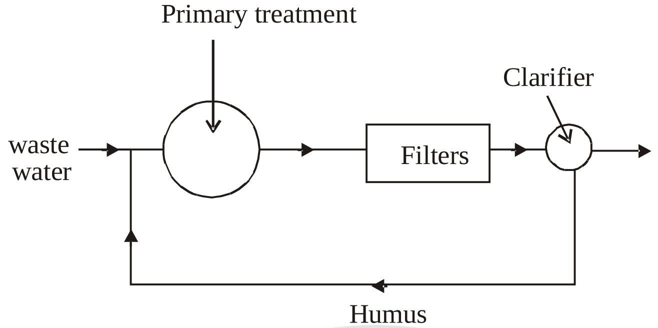
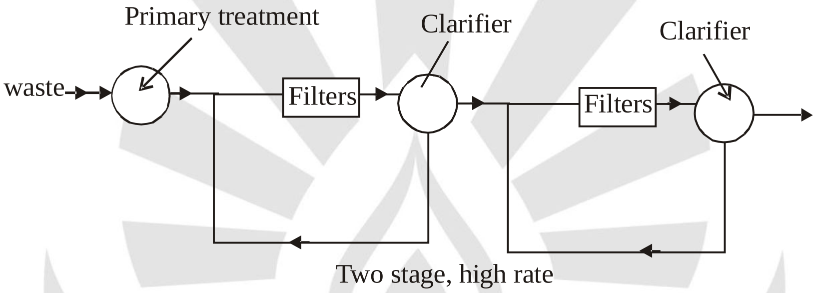
DETAILS EXPLANATIONS

1. (A) *Compare the high rate & standard rate trickling filter :*



Standard - rate tricking filtres (SRTF)



High rate tricking filters (HRTF)

- Hydraulic as well as organic loading of high rate trickling filter is many times more than the low rate or standard rate tricking filter.
- Main defect of SRTF is its large area and high initial cost.
- Depth of filter media in HRTF is 1.2 to 1.8 m
  But in SRTF is 1.8 to 2.4m
- Hydraulic loading (m^3/m^2/day) in HRTF is 30 : 40
  But in SRTF is 1 to 4.
- Organic loading as 5-day BOD in (gm/m^3/day) in HRTF is '500 to 1000' but in SRTF is '80 to 320'.
- Recirculation system in HRTF is always provided in the range of 1 : 1 to 4 : 1 but in SRTF is usually not provided but can be provided if hydraulic load does not exceed limit.
- In high rate trickling filter, single stage or 2-stage are recommended for medium to relatively high strength domestic & efficiency by reducing the BOD load generally as compare to SRTF.
- Cost of operation is more in SRTF as compare to HRTF.

(B) ***Given :*** Circular settling tank for primary treatment of sewage

$$\text{Discharge} = 12 \times 10^6 \text{ lit/day}$$

$$D_t = 2 \text{ hrs}$$

$$\text{Surface loading} = 40000 \text{ lit/m}^2\text{/day}$$

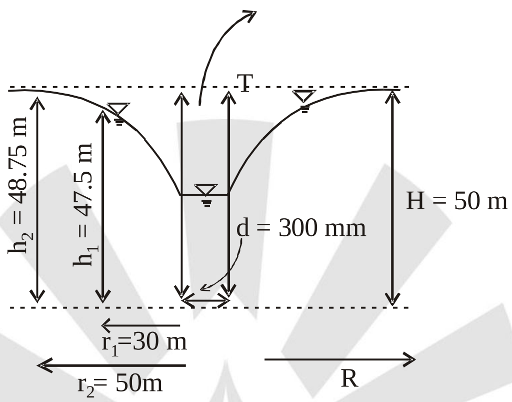
$$\text{Volume of tank} = \frac{12 \times 10^6 \times 2}{24} = 1 \times 10^6 \text{ lit}$$

@ 2hr.

$$\text{Volume} = 1000 \text{ m}^3$$
$$H = 3\text{m}$$
$$\text{Volume} = D^2[0.11D + 0.785H]$$
$$1000 = D^2[0.11D + 2.355]$$
$$0.11D^3 + 2.355 D^2 - 1000 = 0$$
$$D = 15.66 \text{ m}$$

OR

(A)



$$Q = 1750 \text{ lit/min} = 1750\times\frac{10^{-3}}{60}\frac{\text{m}^3}{\text{sec}} = 0.0291 \text{ m}^3/\text{sec}$$

