MODULE – III

Soil

Soil is normally referred to as the naturally occurring organic material found in the earth's surface. It is mainly composed of minerals, nutrients, water and other organic particles and some residues of plants and animals. The soil is the part of earth's surface which includes disintegrated rock, humus, inorganic and other materials.

For the formation of soil, it takes around hundreds to thousands of years. The soil is usually generated when rocks break up into their constituent parts. When a range of different forces acts on the rocks, they break into smaller parts to form the soil.

The soil is mainly classified by its texture, proportions and different forms of organic and mineral compositions. The soil is basically classified into four types

- Sandy soil
- Clay soil
- Silt soil
- Loamy soil

Sandy Soil

- the first type of soil.
- It consists of small particles of weathered rock.
- Sandy soils are one of the poorest types of soil for growing plants because it has very low nutrient and poor in holding water, which makes it hard for the plant's roots to absorb water.
- This type of soil is very god for the drainage system.

Silt Soil

- Silt which is known to have smaller particles compared to the sandy soil and is made up of rock and other mineral particles which are smaller than sand and larger than clay.
- It is smooth and quite fine quality of the soil that holds water better than sand.

Clay Soil

- Clay is the smallest particles amongst the other two types of soil.
- The particles in the soil are tightly packed together with very little or no airspace..
- This soil has very good water storage quality sand resistance for moisture and air to penetrate into it.
- It is very sticky to the touch when wet but smooth when dried.

Loamy Soil

- It s the combination of sand, silt and clay such that the beneficial properties from each is included.
- It has the ability to retain moisture and nutrient.

- This is also referred to as an agricultural soil.

Soil Classification

Classification of soil can be done by any of the following method

- Particle size classification
- Unified soil classification
- Textural classification
- AASHTO classification
- Highway Research Board or Public Road Association Classifiction
- Indian Standard soil classification

FOUNDATIONS

Objectives of foundation:

- To distribute the total load coming on the structure on a larger area.
- To support the structures
- To give enough stability to the structure against various disturbing forces, such as wind and rain.

Types of foundation

Foundation may be broadly classified as

1. Shallow Foundation
2. Deep Foundation

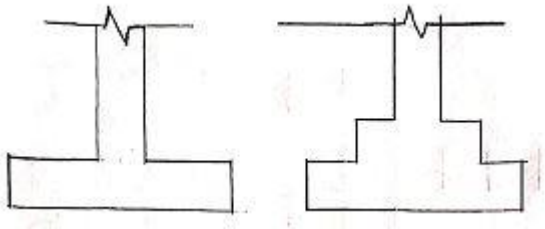
Shallow Foundation*:* When the depth of the foundation is less than or equal to its width, it is defined as shallow foundation.

Deep foundation*:* Deep foundation consists of pile and pier foundation. Pier foundations are rarely used for buildings. This consists in carrying down through the soil a huge masonry cylinder which may be supported on solid rock.

Types of shallow foundation:

Isolated column footing: It is used in framed structures where several columns are to be constructed, isolated buildings can be adopted.

Wall footing: It is the footing provided throughout the length of the wall in the load bearing walls, then it is called wall footing.



Stepped Footing:

- When the ground is sloping, stepped footings are provided.

- It consists of two or more footings of brick or stone masonry and a concrete bed below the ground level.
- The overlap between two layers of foundation concrete slab is equal to the depth of concrete slab or two times the height of the step, whichever is more.

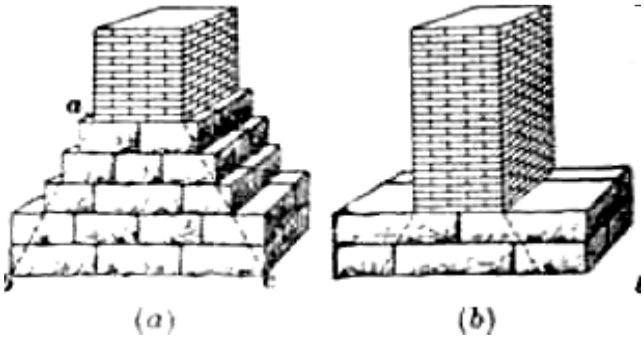
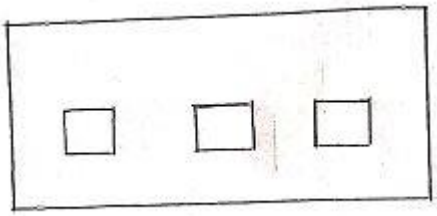


