Cross drainage works

Defination: A cross drainage work is a structure carrying the discharge from a natural stream across a canal intercepting the stream.

Canal comes across obstructions like rivers, natural drains and other canals.

The various types of structures that are built to carry the canal water across the above-mentioned obstructions or vice versa are called cross drainage works.

- **Types of cross drainage works**

Depending upon levels and discharge, it may be of the following types:

(a)Cross drainage works carrying canal across the drainage.

the structures that fall under this type are:

1. Aqueduct

2. Siphon Aqueduct

1) Aqueduct: - When the HFL of the drain is sufficiently below the bottom of the canal such that the drainage waterflows freely under gravity, the structure is known as Aqueduct.

Crossing works: (aqueducts)

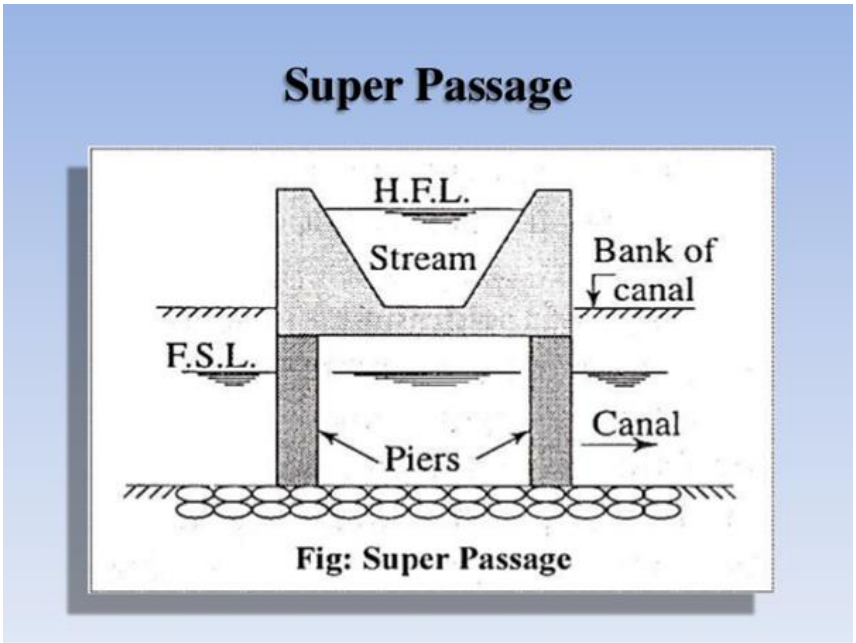
2) Siphon Aqueduct: In a hydraulic structure where the canal is taken over the drainage, but the drainage water cannot pass clearly below the canal. It flows under siphonic action. So, it is known as siphon aqueduct. This structure is suitable when the bed level of canal is below the highest flood level.

b) Cross drainage works carrying drainage over canal.

The structures that fall under this type are:

1. Super passage
2) Canal siphon

1) Super passage: -if the bed level of drainage is sufficiently above the F.S.L of the canal the structure is known as super passage.



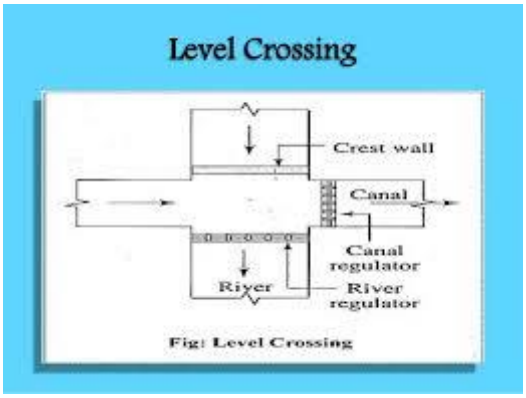
2) canal syphon: -if the F.S.L of the canal is much above the bed level of the drainage through the structure is known as canal syphon.

c) canal and normal drain intersecting each other.