(i) For unconfined aquifers [Dupits theory]

$$Q = \frac{\pi k[H^2 - h_0^2]}{2.303\log_{10}\left(\frac{R_e}{r_w}\right)}$$

$$Q = \frac{\pi k[h_2^2 - h_1^2]}{2.303\log_{10}\left[\frac{r_2}{r_1}\right]}$$

$$0.0291 = \frac{\pi k[48.75^2 - 47.5^2]}{2.303\log_{10}\left[\frac{50}{30}\right]}$$

$$K = 3.32 \times 10^{-5} \text{ m/sec} = 3.32 \times 10^{-3} \text{ cm/sec}$$

According to Dupit's
$$Q = \frac{\pi k[h^2 - h_0^2]}{2.303\log\left(\frac{R}{r_w}\right)}$$

(ii) For 'h_0' calculation
$$Q = \frac{\pi k[h_1^2 - h_0^2]}{2.303\log\left(\frac{r_1}{r_w}\right)}$$

$$0.0291 = \frac{\pi\times 3.32\times 10^{-5}\times\left[47.5^2 - h_0^2\right]}{2.303\log\left(\frac{30}{0.15}\right)}$$

$$1478.49 = 47.52 - h_0^2$$

$$h_0 = \sqrt{777.75}$$

$$h_0 = 27.88 \text{ m}$$

Then

$$Q = \frac{\pi k[h^2 - h_0^2]}{2.303\log\left(\frac{R}{r_w}\right)}$$

$$0.0291 = \frac{\pi \times 3.32 \times 10^{-5} \times \left[50^2 - 27.88^2\right]}{2.303\log\left(\frac{R}{.15}\right)}$$

$$\log\left(\frac{R}{.15}\right) = 2.68$$

$$\frac{R}{.15} = 479.83$$

$$R = 71.97 \text{ m}$$

2. **(A)** ***(a) Fluctuations in demand***

In water demand we consider different types of water demand such as :

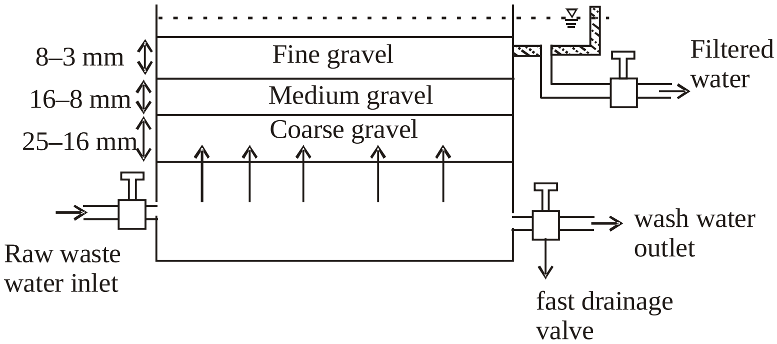
(i) Domestic demand
(ii) Public demand
(iii) Industrial demand
(iv) Commercial demand
(v) Fire demand

Above these types of water demands are affected by some factor such as.

(i) Climate condition
(ii) Cost of water
(iii) Size of city
(iv) Distribution system {Pressure}
(v) supply system {continous & intermediate}
(vi) Industrialization
(vii) Quality of water
(viii) Habit of people

Due to the above mentioned factors and some other related factor which are affected the demand of water hence the demand of water is never constant for a fixed period and this phenomenon is called fluctuations in demand.

(b) Roughing filters



Roughing filters are often used to pretreat water by removing suspended solids from the water that could rapidly clog a slow sand filter. Roughing filters can also considerably reduce the number of pathogens in the water as well as the amount of iron and manganese. There are many types of roughing filters with different flow directions (downflow, upflow & horizontal flow filters) and with different types of filter medium (eg-sand, gravel, coconut husk fibre). Upflow roughing filters are relatively cheap and easier to clean than downflow or horizontal flow filters & filteration rate is approximately 0.6 m/h. If raw water with a turbidity below 50 NTU is used as the source for a roughing sand filter, the outflow has filter, the outflow has a turbidity below 12 NTU. Approximately 84-98% of suspended solids are removed. Better results are obtained with two or three filters in series.

(c) Street inlets

Although streets play an important role in storm water collection & conveyance, the primary function of a street or roadway is to provide for the safe passage of vehicular traffic at specified level of service if the storm water system are not designed properly, the primary function will be impaired. To ensure this does not happen, streets are classified for drainage purpose based on their traffic volume, parking practices & other criteria. The four street classifications are -

(a) Local : Low speed traffic for residential or industrial area access.