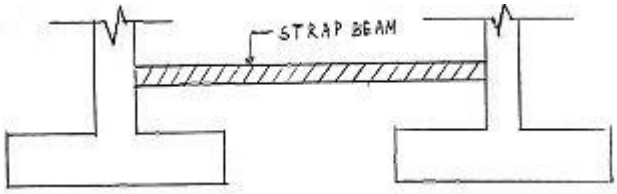
Figure : Stepped footong

Continuous footing: In this type of footing, a single continuous RC slab is provided as foundation for three or more columns in a row. This type of footing is more suitable to prevent the differential settlement in the structure.



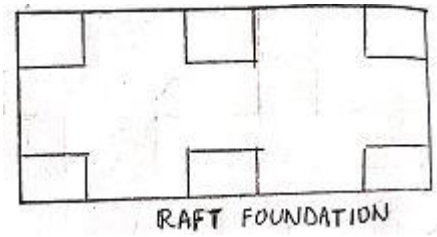
Strap or Cantilever footing:

- Used to prevent differential settlement between two footings by providing a strap beam which connects both the footings.



Raft foundation:

- It supports many columns or walls.
- Used when soil is weak.
- Generally used over sand



Types of deep foundation

1. Pile foundation:

- Pile is an element of construction used as foundation.
- It may be driven in the ground vertically or with some inclination to transfer the load safely.
- Loads are supported in two ways. i.e., either by the effect of friction between the soil and the pile skin or by resting the pile on a very hard stratum.
- The former is called *friction pile* and later one is the *load bearing pile.*

2.Under reamed pile:

- Structures build on expansive soils often crack due to the shrinking of the soil.
- Under reamed piles provide a satisfactory solution to the above problem.
- The principle of this type of foundation is to transfer the load to the hard strata which has sufficient bearing capacity to take the load.
- Single and double under reamed piles may also be provided for foundation of structures in poor soils overlying firm soil strata

3.Cassion or Well foundation:

- These are box like structure which are sunk from surface of either land or water to the desired depth.
- Inside of this structure is hollow which may be filled with sand and plugged from bottom.

Irrigation:

It is the process of artificially supplying water to soil for raising crops.

Irrigation Engineering: The engineering of controlling the various natural sources of water, by construction of demand reservoirs, canals and headwork and finally distributing the water to the agriculture fields is called as irrigation engineering.

The necessity of irrigation depends upon the following points:

- Less Rainfall
- Non-uniform rainfall
- Growing a number of crops during a year
- Growing perennial crops
- Commercial crops with additional water
- Controlled water supply

Advantages & disadvantages of irrigation

Advantages of Irrigation

Direct advantages

(i) Increase in food production: Increase in crop yield due to irrigation leads to increase in food production, thus developing people as well as society.

(ii) Protection against drought: The provision of adequate irrigation facilities in any region ensures protection against failure of crops from famine or drought.

(iii) Revenue generation: When regular supply of water is assured for irrigation the cultivators can grow certain superior or high priced crops (like cash crops) in place of inferior or low priced crops. Thus revenue is generated.

(iv) Mixed cropping: Means sowing of two or more crops together in the same field. This practice is followed so that if weather conditions are not favourable for one crop it may be suitable for other crop. But if irrigation facilities are made available, the need of mixed cropping is eliminated

Indirect advantages

Power generation: Major river valleys projects are usually planned to provide hydroelectric power together with irrigation. However relatively small quantity of hydroelectric power may also be generated at a small cost on projects which are primarily planned for irrigation.

Transportation: Most of the irrigation canals are provided with unsurfaced roads primarily for purposes of inspection and maintenance. These roads provide a good pathway to the local people. The network of irrigation canals can be used as the most economical means of transportation of goods as well as human beings.

Ground water table: In areas where irrigation facilities are provided due to constant percolation of a portion of water flowing in the canals and also that is supplied to the field, the ground water storage is increased and consequently ground water table is raised.

