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TED(15) 4012. IRRIGATION ENGINEERING. 1

## Scheme of Valuation

### I. Part A

(a) **Irrigation:** Irrigation may be defined as the supply of water by artificial methods to the fields for cultivating the crops.

(b) **Weir:** It is a barrier constructed across the river. It is of a small height and raises the water level locally against its face. Thus the diversion of water from river to canal takes place.

(c) **Creep length:** The total length covered by percolating water into the foundation till it emerges out at the downstream ends is called as Creep length.

(d) **1. Rigid dam:** Timber dams, Steel dams, Arch dams, Buttress dams, Solid gravity dams.

2. **Non Rigid dam:** Rock fill dam, Rock and earth fill dam, Earth dam.

(e) **Berms:** A berm is a horizontal spacing given in between cutting and embankments or in between two cuttings. **(5 x 2 = 10)**

### II. Part B

1. **Factors for selecting suitable site for a rain gauge station:**

   1. Rain gauge should be set up in open place by at least 30 meters away from obstruction.
   2. The rain gauge should not be set up on the top of hill.
   3. If it is not find a levelled surface the site should be properly shielded from gusty winds.
   4. A fence should be erected to protect the gauge from cattle. **(1.5 x 4 = 6)**

2. **Good Catchment:** If the characteristics of a catchment area contributes of more yield it is called a good catchment. Fan shaped area is a high rain fall zone with light soil and less vegetation with no ponds contributes good catchment. A good catchment has high run-off coefficient.

   **Bad Catchment:** If the characteristics of catchment area contributes to less yield it is called a bad catchment. Fern shaped catchment in a low rain fall zone with high porosity, large vegetation, more number of ponds forms bad catchment. A poor catchment has low run off coefficient.

**Average Catchment:** If the characteristics of a catchment area contributes average runoff it is called average catchment area. An area with average rain fall, medium vegetation. medium porosity forms average catchment.

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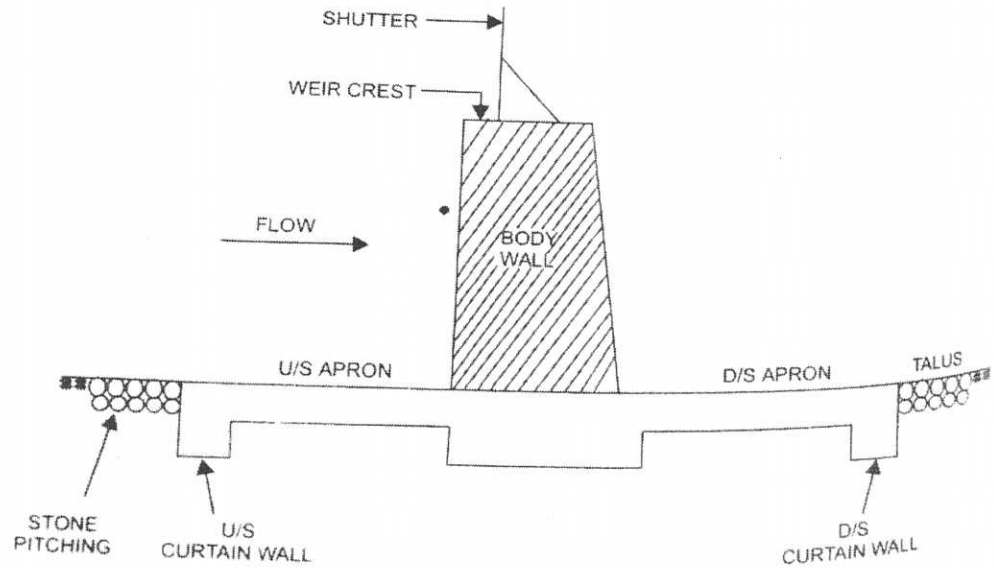



4. 1. Water pressure 2. Uplift pressure 3. Self weight of dam 4. Earthquake pressure 5. Ice pressure 6. Earth and silt pressure 7. Wind pressure 8. Wave pressure