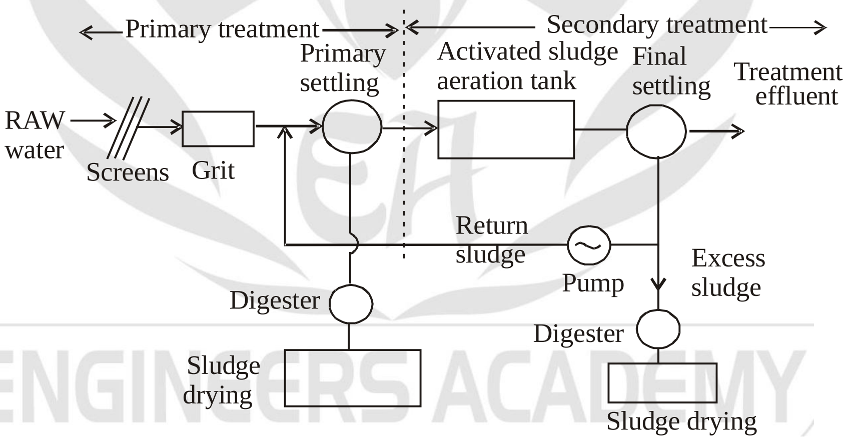
(b) Collector : Low/moderate - speed traffic providing service between local streets and arterioles.

(c) Arterial : Moderate/high speed traffic moving through urban areas & accessing freeways.

(d) Freeway : High speed travel generally over long distances.

(d) Activated sludge Process.

The most common suspended growth process used for municipal waste water treatment is the activated sludge process (ASP) as show in fig.



Activated sludge plant involves:

1. Wastewater aeration in the presence of a microbial suspension
2. Solid liquid separation following aeration
3. Wasting of excess biomass
4. Discharge of classified effluent.
5. Return of remaining biomass to the aeration tank

In activated sludge process wastewater containing organic matter is aerated in an aeration basin in which micro-organisms metabolize the suspended and soluble organic matter.

OR

(A) ***In the construction of WBM roads following steps are:***

1. **Preparation of foundation for receiving the WBM course:** The foundation layer i.e. subgrade, sub-base or base course is prepared at required grade and camber and the dust and either loose materials are cleaned. On existing road surfaces, the depressions and potholes are filled and corrugations are removed by scarifying and reshaping the surface to the required grade and camber.
2. **Provision of lateral Confinement :** Provision of lateral confinement may be done by constructing the shoulders to advance, to a thickness equal to that of the compacted WBM layer.
3. **Spreading of Coarse Aggregates :** The coarse aggregates are spread uniformly to proper profile to even thickness upon the prepared foundation and checked by templates.
4. **Rolling :** Rolling is started from the edges and then gradually shifted towards the centre line of the road.
5. **Application of Screenings :** After the coarse aggregate are rolled adequately, the dry screenings are applied gradually over the surface to fill the intersections in three or more applications. Dry rolling is continued as the screening are being spread and brooming carried out.
6. **Sprinkling and Grouting :** After the application of screenings, the surface is sprinkled with water, swept and rolled. Wet screenings are swept into the voids using hand brooms.
7. **Application of Binding Material :** After the application of screening and rolling, binding material is applied at a uniform and slow rate at two or more successive thin layers. After each application of binding material, the surface is copiously sprinkled with water and Wet slurry swept with broom to fill the voids.
8. **Setting and Drying :** After final compaction, the WBM course is allowed to set over -night. On the next day the 'hungry' spots are located and are filled with screenings or binding material, lightly sprinkled with water if necessary and rolled. No traffic is allowed till the WBM layer sets and dries out.

Advantages of WBM:

- Design is simple.
- No need of skilled workers.
- Can be constructed using locally available materials.
- Most economical hence suitable in rural areas.
- Maintenance is easy.

Disadvantages of WBM:

- WBM roads are damaged rapidly due to the heavy mixed traffic.
- In dry weather dust is formed which create nuisance.
- Pot holes and ruts are formed in WBM roads due to heavy loaded vehicles.
- During rains mud is formed and due to combined effect of traffic and rain water, WBM roads are badly damaged.
- WBM roads are pervious in nature, so these cannot be used in heavily rainfall areas.

3. ***(A) IRC loading for design of Road bridges :***

Various design loads to be considered in the design of bridges are :

1. Dead load	2. Live load	3. Impact load
4. Wind load	5. Longitudinal forces	6. Centrifugal forces
7. Buoyancy effect	8. Effect of water current	

9. Thermal effect
10. Deformation and horizontal effect
11. Erection stresses
12. Seismic loads

1. **Dead load :** Dead load is nothing but a self weight of the bridge elements.
2. **Live Load :** Live load on the Bridge is moving load on the bridge throughout its length. The moving loads are vehicles, pedestrians, etc.

