.78
Floating Pan	0.70-0.80	0.80

2.1.6 USE OF EMPIRICAL FORMULAE

Based on Dalton‘s law of evaporation, various formulae have been suggested to estimate evaporation.

1. Meyer‘s formula:

$$\mathbf{E = C*(e_s - e_a)*(1+0.06215V)}$$

Where, E = evaporation from water body (mm/month)

e_s= saturation vapour pressure at water surface (mm of mercury) corresponding to mean monthly temperature of water

e_a= actual vapour pressure of air based on mean monthly temperature & relative humidity

v = monthly mean wind velocity in Km/hr, 10m above the ground

c = 50 (small shallow ponds)

= 11 (for large or deep water bodies)

2. Rohwer's formula:

$$\mathbf{E = 0.771(1.465 - 0.000732Pa)*(0.44+0.7334v)*(e_s - e_a)}$$

Where, E = evaporation in mm/day

Pa = Mean Barometric Reading in mm mercury

e_s= saturation vapour pressure at water surface (mm of mercury) corresponding to mean monthly temperature of water

e_a= actual vapour pressure of air based on mean monthly temperature & relative humidity

v = monthly mean wind velocity in Km/hr, 10m above the ground

2.1.7 METHODS TO CONTROL EVAPORATION FROM LAKES

Following are some recommended measures to reduce evaporation from water surfaces.

1) Storage reservoirs should have more depth and less surface area. The site for construction of a dam should be so chosen that a deep reservoir with minimum surface area exposed to atmosphere is formed.

2) Tall trees on the wind ward side of the reservoir should be planted so that they act as wind breakers.

3) By spraying a chemical such as Acetyl Alcohol on water surface, a film of 0.15 microns thickness is produced on the surface. This film allows precipitation in but does not allow evaporation. This is suitable when wind velocities are less and for small and medium sized reservoirs.

4) In case of ponds and lakes entire water body can be covered by thin polythene sheets as mechanical covering.

5) In reservoirs outlet arrangements should be so done to let out warmer water at top than cold water from bottom.

6) De-weeding the reservoirs should be done such that water consumed by weeds is reduced.

7) The streams and channels to be straightened so that length and in turn exposed area to atmosphere are reduced.

2.2 EVAPOTRANSPIRATION

- **Evapotranspiration:** In agricultural fields apart from transpiration, water is also lost due to evaporation from adjacent soil. The sum of these two losses is often termed as evapotranspiration (Et) or consumptive use (Cu).
- **Potential evapotranspiration**: When sufficient moisture is freely available to completely meet the needs of the vegetation fully covering an area, the resulting evapotranspiration is called potential evapotranspiration.
- **Actual evapotranspiration**: The real evapotranspiration occurring in a specific situation in the field is called actual evapotranspiration. The knowledge of evapotranspiration, potential evapotranspiration and actual evapotranspiration are very much useful in designing irrigation systems (in deciding the amount of water to be supplied for raising crops).

2.2.1 FACTORS AFFECTING EVAPOTRANSPIRATION

Potential evapotranspiration is controlled by meteorological facts but actual evapotranspiration is affected by plant and soil factors. In total the factors affecting evapotranspiration are:

1. Temperature
2. Humidity
3. Percentage sunshine hours
4. Wind speed
5. Type of crop
6. Season
7. Moisture holding capacity of soil
8. Irrigation Methods
9. Cropping patterns

2.2.2 DETERMINATION OF EVAPOTRANSPIRATION (ET) OR CONSUMPTIVE USE OF WATER

The time interval for supplying water to agricultural crops, is a factor dependent on water requirement of crops, soil properties and as well as consumptive use. Hence accurate determination of consumptive use or evapotranspiration is very much essential. The methods of determining consumptive use are:-

i) Direct measurement method

ii) By use of empirical formulae

❖ Direct measurement methods

The different methods of direct measurement are

a. Soil moisture studies on plots

b. Tank and lysimeter method

c. Field experimental plots

d. Integration method

e. Inflow and outflow studies for large areas

a) Soil moisture studies on plots

Soil moisture measurements are done before and after supplying water. The quantity of water extracted per day from the soil is computed for each required period. A curve is drawn by plotting the rate of water consumed against time. This curve is useful for determining the average consumption daily or on monthly basis.