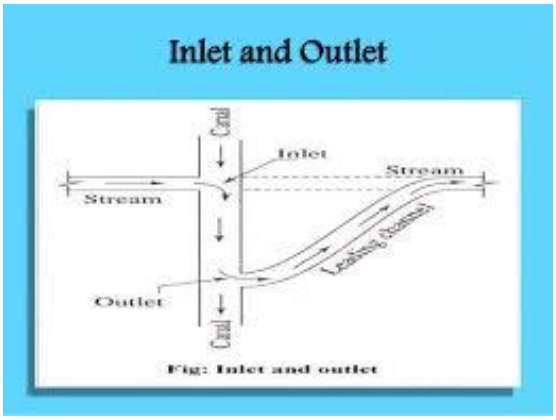
The structures that fall under this type are:

1. level crossing
2. inlets and outlets

1) level crossing: - When the bed level of canal and the stream are approximately the same and quality of water in canal and stream is not much different, the cross-drainage work constructed is called level crossing where water of canal and stream is allowed to mix.



2. inlets and outlets: -when irrigation canal meets a small stream or drain at same level, drain is allowed to enter the canal as in inlet.at some distance from this inlet point a part of water is allowed to drain as outlet which eventually meets the original stream. Stone pitching is required at the inlet and outlet.



- **Selection of suitable site for cross drainage works: -**

The factors which affect the selection of suitable type of cross drainage works are:

- Relative bed levels and water levels of canal and drainage
- Size of the canal and drainage.
- The following considerations are important

- When the bed level of the canal is much above the HFL of the drainage, an aqueduct is the obvious choice.
- When the bed level of the drain is well above FSL of canal, super passage is provided.
- The necessary headway between the canal bed level and the drainage HFL can be increased by shifting the crossing to the downstream of drainage. If, however, it is not possible to change the canal alignment, a siphon aqueduct may be provided.
- When canal bed level is much lower, but the FSL of canal is higher than the bed level of drainage, a canal siphon is preferred.
- When the drainage and canal cross each other practically at same level, a level crossing may be preferred. This type of work is avoided as far as possible.

Hydraulic structures with sketches

Hydraulic structure: - A hydraulic structure is a structure submerged or partially submerged in any body of water, which disrupts the natural flow of water. They can be used to divert, disrupt or completely stop the flow. A hydraulic structure can be built in rivers, a sea, or any body of water where there is a need for a change in the natural flow of water. An example of a hydraulic structure would be a dam, which slows the normal flow rate of river in order to power turbines. Hydraulic structures may also be used to measure the flow of water.

- **Canal Fall: -** The canal falls are required when the natural slope of the canal alignment is sleeper than the bed slope of the canal. The canal bed slope may vary from 1 in 4000 for a discharge of about 1.5 cumecs to about 1 in 50. The difference in the slopes is adjusted by providing vertical falls in the bed of the canal at suitable intervals.

Different type of canal falls: -

1. Ogee fall
2. Rapid fall
3. Stepped fall
4. Notch fall
5. Vertical drop fall
6. Glacis fall

1)Ogee fall: - ogee curve is the combination of convex and concave curves. So, Ogee fall consists of both convex and concave curves gradually. This gradual combination helps to provide smooth transition of flow and also reduce the impact. If the canal natural ground surface is suddenly changed to steeper slope, ogee fall is recommended for that canal. Stone pitching is provided in the upstream and downstream of the fall.

2)Rapid canal falls: -Rapid fall consists a long sloping glacis. It is constructed if the available natural ground surface is plane and long. For this, a bed of rubble masonry is provided and it is finished with cement mortar of 1:3 ratio. To maintain the slope of bed curtain walls are provided at both upstream and downstream. Rapid falls are high priced constructions.

3)Stepped canal falls: - As in the name itself, stepped fall consist vertical steps at gradual intervals. Stepped fall is the modification of rapid fall. It is suitable for the canal which has it upstream at very high level as compared to downstream. These two levels are connected by providing vertical steps or drops as shown in figure.

4) Notch fall: - In case of trapezoidal notch falls, a high crested wall is built across the channel and trapezoidal notches are provided in that wall. Trapezoidal falls are very economical and suitable for low discharges.

5)Vertical drop fall: - Simple vertical drop fall or sarda fall consists, single vertical drop which allows the upstream water to fall with sudden impact on downstream. The downstream acts like cushion for the upstream water and dissipate extra energy. This type of fall is tried in Sarda Canal UP (India) and therefore, it is also called Sarda Fall.