The vehicle loadings are categorised into three types and these are :

IRC class AA loading

IRC class A loading

IRC class B loading

3. **Impact Loads :** Impact load on bridge is due to sudden loads which are caused when the vehicle is moving on the bridge. When the wheel is in movement, the live load will change periodically from one wheel to another which results the impact load on Bridge.
4. **Wind Load :** Wind load is also an important factor in the bridge design. For short span bridges, wind load can be negligible. But for medium span bridges wind load should be considered for substructure design. For long span bridges, wind load is considered in the design of super structure.
5. **Longitudinal Forces :** The longitudinal forces are caused by braking or accelerating of vehicles on the bridge. When the vehicle stops suddenly or accelerates suddenly it Induces longitudinal forces on the bridge structure.
6. **Centrifugal forces :** If bridge is to be built on horizontal curves, then the movement of vehicle along curves will cause centrifugal force on the super structure.
7. **Buoyancy effect :** Buoyancy effect is considered for substructures of large bridges submerged under deep water bodies.
8. **Forces by water current :** When the bridge is constructed across a river, some part of the substructure are under submergenece of water. The water current induces horizontal forces on submerged portion. The forces caused by water currents are maximum at the drop of water level and zero at the bed level.
9. **Thermal stresses :** Thermal stresses are caused due to temperature. When the temperature is very high or very low they induce stresses in the bridge elements. The stresses are tensile in Nature.
10. **Seismic loads :** When the bridge is to be built in seismic zone or earthquake zone, earth-quake loads must be considered. They induce both vertical and horizontal forces during erthquake.

OR

(A) ***(i) Weaving Length:***

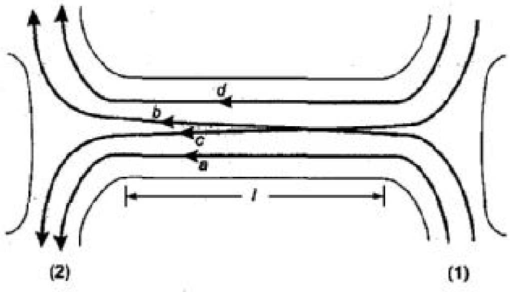
Assume,

a = Traffic generated from section under consideration and goes to left (say section (2))

b = Traffic generated from (1) and goes to other section excepting section (2)

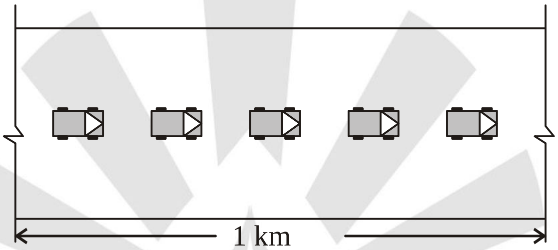
c = Traffic generated from section other than (1) and goes to section (2)

d = Traffic generated from section other than (1) and (2) and goes to section other than (1) and (2).



From above figure it is clear that the weaving of traffic occurs in segment of length '*l*'. This length is called weaving length.

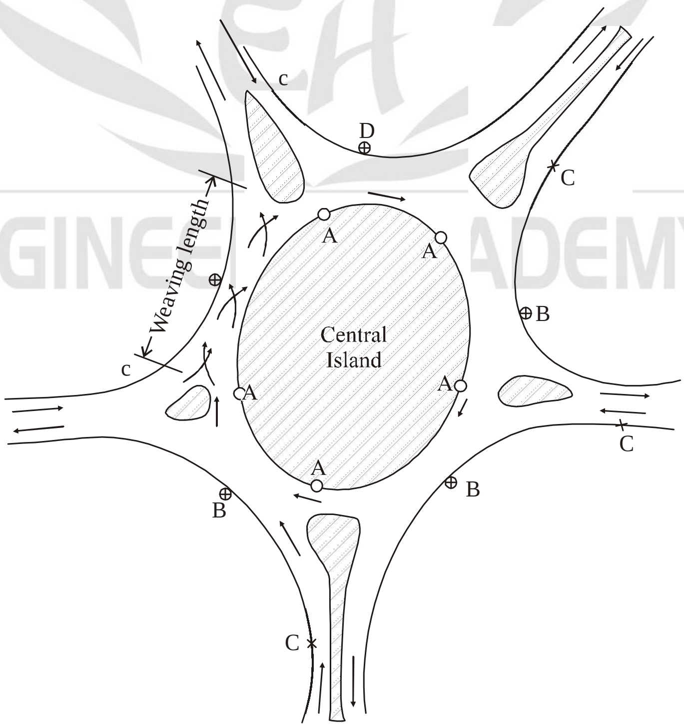
(ii) **Traffic Density:** It is the number of vehicles present in a unit length of roadways per lane at a particular instant, It is expressed as vehicles/km



The highest traffic density will occur when the vehicles are practically at a stand still on a given route and in this case traffic volume will approach to zero.