Employment: During the constructions of irrigation works, employment is provided

Disadvantages of Irrigation

- Abundant supply of irrigation water tempts the cultivators to use more water than required
- Excess water supplied to the field would percolate into the soil. Hence, due to constant percolation ground water table would be raised and will lead to water logging
- The ground water can get polluted due to seepage of the nitrates into the ground water (applied to the soil as fertilizers).

Types of irrigation

Following are the two types of irrigation mentioned below

(1) Surface irrigation

- Surface irrigation is defined as the group of water application techniques where water is applied and distributed over the soil surface either by gravity or by pumping
- More than 75% of irrigated lands in India is supplied water by surface irrigation methods.
- This method is best suited to soils with low to moderate infiltration capacities and to lands with relatively uniform terrain.
- Surface irrigation can be further classified into
    - Flow irrigation: When the water is available at a higher level, and it is supplied to lower level, by the mere action of gravity, then it is called Flow Irrigation.

- Lift irrigation: If the water is lifted up by some mechanical or manual means, such as by pumps, etc. and then supplied for irrigation, then it is called Lift Irrigation. Use of wells and tubewells for supplying irrigation water fall under this category.

Flow irrigation can be further sub-divided into:

(a) Perennial irrigation (b) Flood irrigation.

(a) Perennial Irrigation

- In perennial system of irrigation, constant and continuous water supply is assured to the crops in accordance with the requirements of the crop, throughout the crop period.
- In this system of irrigation, water is supplied through canal distribution system taking off from above a weir or a reservoir
- When irrigation is done by diverting the river runoff into the main canal by constructing a diversion weir or a barrage across the river, then it is called as direct irrigation. But if a dam is constructed across a river to store water during monsoons, so as to supply water in the off-taking channel during periods of low flow, then it is termed as storage irrigation

(b) Flood Irrigation

- In this method of irrigation, soil is kept submerged and thoroughly flooded with water, so as to cause thorough saturation of the land.
- It is usually practised in delta regions where the river water level during flood is sufficiently high to supply water to the land by flow, or partly by flow and partly by lift.
- This system of irrigation is also called uncontrolled irrigation or inundation irrigation.

(2) **Sub-surface Irrigation**

In this type of irrigation, water does not actually wet the soil surface rather it flows underground and nourishes the plant roots by capillarity.

It may be divided into the following two types () Natural sub-irrigation (ii) Artificial sub-irrigation.

(i) Natural sub-irrigation

• Leakage water from channels, goes underground and during passage through the sub-soil, it own on lower lands, by capillarity. Sometimes, leakage causes the water table to rise up, which helps in irrigation of crops by capillarity.

(ii) Artificial sub-irrigation

When a system of open jointed drains is artificially laid below the soil, so as to supply water to the crops by capillarity, then it is known as artificial sub irrigation. It is a very costly process and hence, adopted on a very small scale.

Methods of irrigation

There are various ways in which the irrigation water can be applied to the fields. Following are the main classifications:

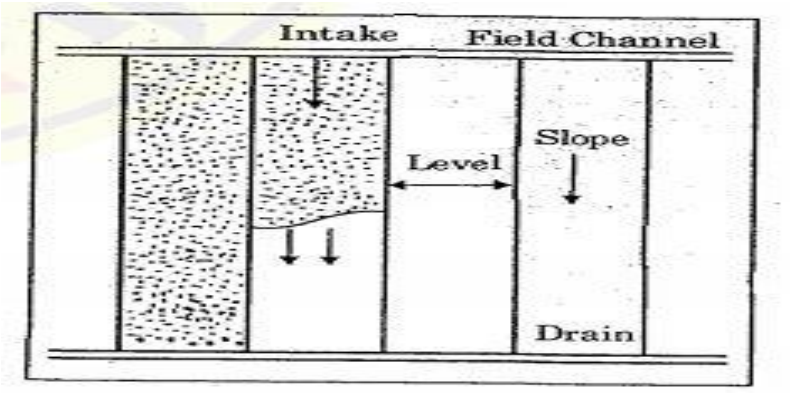
(1) Free flooding
(2) Border flooding
(3) Check flooding
(4) Basin flooding
(5) Furrow method or furrow irrigation
(6) Sprinkler irrigation method
(7) Drip irrigation method