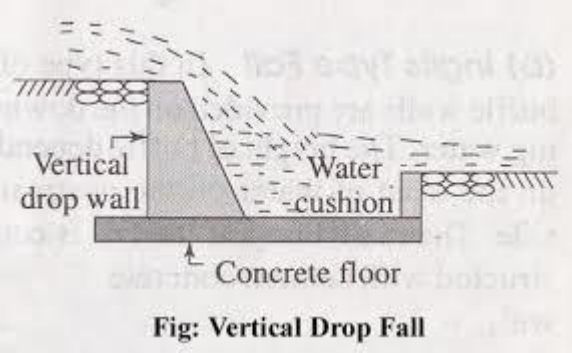
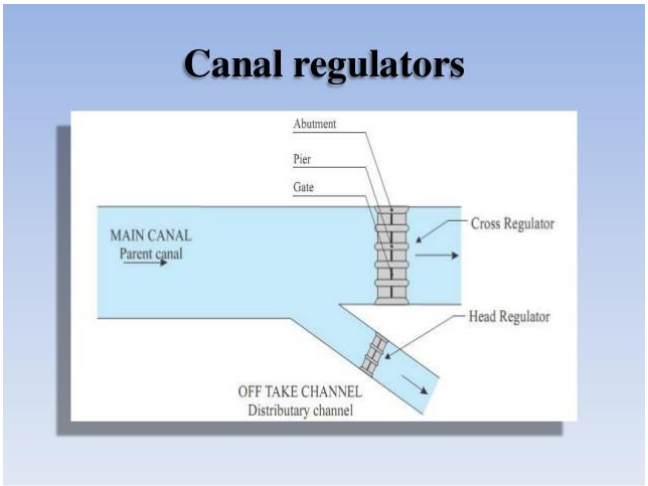


Fig: Vertical Drop Fall

6)Glacis fall: -This is the modern type of construction, in which a raised crest is constructed across the canal and a gentle straight inclined surface is provided from raised crest to the downstream. The water coming from upstream crosses the raised crest and falls on inclined surface with sufficient energy dissipation.

- **Cross and head regulator: -**The supplies passing down the parent canal and off take channel are controlled by cross regulator and head regulator respectively.



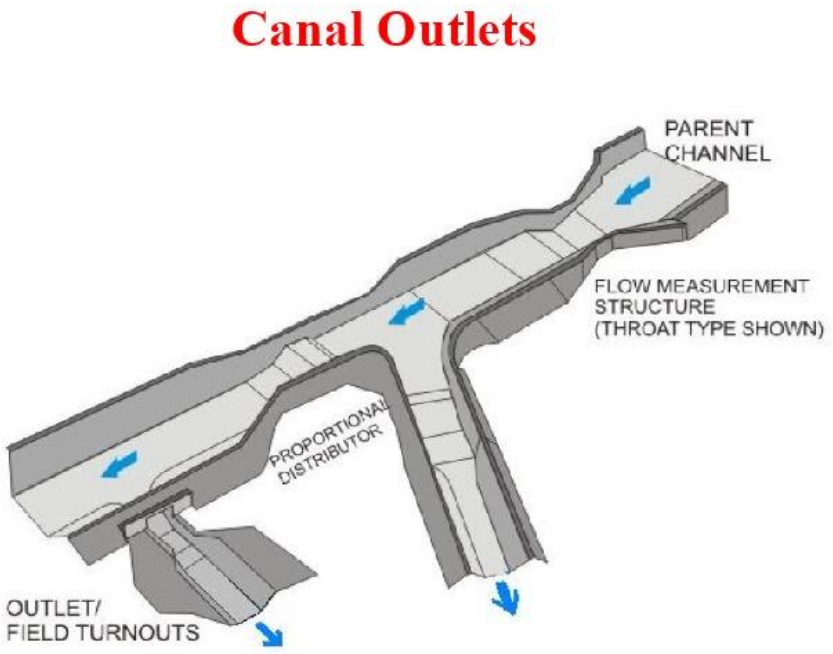
Functions of Cross Regulators: -

1.Regulation of the canal system.
2.Raising the water level in the main canal in order to feed the off-take channels.
3.To facilitate communication by building a road over the cross regulator with little extra cost.
4.To absorb the fluctuations in the canal system.