b) Tank and lysimeter method

Tanks are watertight cylindrical containers which are open at one end. They have a diameter of 1-3 m and depth of 2-3 m. They are set in ground with the rim in flush with the ground surface. The quantity of water to keep a constant moisture content (for optimum growth) is determined, which itself represents consumptive use. A lysimeter is a container similar to tank but has pervious bottom free drainage through the bottom is collected in a pan which is kept below. The consumptive use of water in this case therefore the difference between the water applied and drainage collected in the pan.

c) Field experimental plots

In this method water is applied to selected field plots in such a way that there is neither runoff nor deep percolation. Yield obtained from different plots is plotted against total water used. It can be observed that increase in yield occurs with increase in water applied up to a certain point. Further increase in water content reduces yield. This break point in water application is taken as consumptive use.

d) Integration method

In this method the consumptive use of water for large areas is determined as the sum of the following products.

I) Consumptive use of each crop and its area

II) Consumptive use of natural vegetation and its area

III) Evaporation from water surfaces and their area

IV) Evaporation from open lands and their area

e) Inflow and outflow studies for large areas

In this method consumptive use of water for large areas is given by the equation:

$$Cu = I + P + (Gs - Ge) - O$$

Where, I= Total inflow into the area during a year

P = Total precipitation in the area during a year

Gs = Ground water storage at the beginning of the year

Ge = Ground water storage at the end of the year

O = Outflow from the area during the year

- **By Use of Empirical formulae**

Following are some of the empirical methods or relations suggested for calculating consumptive use

a) Blaney Criddle method

b) Penman method

c) Lowry and Johnson method

d) Hargreaves pan method

2.2.3 BLANEY CRIDDLE EQUATION

Blaney and Criddle developed a simple equation for estimating evapotranspiration. It is assumed that the evapotranspiration is closely correlated with the mean monthly temperatures and daylight hours. The monthly consumptive use factor 'f' is defined as:

$$f = (p * Tm / 100)$$

Where Tm is the monthly mean temperature in ^{0}F, p is the monthly daylight hours expressed as percent of the daylight hours of the year and f is in inches.

In other words p is obtained from the expression p = (possible sunshine hours for the particular month/ possible sunshine hours for the whole year) * 100

p = (possible sunshine hours for the particular month/ 365*12) * 100

The value of p depends on the latitude of the place and the month of the year.

The monthly consumptive use is then obtained as:

$$u = k*f$$

Where k is an empirical crop co-efficient. The monthly consumptive use u are added for all the months of the crop to yield the seasonal consumptive use or the total evapotranspiration in inches. The value of k depends on the month and the place.

The Blaney – Criddle equation gives reasonably accurate estimates of evapotranspiration provided a locally developed crop co-efficient is used. However it takes only temperature and daylight hours into account and the other important factors like humidity and wind are ignored.

2.3 INFILTRATION

2.3.1 INTRODUCTION

The water entering the soil at the ground surface after overcoming resistance to flow is called infiltration. The process is also termed as infiltration. Infiltration fills the voids in the soil. Excess water moves down by gravity and it is known as percolation. Percolation takes place till water reaches ground water table. For continuous infiltration to occur it is essential that percolation should also be continuous, which is also dependent of ground water movement. Infiltration process: Infiltration plays an important role in the runoff process and it can be easily understood by a simple analogy as shown below. The soil medium where infiltration is to be observed may be considered as a small container covered with a wire gauge mesh. If water is poured over the gauge, part of it enters the soil and some part over flows. Further the runoff and infiltration depend on the condition of soil. When soil reaches saturated condition infiltration stops and all input becomes runoff. Usually at the beginning of a storm infiltration is more and runoff is less and when storm continues infiltration becomes lesser and runoff become constant. The volume of rainfall that will result in runoff is called _Rainfall excess‘.