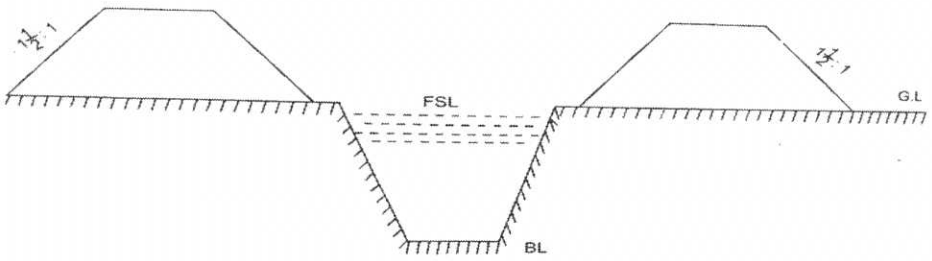
5. **Geological Factors:**

1. Reservoir catchment must not have loose soil cover.
2. Area of the reservoir should be far away from the earth – quake epicenter.
3. Reservoir bed should be impermeable and should not allow quick percolation of stored water.
4. Soil in the reservoir area should not contain any type of harmful salts.
5. Reservoir site should not be lying over an excessively faulted rock. **(Any 4x1.5 =6)**

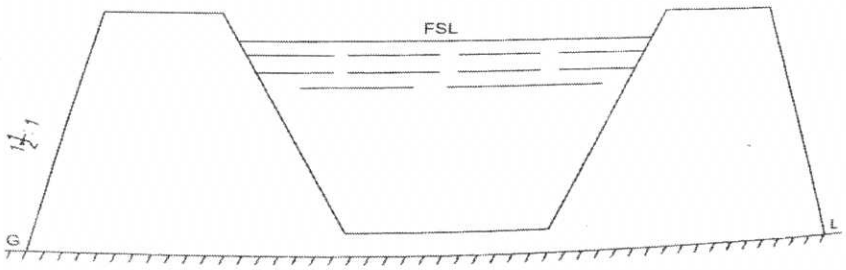
6. **Advantages of canal lining:**

1. Saves water for extending irrigation. 2. Checks growth of weeds on the canal bed.
3. Water logging can be avoided 4. Reduces the cost of maintenance of canals
5. Prevents canal breaches 6. Permits water to flow at higher velocities.

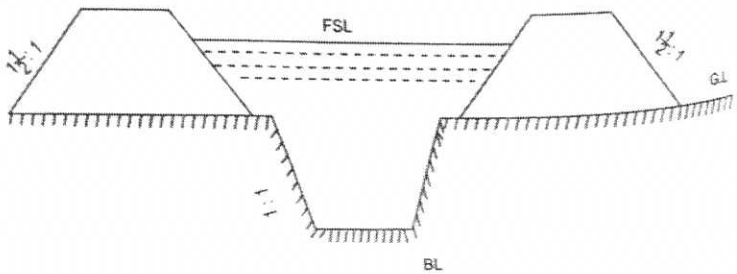
7. 1. **Canal in full cutting:** When the full supply level of the canal is below the natural ground level the section is said to be in full cutting.
   2. **Canal in full banking:** When bed level of the canal is above the natural ground level the section is said to be in full banking.
   3. **Canal in partial cutting:** When the full supply level of the canal is above the natural Ground level and the bed level is below the natural ground level the section is said to be in partial cutting and partial banking.




Canal in Full Cutting




Canal in Full Banking




Canal in Partial Cutting

**(3 + 3 = 6)**

## PART – C

III (a) **Duty:** The relation between the area of crop irrigated and the quantity of irrigation water required to supply is termed as the duty of water.

**Delta:** Delta is the total depth of water required by a crop during the entire crop period and is denoted by symbol Δ.

**Crop period:** Crop period is the period in number of days that a crop takes from the instant of sowing to that of its harvesting.