Functions of Head Regulators: -

1.To regulate and control supplies entering the off-take channel (distributary) from the main(parent) canal.
2.To control silt entering into the distributary.
3.To serve for measurement of discharge.

- **Canal outlets: -**canal outlets are a structure or device through which water is released from a distributing channel into a water course or field channel.



Classification of Outlets:

1) Non modular outlets
2) Semi modular outlets
3) Modular outlets

1)Non-Modular outlets: -These outlets operate in such a way that the flow passing through them is a function of the difference in water levels of the distributing channel and the watercourse.

2)Semi-modular outlets: -The discharge through these outlets depend on the water level of the distributing channel but is independent of the water level in the watercourse so long as the minimum working head required for their working is available.

3)Module outlets: -The discharge through modular outlets is independent of the water levels in the distributing channel and the watercourse, within reasonable working limits. This type of outlets may or may not be equipped with moving parts.

- **Canal escapes:** -a canal escapes are a structure constructed on an irrigation canal for the disposal of surplus water from the canal.it is a sort of safety valve.

Different types of escapes: -

1. Surplus water escapes
2. Canal scouring escapes
3. Tail escapes

1)Surplus water escapes: -a surplus water escapes is a structure constructed on an irrigation channel to dispose off surplus water from the channel.it is also known as canal water escapes.

2) canal scouring escapes: -This escape is constructed for the purpose of scouring of excess silt deposited in the head reaches from time to time. Hence, it is called scouring escape.

3)Tail escapes: -an irrigation canal generally ends in a natural drain or river. The escapes provided at the tail of branch canal or distributary to dispose of the surplus water is called tail escapes.

River training works

River training works: -Any work constructed in order to contain the rivers in their specified path of flow.

Classification of rivers: -

The rivers on alluvial soils may be classified into three types:

1. The meandering type
2. The aggrading type
3. The degrading

Objects of river training: -

1. To achieve safe and expeditious passage of flow through the river.
2. To achieve efficient transport of bed silt and suspended silt.
3. To achieve stable stream course with minimum bank erosion.
4. To achieve sufficient depth of flow for navigation.

Methods of river training works: -

1. **Guide banks:** they are used to guide the river to pass through the constrained width of the river at the structure as bridge or diversion structures.

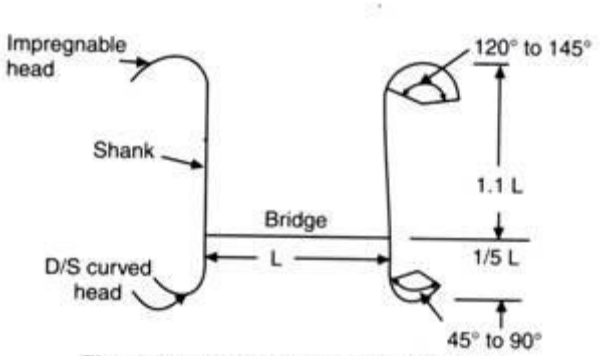
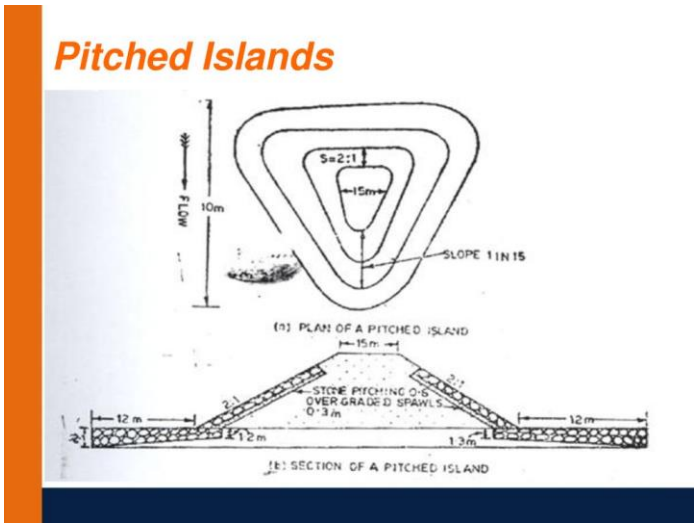


Fig. 14.6. Dimensions of guide banks

2. **Pitched Islands:** it is an artificially created in the river. It may be made of masonry or earth embankment. but pitched all-round.