(1)Free flooding or Ordinary flooding

- In this method, ditches are excavated in the field, and they may be either on the contour or up and down the slope,Water from these ditches, flows across the field.
- It is sometimes called wild flooding (as the movement of water is not restricted).
- Wild flooding is most suitable for close growing crops, pastures, etc., particularly where the land is steep This method may be used on rolling land (topography irregular) where borders checks, basins and furrows are not feasible

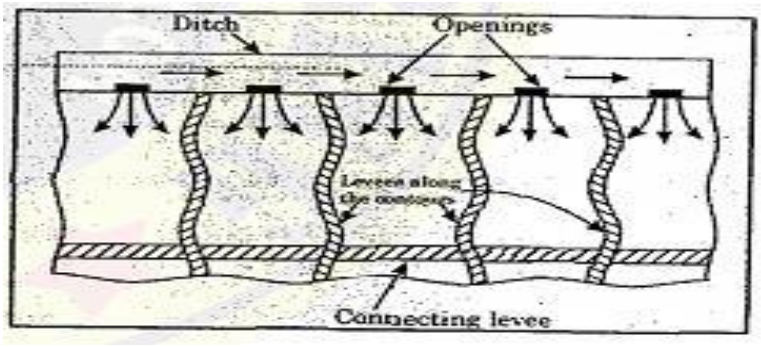
(2) Border flooding

- In this method, the land is divided into a no. of strips, separated by low levees called borders.
- Borders are long, uniformly graded strips of lands, separated by earth bunds. These bunds are to guide the flow of water down the field.
- Water is allowed to flow from the supply ditch into each trip.



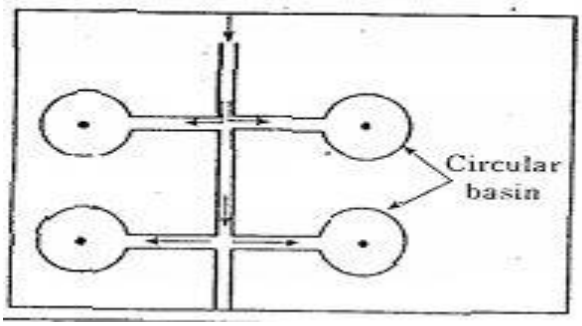
(3) Check flooding

- Check flooding is similar to ordinary.flooding except that the water is controlled by surrounding the check area with low and flat levees.
- Suitable for close growing crops such as jowar or paddy .



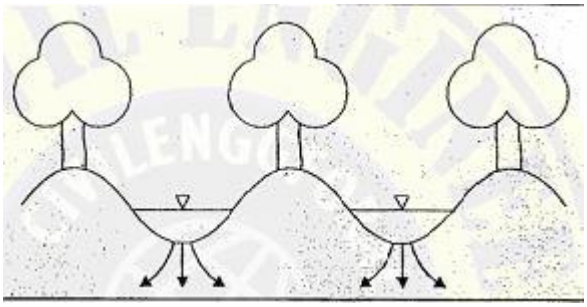
(4) Basin flooding

- This method is a special type of check flooding & adopted specially for orchard trees.
- One or more trees are generally placed in the basin and Shape of the basin can be square rectangular, circular or it may be regular.



(5) Furrow method or furrow irrigation

- In this method of irrigation, water is applied to the land to be irrigated by a series of furrows, Furrows are small parallel channels, made to carry water for irrigating the crops.
- The crops are usually grown on the ridges between the furrows.



(6)Sprinkler irrigation method

- In this method, the irrigation water is applied to the land in the form of spray, somewhat as in ordinary rain through a network of pipes and pumps.
- The sprinkler irrigation can be used for all the crops except rice and jute.

(7) Drip irrigation method

- One of the latest method of irrigation which is becoming increasingly popular in areas with acute scarcity of irrigation water and salt problems.

- In this method, water and fertilizer is slowly and directly applied to the root zone of the plants.
- It is also known as trickle irrigation.

Hydraulic Structure

A hydraulic structure is a structure submerged or partially submerged in any body of water, which disrupts the natural flow of water.

Any hydraulic structure which supplies water to the off-taking canal is called a Headwork

Types:

1. Storage Headwork: A Storage headwork comprises the construction of a dam on the river. It stores water during the period of excess supplies and releases it when demand overtakes available supplies.