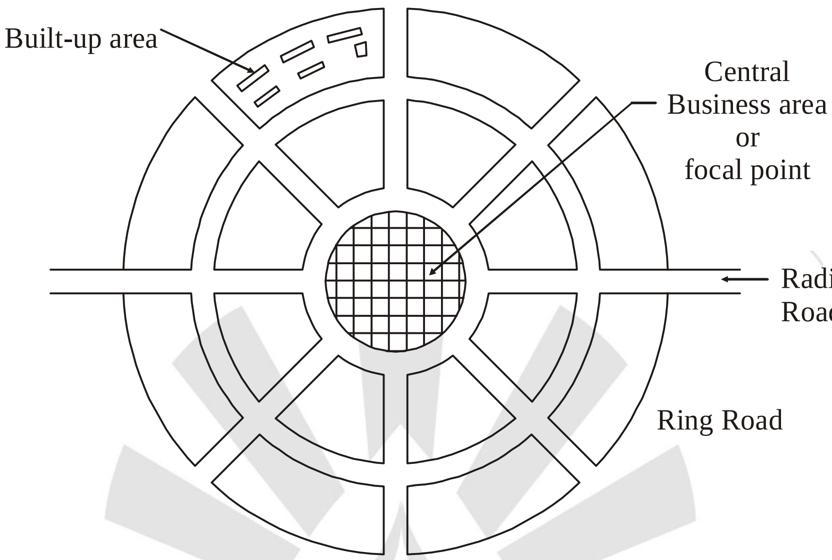
(iii) **Traffic rotaries and round abouts :**

A rotary intersection or round about is an enlarged road intersection where all converging vehicles are forced to move around a large central island in one direction (clockwise direction) before they can weave out of traffic flow into their respective directions radiating from central island. The main objects of providing a rotary are to eliminate the necessity of stopping even for crossing streams of vehicles and to reduce the area of conflict.



(iv) Radial and Circular Road Pattern :

In this system, the main radial roads radiating from central business area are connected together with concentric roads. In this areas, boundary by adjacent radial roads and corresponding circular roads, the build-up area is planned with a curved block system.



Radial and circular pattern

Advantages:

1. At traditional intersections with stop signs or traffic signals, some of the most common types of crashes are right angle, left-turn, and head-on collisions. These types of collisions can be severe because vehicles may be travelling through the intersection at high speeds with circular pattern, these types of potentially serious crashes essentially are eliminated because vehicles travel in the same direction.
2. Installing circular pattern in place of traffic signals can also reduce the likehood of rear-end crashes.
3. Removing the reason for drivens to speed up as they approach green lights and by reducing abrupt stops at red lights.
4. Round abouts improve the efficiency of traffic flow, they also reduce vehicle emission and fuel consumption.

*Example:*Connaught place in New Delhi is an example of radial and circular road pattern.

4. (A) $Q = 500$ cumecs, $S_0 = \frac{1}{4000}$, $m = 1$

Roughness coefficient, $n = 0.014$

Permissible velocity, $V = 2.5$ m/s

For discharge greater than 150 cumec, trapezoidal section with round corners is used.

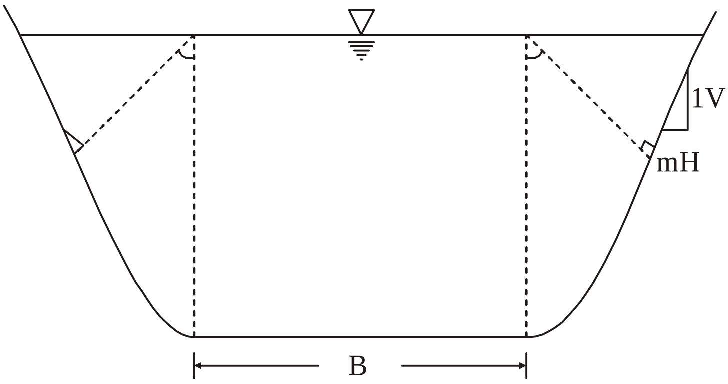
$$m = \cot\theta$$

$$\cot\theta = 1$$

$$\theta = 0.785 \text{ radian}$$

$$A = By + y^2(\theta + \cot\theta) \quad ...(i)$$

$$P = B + 2y(\theta + \cot\theta) \quad ...(ii)$$



Using, $Q = AV$

$$A = \frac{Q}{V} = \frac{500}{2.5} = 200\ m^2$$

Now using Manning's equation, $V = \frac{1}{n}R^{2/3}S_0^{1/2}$

$$2.5 = \frac{1}{0.014} \times R^{2/3} \times \left(\frac{1}{4000}\right)^{1/2}$$