3.Spurs or Groynes: they are structures-built transverse to the river flow, extending from the bank towards the river, they perform many functions as:

- Increase silting
- Cause scouring
- Deflecting the flow of water

3. **Artificial and Natural cut-off:** when meandering river develops very sharp horse-shoe bends, a small cut is given to connect the peaks with slope more than the slope of the river ,then less Q will pass through the curved river and silted ,then the shape of the river will change after many years to straight river.

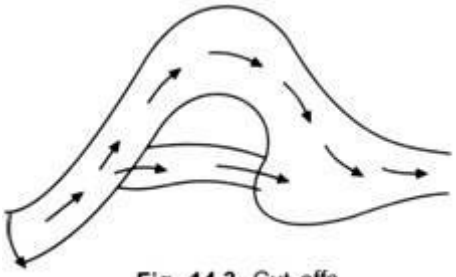


Fig. 14.3. Cut offs

4. **Retired embankments:** Retired embankments are constructed at a distance from the river banks. Thus, retired embankments are the intermediate type between the case of marginal embankments and river with no embankments. Retired embankments are generally constructed on a lower ground away from the banks.

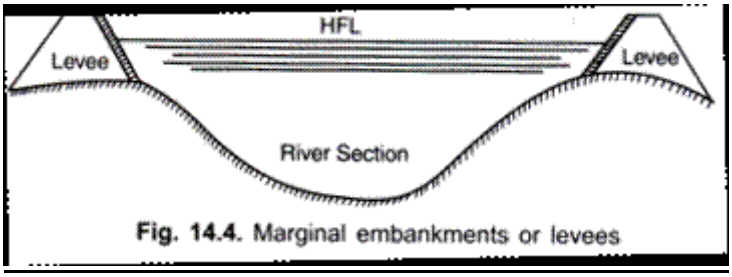


Fig. 14.4. Marginal embankments or levees

Water logging and drainage and ground water re-charge

Water logging: - When the conditions are so created that the crop root-zone gets deprived of proper aeration due to the presence of excessive moisture or water content, the tract is said to be waterlogged. To create such conditions, it is not always necessary that under groundwater table should enter the crop root-zone. Sometimes even if water table is below the root-zone depth the capillary water zone may extend in the root-zone depth and makes the air circulation impossible by filling the pores in the soil.

Causes of Waterlogging: -

1. Over irrigation
2. Seepage from canals
3. Obstruction of natural drainage
4. Inadequate surface drainage
5. Nature of soil
6. Defective method of cultivation
7. Defective practice of irrigation
8. Construction of reservoir

Effects of water logging: -

1. Creation of Anaerobic Condition in the Crop Root-Zone
2. Growth of Water Wild Plants
3. Accumulation of Harmful Salts
4. fall in soil temperature
5. Lowering of Soil Temperature
6. damp climate
7. difficulty in cultivation
8. reduction in plant growth
9. increase in plant diseases
10. increase in incidence of malaria

Remedial and prevention of water logging: -

1. Restricted irrigation
2. Changing the crop pattern
3. Efficient surface drainage
4. Adopting well irrigation
5. Changing the assessment method
6. Reducing seepage from canals
7. Improving natural drainage of the area

Reclamation of soil: -soil reclamation is the process of reclaiming the soil's quality like lost fertility, minerals, nutrients and moisture to make if fit for intensive use again.