**Base period:** Base period of a crop refers to the entire period of cultivation from the time when the irrigation water is first applied for the preparation of the ground to its last watering before harvesting. **(4x2=8)**

(b) **Factors affecting Run off:**

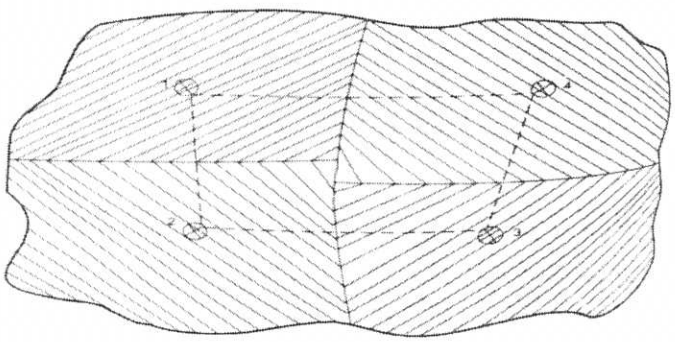
1. **Pattern of Rainfall:** If the intensity of rain fall is more the run – off will be more. If the duration of rain fall is short, it will not produce any run – off. Run – off will be more, if the rain falls over the entire area of the catchment.
2. **Character of catchment surface:** If the surface of the catchment is rocky or compactive, the rain falling on such a catchment will be converted into more run – off because of less seepage losses.
3. **Topography:** Run off depends on the topography of the country also. If the area has a steep slope the rate of run off will be fast and more depressions resulting in less run off.
4. **Shape and size of catchment area:** If the size of the catchment area is large it will give more run – off and vice versa. The amount of run – off in case of a fan shaped catchment will be more as the area is more. In case of fern shaped catchment the run off will be less.
5. **Vegetation in the catchment area:** If the catchment area has a vegetation cover over a greater extent it will reduce seepage losses thus increasing the rate of run – off.
6. **Geological features of the area:** If the area is hard the run – off will be increased, whereas if the area has more fissures, cracks etc, the run – off will be reduced.

7. **Meteorological Condition:** Run – off also depends on annual temperature prevailing on the area. Run – off will be more if the ground is in a saturated condition. If the temperature is high run – off will be less because loss due to infiltration will be more.

IV (a) **Advantages of Irrigation:**

1. It gives good return in the form of irrigation charges realized from cultivators.
2. It prevents famines and improves the general conditions of the country.
3. New irrigation works are taken up at the time of famines to provide employment to the people.
4. When irrigation fascilities are available, valuable crops like sugarcane, cotton, paddy etc, can be grown.
5. Projects which are of multipurpose in nature can provide hydro – electric power.
6. Irrigation canals provide navigation fascilities also where possible.
7. In some cases irrigation canals provide water supply for towns, villages that are there on the banks.
8. Irrigation helps in growing ornamental timber and fruit growing trees.

(b) **Theissen's Polygon Method:**



This method gives accurate results. It is useful when the basin has a bigger area like 500 to 5000 square kilometers. Join the adjacent rain gauge stations 1,2,3,4 etc. by straight lines. Construct the perpendicular bisectors of each of these lines. This is called as Theissen network. The Polygon formed by the perpendicular bisectors around a station encloses an area which is closer to that station than any other station. Find the

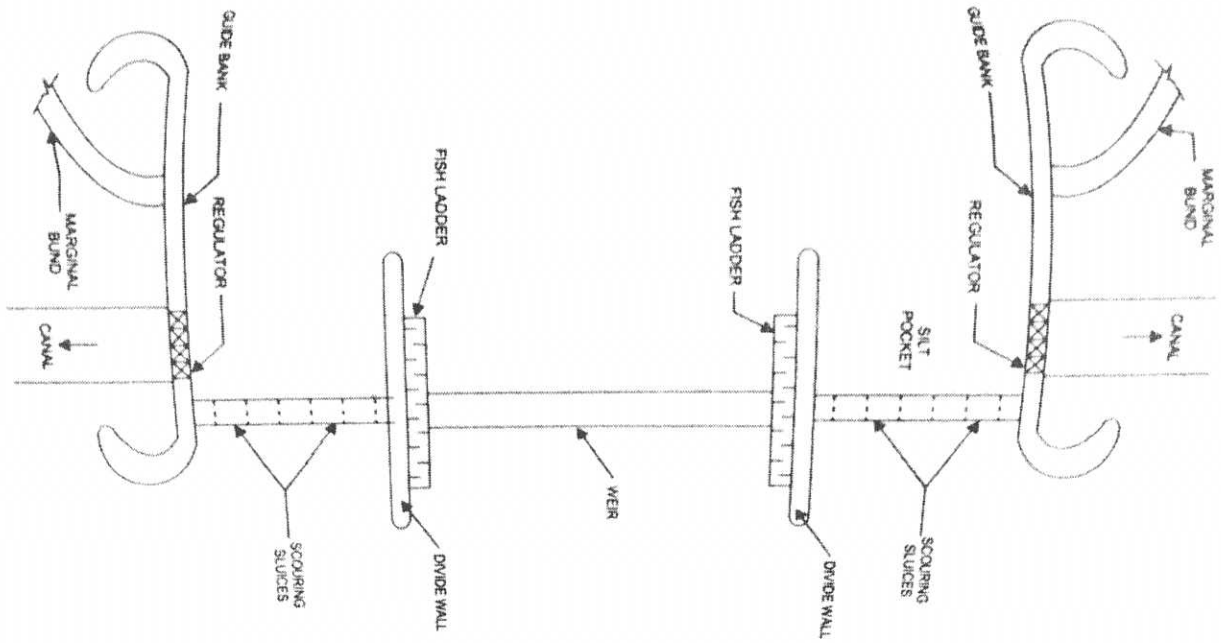
rain gauge value of the enclosed station. Find out the total area of the catchment. Calculate the average rainfall by the following equation.