- **Infiltration rate** (f): It is actually the prevailing rate at which the water is entering the given soil at any given instant of time. It is expressed in cm/hr (i.e. depth of water entering soil per unit time).
- **Infiltration Capacity** (fp): It is the maximum rate at which a soil in any given condition is capable of absorbing water.

2.3.2 FACTORS AFFECTING INFILTRATION CAPACITY

The variations in the infiltration capacity are large. The infiltration capacity is influenced by many factors. Some factors contribute to long term variation, but some cause temporary variations.

a. Depth of surface retention and thickness of saturated layer of soil:

Infiltration takes place due to combined influence of gravity and capillary force. Due to this a layer of soil near the surface becomes saturated. If the thickness of saturated soil at any given time and at any given section is 'L' the water will flow through a series of tiny tubes of length 'L'. Therefore infiltration capacity should decrease with time in a continuous rain and become a constant ultimately.

b. Soil Moisture:

The soil moisture affects the infiltration capacity in 2 ways:

(i) If the soil is quiet dry at the beginning of the rain, there is a strong capillary attraction for moisture in subsurface layers that acts in the same direction as gravity and given high initial value of infiltration. As water percolates down the surface layer becomes semi saturated & capillary forces diminish hence f also reduces.

(ii) When the soil is subjected to wetting very fine soil particles called colloids will swell slightly and reduce the size of the voids. This leads to reduce of 'f' with time.

c. Compactness of soil:

(i) Due to rain – The clay surfaced soils are compacted even by the impact of rain drops which reduce 'f'. This compaction not only reduces the porosity but also pore sizes. This effect is negligible in sandy soil. Protection by vegetative cover or practically eliminate this effect even in fine textured soils.

(ii) Due to man & animals – where heavy pedestrian or vehicular traffic moves on the soil, the surface is rendered relatively impervious and this reduces 'f'.

d. In wash of fines:

When the soil becomes very dry, the surface often contains many fine particles. When rain falls and infiltration begins, these fines are carried into the soils and are deposited in the voids, thus reduce the infiltration capacity.

e. Vegetative covers:

The natural surface cover has also an important influence on infiltration. The presence of dense cover on vegetation on the surface increase 'f'. The vegetative covers retard the movement of overland flow and causes high depth of detention. Vegetative cover also reduces the raindrop compaction and provides a layer of decaying organic matter which promotes the activity of borrowing insects and animals which in turn produces permeable soil structures. Transpiration by vegetation tends to keep the soil moisture at low levels. Also these factors tend to increase the infiltration capacity 'f'. Surfaces covered with snow paved urban area will obviously have very low or zero infiltration capacity.

f. Temperature:

The effect of temperature on infiltration capacity is explained through viscosity. The flow through soil pores is almost laminar for which the resistance is directly proportional to the viscosity. At high temperature viscosity of water is low high filtration capacity is expected. During winter season the temperature is less and thus infiltration capacity becomes less. This is one of the factors responsible for seasonable variation in 'f'.

2.3.3 MEASUREMENT OF INFILTRATION

Infiltration rates are required in many hydrological problems such as runoff estimation, soil moisture studies in agriculture, etc. The different methods of determination of infiltration are

1. Use of Infiltro-meters
2. Hydrograph analysis method

The infiltrometer always gives the infiltration capacity at a particular site and infiltration from this at various locations in the basin may give fairly satisfactory estimate average infiltration capacity for the entire basin. In the hydrograph analysis method the actual infiltration rate curve is obtained, provided the accurate measurement of rainfall and runoff from the basin made.

Infiltro-meters are of two types.