$$R = 3.293\ m$$

We know, $R = \frac{A}{P}$

$\therefore$ $P = \frac{A}{P} = \frac{200}{3.293} = 60.72\ m$

Also, $P = B + 2y(\theta + \cot\theta)$

$\therefore$ $60.72 = B + 2y(0.785 + 1)$

$$60.72 = B + 3.57\ y$$

$$B = 60.72 - 3.57\ y$$

From equation (i), $200 = (60.72 - 3.57\ y)y + 1.785\ y^2$

$$1.785\ y^2 - 60.72\ y + 200 = 0$$

On solving above equation, we get

$$y = 3.695\ m$$

Thus, $B = 60.72 - 3.57 \times 3.695 = 47.528\ m$

OR

(A) Lining of canal

Lining means protection of canal with impervious material. Canal lining may be rigid, semi rigid & flexible.

Object of lining:

- To minimize losses due to seepage
- To protect the area prone to water logging
- To increases the discharge capacity of canal

Advantages of lining :

The main advantages derived by canal linings are mentioned below,

1. The lining of canals prevents seepage loss and thus more area can be irrigated by the water. The cost of irrigation is therefore, reduced.

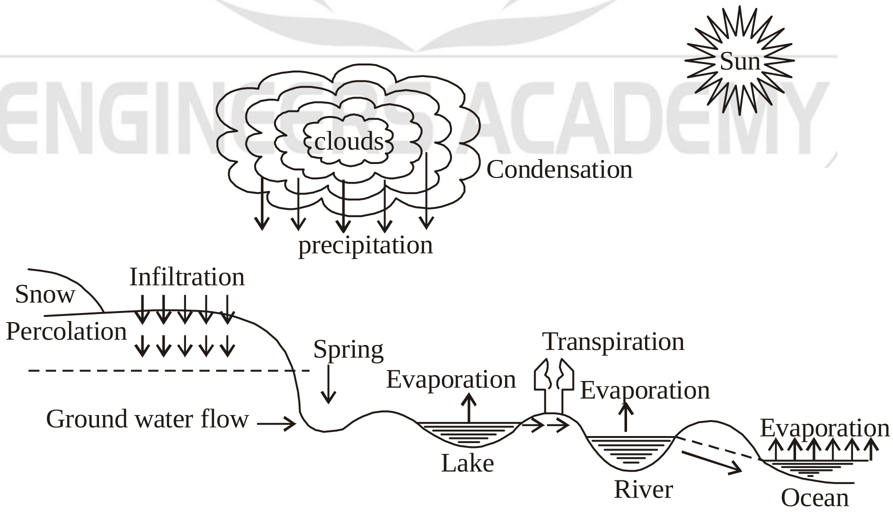
2. The lining of canal is an important antiwater logging measure as it reduces seepage to the adjoining land.
3. The lining provides a smooth surface. The rugosity coefficient, therefore, decreases. The resistance to flow also decreases and hence the velocity of flow in the lined canal increases.
4. The increased velocity minimizes the losses due to evaporation.
5. The increased velocity helps to provided a narrow cross-section for lined channels.
6. Higher velocity helps in providing a flatter hydraulic gradient or bed slope. Thus better command can be obtained.
7. Higher velocity prevents silting of channel.
8. Lining makes the banks more stable in light textured soil.
9. Lining reduces maintenance cost and possibility of breaching due to increased stability of section.
10. Lining of a canal prevents or reduces weed growth.
11. Canal lining assures economical water distribution.
13. Canal lining prevents water to come in contact with harmful salts during transit.

(B) THE HYDROLOGIC CYCLE :

An irrigation engineer is not concerned with the collection and distribution of water for irrigation, but it is also essential for him to know about the occurrence, distribution and movement of water on the earth. Hydrology is the science which deals with the occurrence, distribution and movement of water on the earth, including that in the atmosphere and below the surface of the earth. Water occurs in the atmosphere in the form of vapour, on the surface as water, snow, ice and below the surface as ground water occupying all the voids within a geologic stratum.

Except for the deep ground water, the total water supply of earth is in constant circulation from earth to atmosphere, and back to the earth. The earth's water circulatory system is known as the hydrologic cycle. Hydrologic cycle is the process of transfer of moisture from the atmosphere to the earth in the form of precipitation, conveyance of the precipitated water by systems and rivers to ocean and lakes etc. and evaporation of water back to the atmosphere. Fig. illustrates, diagrammatically the complete hydrologic cycle.