$P_A = A_1 P_1 + A_2 P_2 + \ldots\ldots\ldots An\ P_n / A_1 + A_2 + A_3 + \ldots\ldots\ldots A_n$

V (a) **Factors for suitable for selection of site for head works:**

1. The material required for construction are locally available.
2. The section of river should be narrow to reduce the magnitude of head works and river training works.
3. The site should give fascilities for economical and safe disposal of water.
4. The disposition of the material required for the work should be convenient and communications to the site good.
5. Percolation losses in the region should not be excessive.
6. Demand for water should be sufficiently large.
7. No. of cross drainage should be less.
8. Economical line of canal should be available.

(b)



VI (a) **Percolation:** When a column of water is standing against the face of any irrigation structure and if the structure happens to be one constructed on permeable foundations the water starts moving under the foundations with certain amount of pressure. This movement of water is called as Percolation.

**Percolation gradient:** The percolated water on its way towards the downstream side of the structure loses pressure. The pressure ordinates if plotted would present a gradually sloping line indicating loss of pressure at every stage. This sloping line is called as Percolation gradient.

**Uplift:** When the percolating water exerts excessive upward pressure and when the apron is not sufficiently strong it may fail due to rupture. The uplift pressure is not important for the upstream apron as it is subjected to downward weight of stored water which is sufficient to neutralize the effect of uplift pressure. The upward pressure exerted by the percolating water is called uplift.

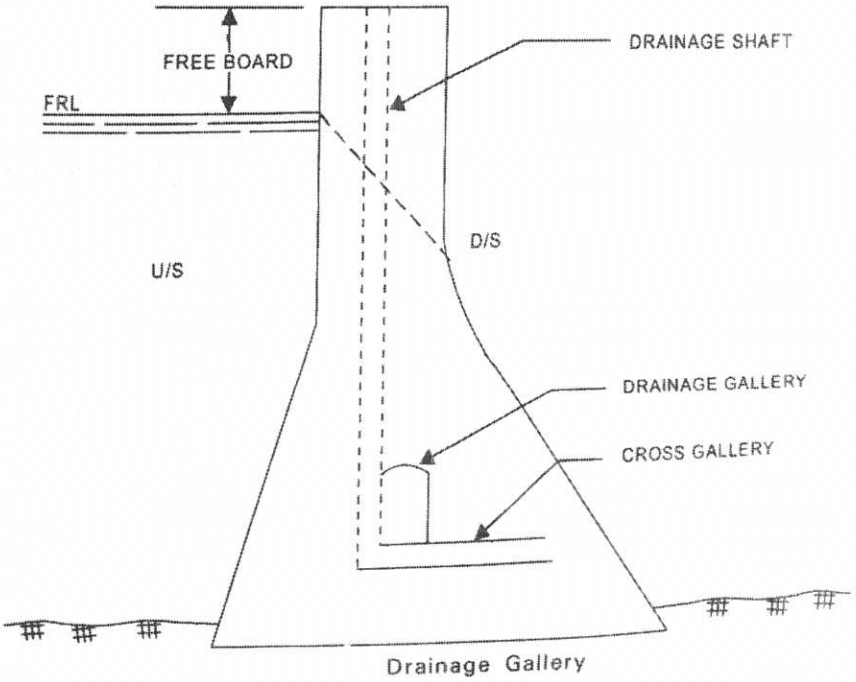
**Scour:** A weir is constructed on a permeable foundation it has to give scope for the percolating water to flow under its foundation also. If proper length of creep and the relevant protective works are not provided under the weir floor the water percolating may try to re-appear at any point. Since this percolating water has certain amount of pressure its re-appearance may cause scour. The effect of this scour would be to carry away the particles of soil and if left unchecked for a longer time would undermine the foundations of the weir itself. To provide sufficient protection against this scouring effect a correct length of creep is to be provided and protective works like solid aprons or loose aprons are to be constructed along the length of creep.