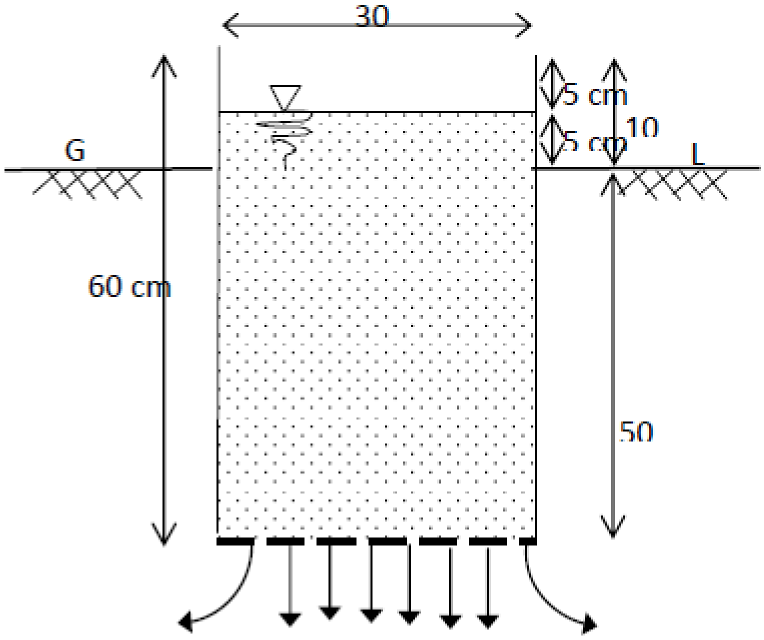
a) Flooding type Infiltro-meters

b) Rainfall simulators

In flooding type Infiltro-meters water is applied in form of a sheet, with constant depth of flooding. The depletion of water depth is observed with respect to time. In case of rainfall simulators water is applied by sprinkling at a constant rate in excess of infiltration capacity and the runoff occurring is also recorded. Infiltro-meters adopted in practice are,

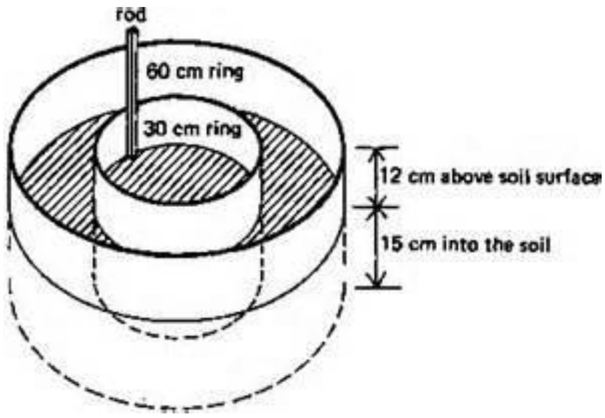
1. Simple (Tube Type) Infiltro-meters
2. Double ring Infiltro-meters

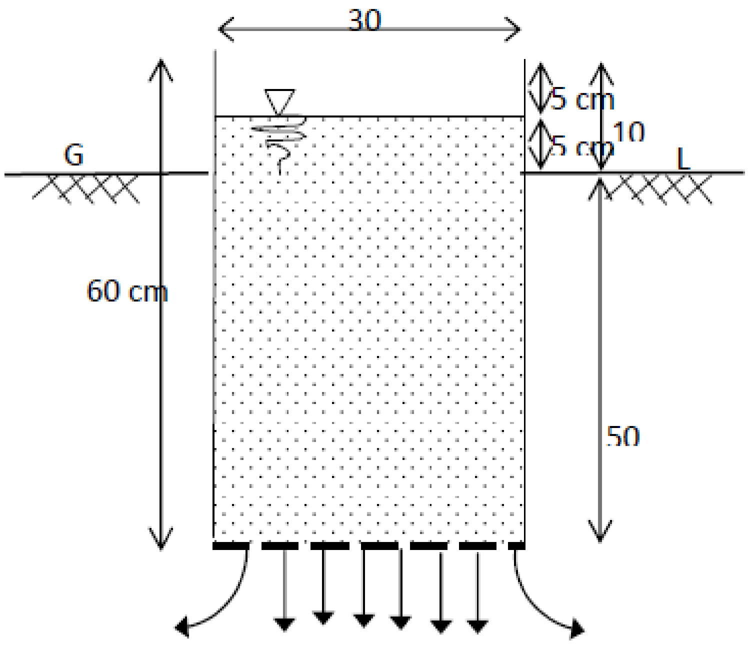
- **Simple (Tube Type) Infiltro-meters** It is essentially a metal cylinder with openings at both ends. It has a diameter of 30 cm and length of 60 cm. This is driven into the ground as shown and water is poured from the top till the pointer level as shown. As infiltration continues the depleted volume of water is made up by adding water from a burette or measuring jar to maintain constant water level. Knowing the volume of water added during different time intervals the infiltration capacity curve is plotted. The experiment is continued till a uniform rate of infiltration is obtained, which may take 2 to 3 hours.