The hydrologic cycle consists of the following processes :



1. Evaporation and transpiration (E)

The water from the surfaces of ocean, rivers, lakes and also from the moist soil evaporates. The vapours are carried over the land by air in the form of clouds. Transpiration is the process of water being lost from the leaves of the plants from their pores. Thus, the total evaporation (E), inclusive of the transpiration consists of;

(i) Surface evaporation

(ii) Water surface evaporation (a) From river surface (b) From oceans

(iii) Evaporation from plants and leaves (transpiration)

(iv) Atmospheric evaporation.

2. Precipitation (P)

Precipitation may be defined as the fall of moisture from the atmosphere to the earth surface in any form. Precipitation may be two forms :

(a) Liquid precipitation i.e. rainfall

(b) Frozen precipitation : This consists of :–

(i) Snow (ii) Hail (iii) Sleet (iv) Freezing rain

3. Runoff (R)

Runoff is that portion of precipitation that is not evaporated. When moisture fall to the earth's surface as precipitation, a part of it is evaporated from the water surface, soil and vegetation and through transpiration by plants, and the remainder precipitation is available as runoff may be classified as following:

- **Surface runoff –** Water flows over the land and is first to reach the streams and rivers, which ultimately discharge the water to the sea.
- **Inter-flow or subsurface runoff –** A portion of precipitation infiltrates into surface soil and depending upon the geology of the basins, runs as subsurface runoff and reaches the streams and rivers.
- **Ground water flow or base flow :** It is that portion of precipitation, which after infiltration, percolates down and joins the ground water reservoir which is ultimately connected to the oceans.

Thus, the hydrologic cycle may be expressed by the following simplified equation :

PRECIPITATION = EVAPORATION + RUNOFF

$$(P) = (E) + (R)$$

Provided adjustment is made for the moisture held in storage at the beginning and at the end of the period.

5. (A) Factors affecting evaporation :

1. Evaporation, which depends upon humidity
2. Mean monthly temperature
3. Growing season of crop and cropping pattern
4. Monthly precipitation in the area
5. Irrigation depth or the depth of water applied for irrigation
6. Wind velocity in the locality
7. Soil and topography
8. Irrigation practices and method of irrigation

Evaporation :

It is transfer of water from the liquid to the vapour state. The rate of evaporation from water surface is proportional to the difference between the vapour pressure at the surface and the vapour pressure in the overlaying air when irrigation water is applied by flooding methods, large amount of water are lost by direct evaporation from soil surface without having passed through the root's stems and leaves of the plant's.

Transpiration :

It is the process by which plant dissipate water from the surface of their leaves, stalks and trunk's in the process the growth. As much as 99% of total water received by a plant through it's root's is lost to the atmosphere by this process. Transpiration is associated with photosynthesis of plant's, it is therefore, a process of day light hours water from soil is taken up by plant root's through a membrane by a process called osmosis. Green cell's called chloroplast in plant leaf prepare food in presence of sun light and CO_2 and leave water through tiny opening called stomata the density of which may vary from 8000 to 12000 per sq. cm. The transpiration ratio is the ratio of the weight of water transpired by the plant during it's growth to the weight of dry matter produced by the plant exclusive of roots. The average values of transpiration ratio for wheat and rice are 560 and 680 respectively.

(B) SELECTION OF SITE FOR A DAM

The following are requisites of good sites for various types of dams :

1. Foundations

Suitable foundations should be available at the site selected for a particular type of dam. For gravity dams, sound rock is essential. For earth dams, any type of foundation is suitable with proper treatment. In general, however, the foundation should be free from seams, open pockets or fault planes.

Formation in which hard and soft layers alternate are not generally good, because the penetration of water may weaken the soft layers and lead to movement along them. Alternations of sand, stones and shales may also lead to slipping during excavation of the trench. Beds which dip gently upstream and strike across the valley provide probably the best foundation conditions among sedimentary rocks, as the resultant of the weight of the dam and water pressure will then act nearly at right angles to the bedding planes of the strata.

2. Topography

(i) The river-cross-section at the dam site should preferably have a narrow gorge to reduce the length of the dam. However, the gorge should open but upstream to provide large basin for a reservoir.

(ii) A major portion of the dam should preferably be on high ground, as this would reduce the cost and facilitate drainage.

3. Site for spillway

Good site for the location of a separate spillway is essential specially in the case of earth or rockfill dam. However in the case of gravity dam, spillway may be located at its middle. The best site for a dam may be considered to be one where a deep gorge and a flank at its sides are separated by a hillock higher than the height of the dam.