2. Diversion Headwork: The works which are constructed at the head of the canal , in order to divert the river water towards the canal, so as to ensure regulated continuous supply of silt free water with certain minimum head into that canal is called as diversion head works.

a) Temporary Spurs or bunds:- which are temporary and constructed every year after floods

b) Permanent Weirs and Barrages

DAM

Dams are massive barriers built across rivers and streams to confine and utilize the flow of water for human purposes. These purposes may be Irrigation, Hydropower, Water-supply, Flood Control, Navigation, Fishing and Recreation. This confinement of water creates lakes or reservoirs.

Classification of Dam

1. Based on function

- Storage dam or impounding dam
- Detention dam
- Diversion dam
- Coffer dam
- Debris dam

2. Based on hydraulic design

- Overflow dam
- Non overflow dam

3. Based on material of construction

- Rigid dam
- Non rigid dam

4. Based on structural behaviour

- Gravity dam
- Arch dam
- Buttress dam
- Embankment dam

CANAL

A canal is defined as an artificial channel constructed on the ground to carry water from a river or another canal or a reservoir to the fields.

Classification of canal

A) **Classification based on alignment**:

1) Ridge canal

2) Side slope canal.

B) **Classification based on position**:

1) Main Canal

2) Branch Canal

3) Major Distributary

4) Minor distributary

5) Water Course

6) Head Work

C) **Classification based on function**

1) Irrigation Canal

2) Navigation Canal

3) Power Canal

4) Feeder Canal

SPILLWAY

A spillway is a hydraulic structure built at dam site for diverting the surplus water from a reservoir, if the store after it has been filled to its maximum capacity.

Types of spillway

- Ogee spillway
- Straight drop spillway
- Side channel spillway
- Chute spillway

WEIR

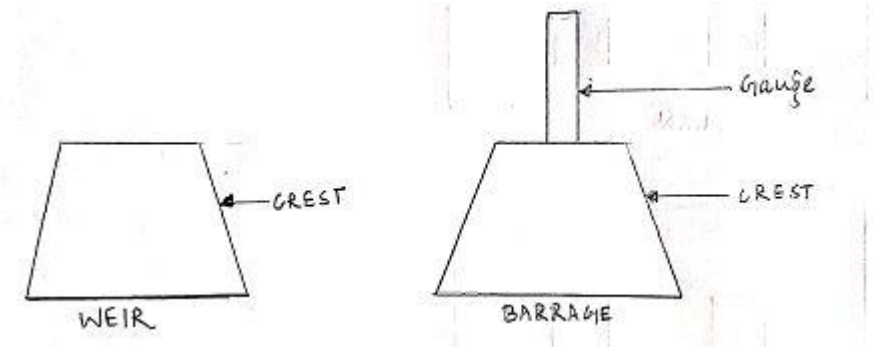
The weir is a hydraulic structure constructed across the river to raise its water level and divert the water into the canal. If a weir also stores water for tiding over small periods of short supplies, it is called as storage weir.

The main difference between a storage weir and dam is only in height and duration for which supply is stored.

BARRAGES

A barrage is a weir that has adjustable gates installed over top of it, to allow different water surface heights at different times. The water level is adjusted by operating the adjustable gates.

It has small crest with gauges (mechanically operated gates) which are often used to control and stabilize water flow for irrigation systems.



Cross Drainage Works

In an Irrigation project, when the network of main canals, branch canals, distributaries, etc.are provided, then these canals may have to cross the natural drainages like rivers, streams, nallahs, etc. at different points within the command of the project. The crossing of the canals with such obstacle cannot be avoided. So, suitable structures must be constructed at the crossing point for the easy flow of water of the canal and drainage in the respective directions. These structures are known as cross-drainage works.

Irrigation Canals while carrying water from headworks to crop field, have to cross few natural drainage streams, nallah, etc.. To cross those drainages safely by the canals, some suitable structures are required to construct.

Works required to construct to cross the drainage are called Cross Drainage Works (CDW). At the meeting point of canals and drainages, bed levels may not be same.

Depending on their bed levels, different structures are constructed and accordingly they are designated by different names.