(b) **Diversion head works:** A diversion head work serves to divert the required supply into the canal From the river.

**Purpose of a diversion head work:**

1. It raises the water level in the river so that the command area can be increased.
2. It regulates the intake of water into the canal.
3. It controls the silt entry into the canal.
4. It reduces fluctuations in the level of supply in the river.
5. It stores water for tiding over small periods of short supply.

VII (a)

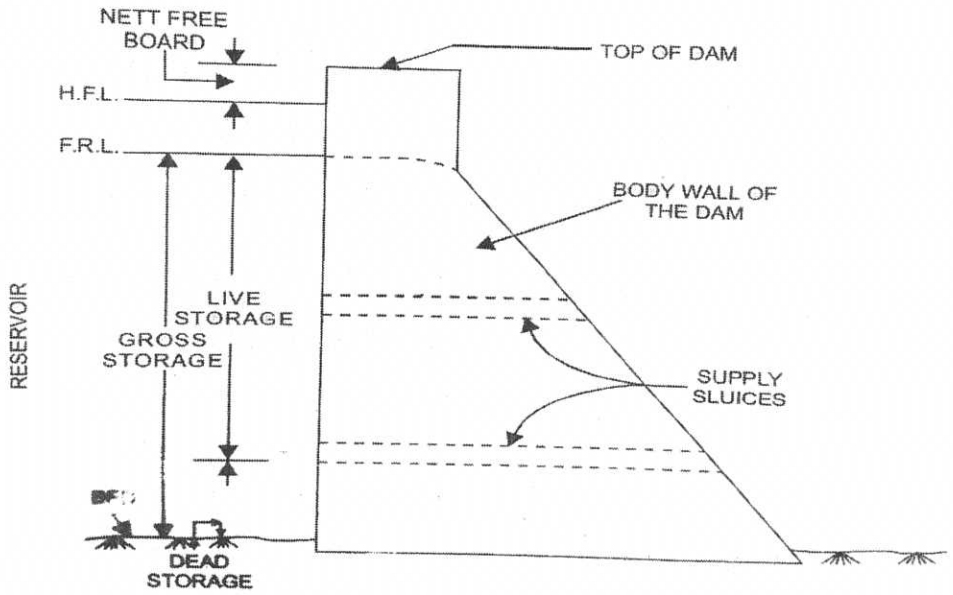



A drainage gallery is an opening provided in the body wall of the gravity dam in the longitudinal direction to the dam. This serves as a longitudinal inspection chamber as well as an outlet for seepage of water. It runs through three fourth of the length of the dam. Suitable cross drains connecting the above with the downstream face of the dam serve also as entrance to the main gallery. It is also an inspection gallery or a foundation gallery. A foundation gallery is provided near the foundation to drain off the water that percolates through foundations. **(4 + 4 = 8)**

(b) **Situation suitable for earth dams:**

1. Where the valley to be covered is wide with a gentle slope.
2. Where there is not much depth of water to be impounded.
3. Where there is no prominence given for water tightness.
4. Where there is ample space for forming the section as the earth dam needs a wide space.
5. Where the spill ways need not be provided in the section.
6. Where the durability is not a prime factor.
7. Where the materials like stone, silt, clay and sand are available in plenty. **(7)**

VIII (a)




Profile of Dam

**Dead storage:** It is the part of stored water in the reservoir which is not available for use. It is the storage of water below the sill of the lowest supply sluice. Dead storage is provided to contain the silt load coming in the reservoir.