4. Materials

Materials required for a particular types of dam should be available nearby, without requiring much of transportation. This would very much reduce the cost of construction.

5. Reservoir and catchment Area

(i) The side should be ensure adequate storage capacity of resevoir basin at a minimum cost.

(ii) The cost of land and property submerged in the water spread area should be minimum.

(iii) The reservoir site should be such that quantity of leakage through its side and bed is minimum.

(iv) The geological conditions of the catchment are should be such that percolation losses are minimum and maximum run-off is obtained.

6. Communication

It would be preferable to select a site which is connected by a road or rail link or can be conveniently connected to site for transportation of cement, labour, machinery food and other equipment.

7. Locality

The surroundings near the site should preferably be healthy and free of mosquitoes etc. as labour and staff colonies have to be constructed near the site.

OR

(A) Various types of irrigation methods

- Surface irrigation method
- Sub surface irrigation method
- Sprinkler irrigation system
- Drip irrigation system

SURFACE IRRIGATION METHOD

In this system of field water application the water is applied directly to the soil from a channel located at the upper reach of the field. It is essential in these methods to construct designed water distribution systems to provide adequate control of water to the fields and proper land preparation to permit uniform distribution of water over the field.

One of the surface irrigation method is flooding method where the water is allowed to cover the surface of land in a continuous sheet of water with the depth of applied water just sufficient to allow the field to absorb the right amount of water needed to raise the soil moisture up to field capacity.

- The flooding method applied in a controlled way is used in two types of irrigation methods as under:
- Border irrigation method
- Basin irrigation method

Border irrigation method

- Borders are usually long uniformly graded strips of land separated by earth bunds (low ridges).
- The essential feature of the border irrigation is to provide an event surface over which the water can flow down the slope with a nearly uniform depth.
- Each strip is irrigated independently by turning in a stream of water at the upper end.

Basin irrigation method

- Basin are flat areas of land surrounded by low bunds.
- The bunds prevent the water flowing to the adjacent fields.
- The basins are filled to desired depth and the water is retained until it infiltrates into the soil. Water may be maintained for considerable periods of time.
- Basin irrigation is suitable for many field crops. Paddy rice grows best when its roots are submerged in water and so basin irrigation is the best method for use with this crop.

Furrow Irrigation

- Furrows are small channels, which carry water down the land slope between the crops rows.
- Water in infiltrates into the soil as it moves along the slope.
- The crop is usually grown on ridges between the furrows.
- This method is suitable for all row crops and for crops that cannot stand water for long periods, like 12 to 24 hours, as is generally encountered in the border or basin methods of irrigation. Furrow irrigation is suitable to most soils except sandy soils that have very high infiltration water and provide poor lateral distribution water between furrows.

As compared to the other methods of surface irrigation, the furrow method is advantageous as :

- Water in the furrows contacts only one half to one fifth of the land surface, thus reducing pudding and clustering of soils and excessive evaporation of water.
- Earlier cultivation is possible.

SUBSURFACE IRRIGATION METHODS :

The applications of water to fields in this type of irrigation system is below the ground surface so that it is supplied directly to the root zone of the plants.

- The main advantages of these types of irrigation is reduction of evaporation losses and less hindrance to cultivation works which takes place on the surface.
- There may be two ways by which irrigation water may be applied below ground and those are termed as :
- Natural sub-surface irrigation method
- Artificial sub-surface irrigation method

SPRINKLER IRRIGATION SYSTEM :

Sprinkler irrigation is a method of applying water which is similar to natural rainfall but spread uniformly over the land surface just when needed and at a rate less than the infiltration rate of the soil so as to avoid surface runoff from irrigation.

- This is achieved by distributing water through a system of pipes usually by pumping which is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground.
- The system of irrigation is suitable for undulating lands with poor water availability, sandy or shallow soils, or where uniform application of water is desired no land leveling is required as with the surface irrigation methods.
- Sprinklers are, however, not suitable for soils which easily form a crust. The water that is pumped through the pump pipe sprinkler system must be free of suspended sediments.

DRIP IRRIGATION SYSTEM :

- Drip Irrigation system is sometimes called trickle irrigation and involves dripping water into the soil at very low rates (2-20 litres per hour) from a system of small diameter plastic pipes filled with outlets called emitters or drippers.
- Water is applied close to the plants so that only part of the soil in which the roots grow is wanted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile.
- With drip irrigation water, applications are more frequent than other methods and this provides a very favourable high moisture level in the soil in which plants can flourish.

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