Types of Cross Drainage Works

- Type I (Irrigation canal passes over the drainage)
  (a) Aqueduct (b) Siphon Aqueduct

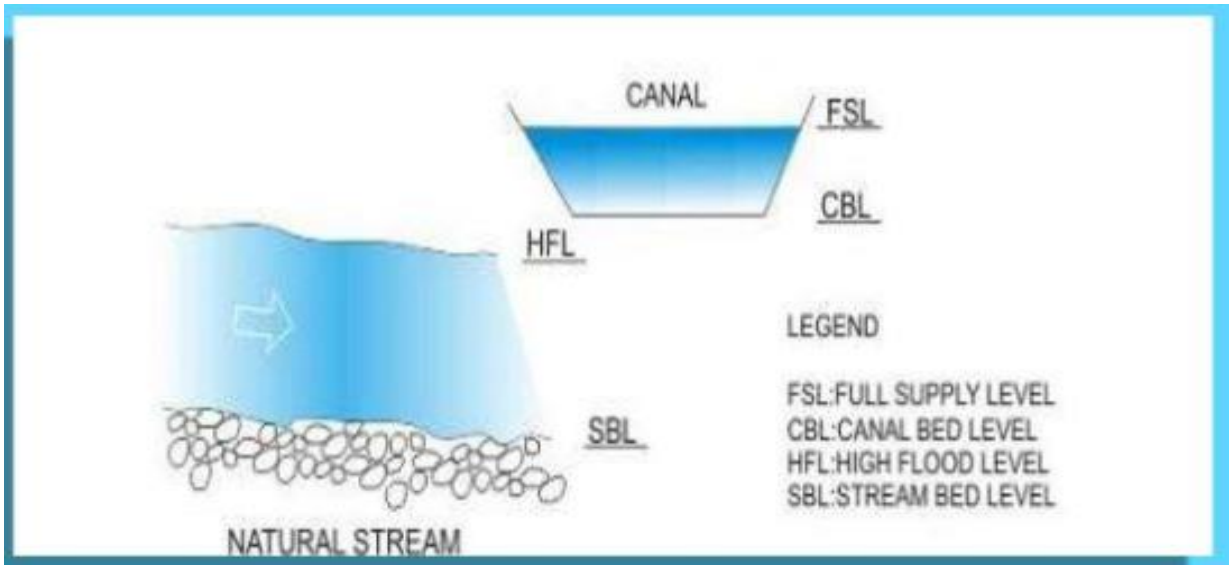
- Type II (Drainage passes over the irrigation canal)
  (a) Super passage (b) Siphon super passage

- Type III (Drainage and canal intersection each other of the same level)
  (a) Level crossing (b) Inlet and outlet

Type-I: Irrigation canal passes over the Drainage. This condition involves the construction of following

Aqueduct

The hydraulic structure in which the irrigation canal is taken over the drainage (such as river, stream etc.) is known as aqueduct. This structure is suitable when bed level of canal is above the highest flood level of drainage. In this case, the drainage water passes clearly below the canal.