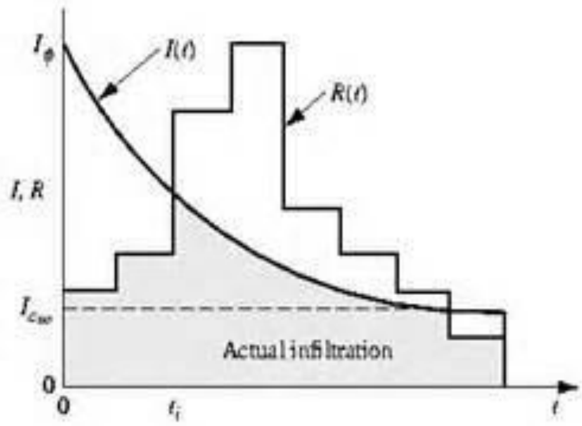
- **Double ring Infiltro-meters**

A tube infiltrometer has a drawback that infiltration in it does not represent or simulate the actual field conditions because the water tends to disperse laterally after coming out at the bottom. To overcome this draw back a Double ring Infiltro-meter is widely used. It consists of two consecutive rings driven into the ground as shown in the figure below. The inner ring has a diameter of 30 cm and outer ring has a diameter of 60 cm. They are concentrically driven into the ground as shown in figure. A constant water depth of 5 cm is maintained in both the rings. The outer ring provides a water jacket to the water infiltrating from the inner ring and thus simulates the natural conditions. The water depths in both the rings are maintained constant during the observation period. The measurement of water volume added into the inner ring is only noted. The experiment is carried out till constant infiltration arte is obtained. To prevent any disturbance or accidental fall of foreign matter the top of the infiltrometer is covered with a perforated disc.





Infiltration capacity curve: It is the graphical representation of variation of infiltration capacity with time, during and a little after rain many factors affect infiltration capacity of a given soil. Typical infiltration capacity curves for a soil are as follows.



2.3.4 INFILTRATION EQUATIONS

The data from Infiltro-meters can be used to plot an infiltration capacity curve. Infiltration capacity curve is a decaying curve which shows high infiltration capacity rate at beginning and decreases exponentially and attains minimum or constant value over time. Many mathematical equations have been proposed to describe the shape of the curve. The most commonly used equation is ―Horton‘s Equation‖.

The infiltration rate (f) at any time ‘t‘ is given by Horton‘s equation

$$\mathbf{Fp = Fc + (Fo - Fc)\ e^{-Kt}}$$

F_o= initial rate of infiltration capacity

F_c= final constant rate of infiltration at saturation

K= a constant depending primarily upon soil and vegetation

e= base of Napier an logarithm

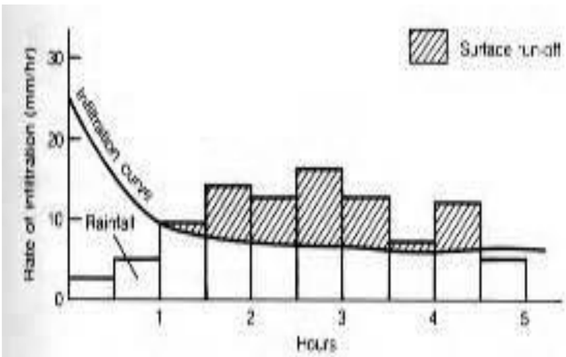
t= time from beginning of storm

Fc= shaded area obtained as shown from the graph also known as field capacity is the amount of rainfall which can be absorbed by soil.