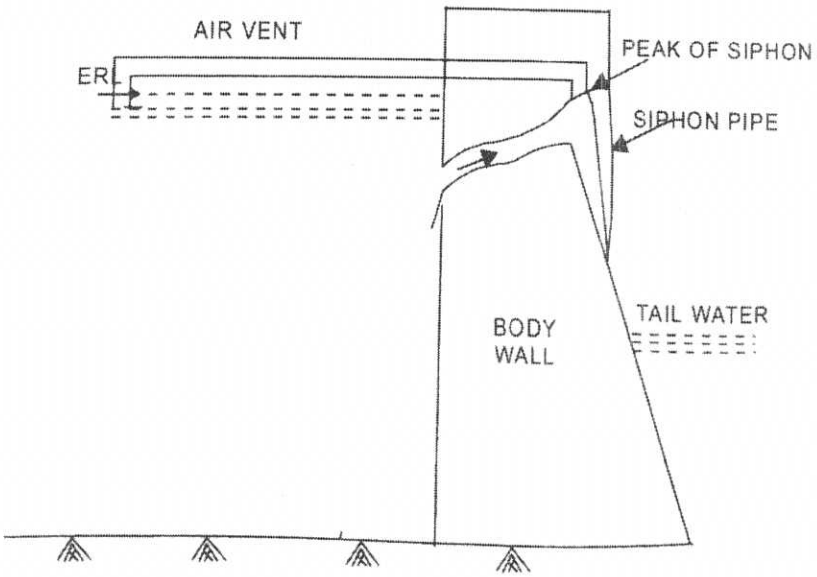
**Live storage:** It can also be called as available storage. It is the difference between gross storage and dead storage.

**Free board:** To prevent overtopping of a dam during the period of peak flood a sufficient margin is left between FRL and top of the dam. **(3 x 2=6 +2 = 8)**

**(b) Siphon Spillway:**

This consists of a siphon pipe with one end of it on the upstream side in contact with the reservoir and the other end passes flow on the downstream side. The crest of the spill way is fixed at full reservoir levels and an air opening is provided. At this level inlet is provided with a screen from where water enters into the pipe to prevent the entry of any floating matter. As the water level in the reservoir rises above FRL the air vent gets submerged. The moment the air enclosed passes out through the downstream side vacuum is created as a result of which more water will be sucked into the pipe. The siphon starts working like this and it will stop

functioning only if the water level comes up to FRL. The rate of discharge in this case will be more and the quicker since the head under which it functions is more when compared to an open spillway.



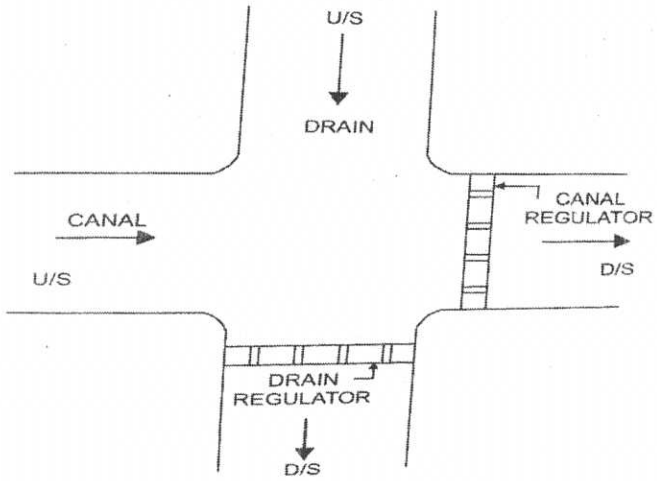

**IX (a) Soil Erosion:** When the top fertile layer of soil is transported from one place to another place by a natural agency like wind or water or glaciers, the phenomenon is called soil Erosion.

**Methods of prevention of soil erosion:**

1. Contour bunding, contour tilting and contour sowing.
2. Providing outlets and spillways so that the velocity of water is arrested and excess run off is allowed to escape.
3. Crop varieties selected should be such that they cover the soil and check the beating of rain directly on soil.
4. Adopting mixed cropping and crop rotation.
5. Afforestation of catchment area is necessary. Areas not economical to grow crops shoud be converted to grass growing pastures.
6. Wind erosion can be prevented by growing trees which obstruct the wind velocity.