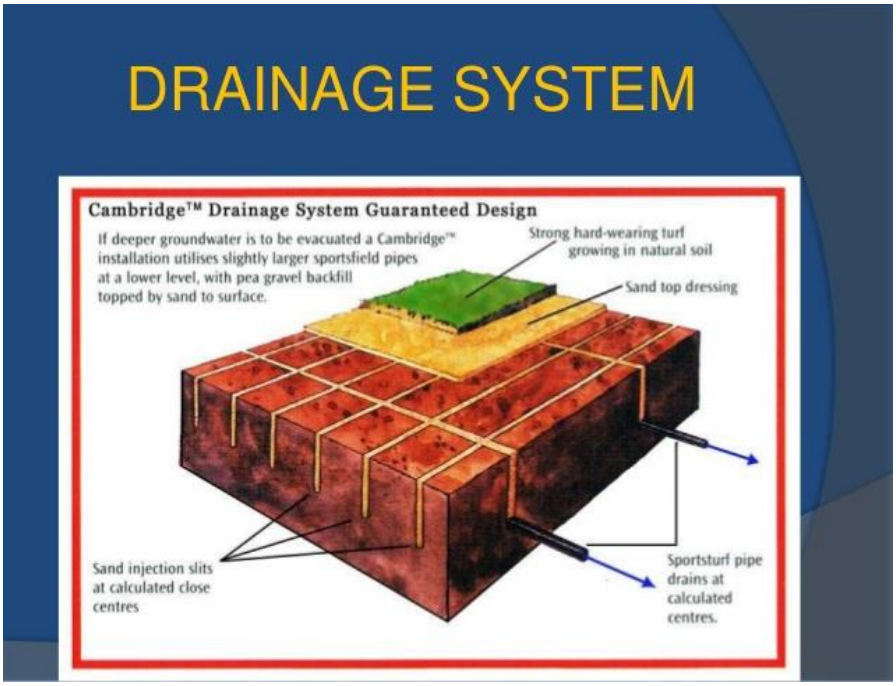
Or

The process by which an unculturable land is made fit for cultivation is referred as land reclamation

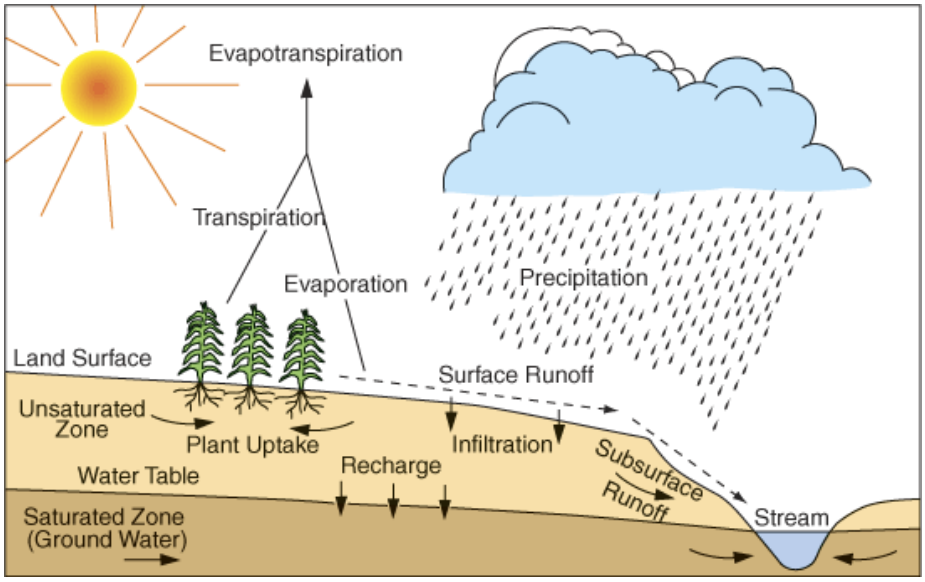
Surface drainage: -Surface drainage refers to the removal

of surface water by development of the slope of the land utilizing systems of drains to carry away the surplus water.

Subsurface drainage: - Subsurface drainage is the removal of excess drainable porosity water in the subsoil, with the aim of lowering or controlling the water table depth below the crop root zone.



Concept of groundwater recharge: -Groundwater recharge or deep drainage or deep percolation is a hydrologic process, where water moves downward from surface water to groundwater. ... This process usually occurs in the vadose zone below plant roots and, is often expressed as a flux to the water table surface.



Techniques used for groundwater recharge: -

1. Spreading Basins
2. Recharge Pits and Shafts
3. Ditches
4. Recharge Wells
5. Harvesting in Cistern from Hill Sides
6. Subsurface Dams
7. Farm Ponds
8. Historical Large Well across Streamlet
9. Check Dams