This equation when conjunctively used with rain fall data (hyetograph) can be used to calculate surface runoff volumes occurring during a storm.

2.3.5 INFILTRATION INDICES

The infiltration capacity curves which are developed either from infiltrometer tests or the hydrograph analyses methods can be used to estimate the runoff from a given storm. The infiltration rate curve appropriate to the soil, vegetation and antecedent moisture conditions existing at the time of occurrence of storm is superimposed on the rainfall hyetograph with base lines coincident as shown in figure below.



FG 4 Changes in infiltraton through a rainstorm for sandy loam soils

The area of the rainfall hyetograph above the infiltration curve would then represents the runoff volume whose time distribution may be obtained through the application of unit hydrograph principle. The rainfall volume below the infiltration curve represents the total depth of infiltration during the storm. Though this approach appears to be simple there are some difficulties. If the rainfall intensity is always more than the infiltration capacity the results are satisfactory. If the rainfall intensity fluctuates above & below the infiltration capacity rate curve the problem is complicated. The above difficulties led to the use of infiltration indices. These indices in general express the infiltration as an average rate throughout the storm. Since the infiltration capacity actually decrease with prolonged rainfall the use of an average value assumes too little infiltration during the first part of the storm and too much near the end of it.

1. Φ - Index

The Φ - Index is an average rainfall intensity above which the rainfall volume equals the runoff volume. The rainfall hyetograph is plotted on a time based and a horizontal line is drawn such that the shaded area above the line exactly equals the measured runoff. Since the unshaded area below the line is also measured rainfall but did not appear, as runoff it represents all the losses including depression storage, evaporation, interception as well as infiltration. However, infiltration is the largest loss compared to the other losses. The Φ - Index can be determined for each flood event for which the runoff measurements are available.

2. W – Index

The W – Index is refined version of Φ - Index. It excludes the depression storage and interpolation from the total losses. It is the average infiltration rate during the time rainfall intensity exceeds the capacity rate.

That is, $W = F/t = (P-Q-S)/t$

Where F is the total infiltration, t is the time during which rainfall intensity exceeds infiltration capacity, P is the total precipitation corresponding to t, Q is the total storm runoff and S is the volume of depression, storage and interception. Thus W- index is essentially equal to Φ - Index minus the depression and interception storage.

3. W_{min} – Index

This is the lowest value of W – Index which is observed under very wet initial conditions. Under these conditions since the retention rate is very low W - Index and Φ - Index tend to be equal. This index is principally used in studies of maximum flood potential.

2.4 IMPORTANT QUESTIONS

- Explain the factors affecting evaporation?
- Define evaporation. With a neat sketch explain measurement of evaporation using “IS class A pan”?
- Explain estimation of evaporation by Meyer’s and Rohwer’s empirical formulae?
- What are the measures taken to reduce evaporation?
- Enlist the factors affecting evapotranspiration?
- Explain Blaney Criddle equation for estimating evapotranspiration?
- What are the different methods of estimating evapotranspiration? Explain any two methods.
- Explain the factors affecting infiltration capacity.
- Describe the method of determining infiltration capacity using double ring infiltrometer.
- Differentiate between:
- W-index & ϕ index (b) AET & PET (c) Infiltrometer & Lysimeter.
- With a neat sketch explain Double mass technique.

2.5 OUTCOMES

- Understand different types of loses in precipitation and factors affecting it.

2.6 FURTHER READING

- https://nptel.ac.in/courses/105101002/3