**(6+2=8)**

(b) **Level crossing:** This type of cross drainage work is constructed when the bed level of the canal and that of the drainage meet at the same elevation. Regulators are provided on the downstream side of the drainage and canal to regulate the quantities of water to be passed. Protective stone pitching are provided on the beds and sides of the canal on upstream and downstream sides. Regulators are provided with sliding shutter. During dry periods the downstream drainage regulator is closed and downstream canal regulator is opened to allow the water in the canal flow without any interruption. During monsoon when the drain is flowing full the downstream drainage regulator is opened to pass off the flood waters.



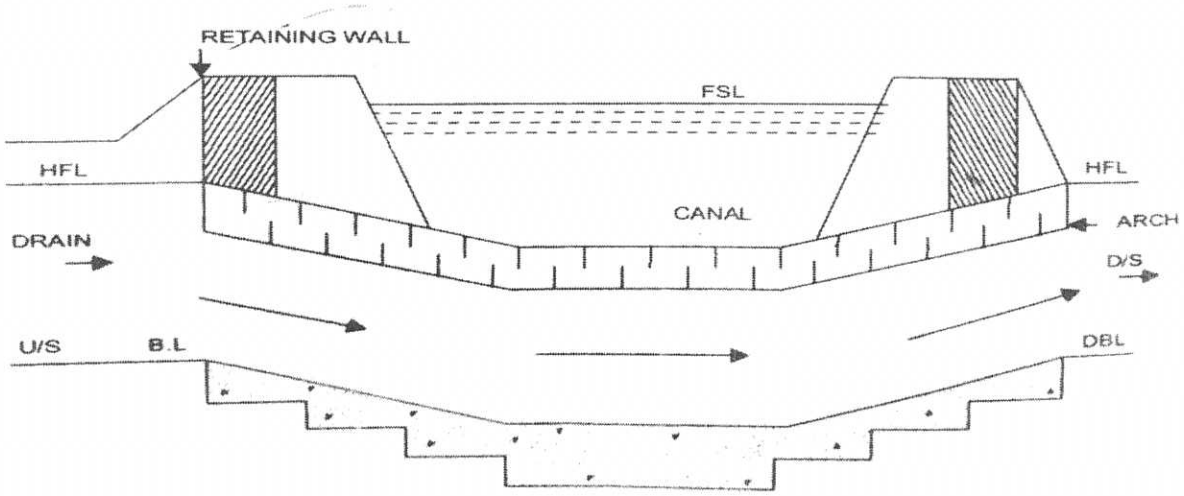

(5+2=7)

**X (a) Permanent types of canal lining:**

1. **Brick lining:** If burnt bricks of good quality are used for protecting the bed and sides of the channel the lining is called as Brick lining. The unburnt bricks should be rejected and the bricks should be thoroughly soaked in water before being laid.
2. **Precast concrete block lining:** In this type of lining precast concrete blocks are used. The blocks are laid on a prepared bed. The thickness of these blocks vary from 5 cms to 6.5 cms.
3. **Cement mortar lining:** Cement mortar mixed in a proportion 1:3 or 1:4 is used as a lining material. It is not durable unless properly protected. If the thickness is more seepage losses can be reduced.

4. **Cement Concrete lining:** This is the best type of lining and can reduce seepage losses to the extent of 95%. Thickness of the lining varies from 5 cms to 15 cms. The subgrade should be well prepared by moistening it so that it will not absorb water from the concrete. The lining is laid in blocks to avoid cracking of concrete. Sometimes reinforcement is also provided.
5. **Stone masonry lining:** This lining is costly and should be taken up only when plenty of stone is available. Pointing is to be done at the joints and when the lining is done properly it will reduce seepage losses to a minimum. **(Any 4x2=8)**

**X (b)** **Syphon Aqueduct:** The types of CD work is necessitated when the HFL of the drainage touched the canal bed level. To provide a greater clearance and also a quicker discharge the bed of the drainage is depressed below the crossing to form an inverted syphon. The water in the syphon flows under hydrostatic pressure and results in a quick discharge of water in the drain running at HFL. The drainage bed is joined by providing vertical drops.




**(4+3=7)**