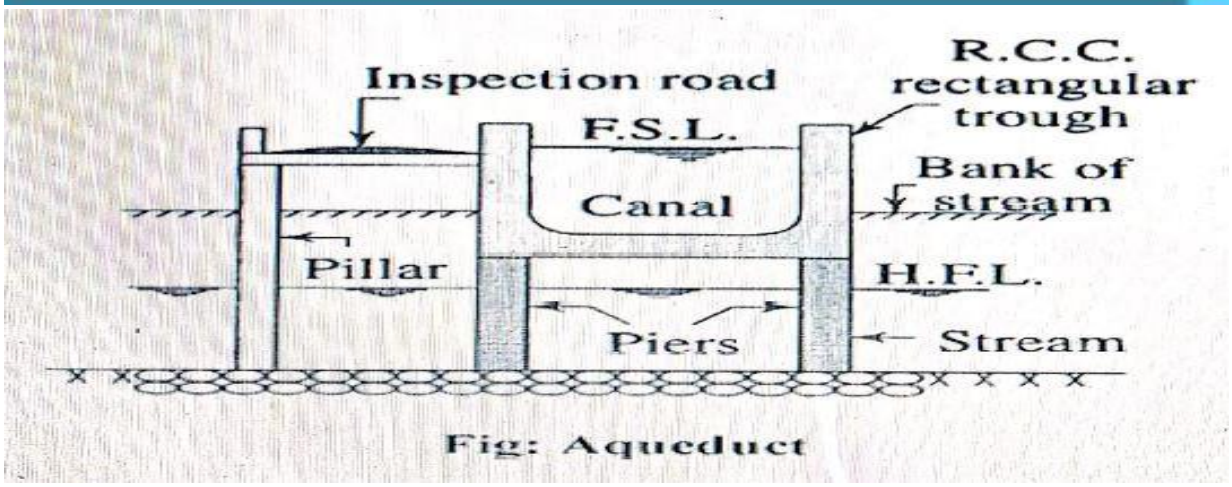
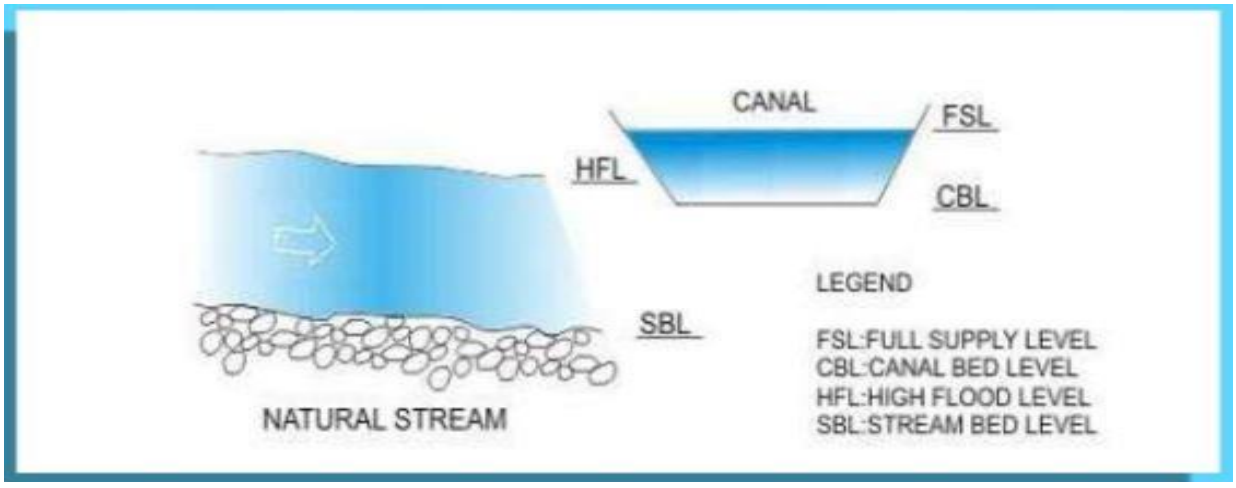


Fig: Aqueduct

Siphon Aqueduct

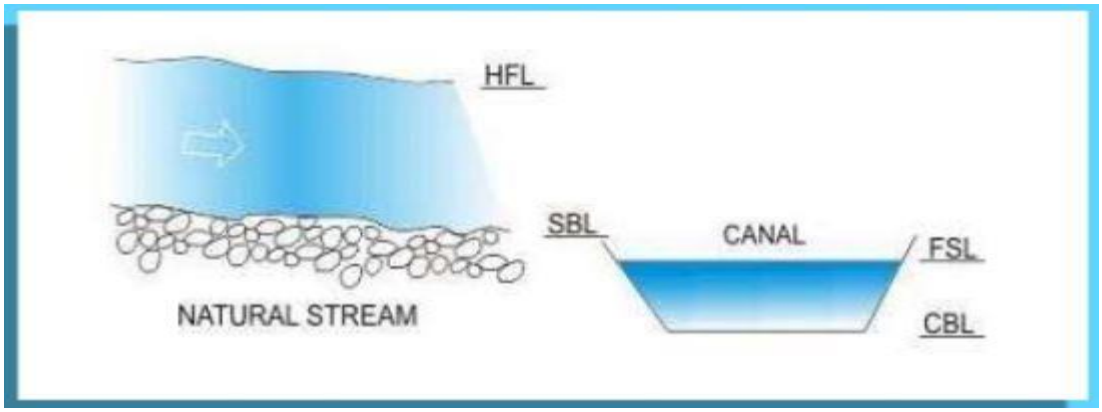
In a hydraulic structure where the canal is taken over the drainage, but the drainage water cannot pass clearly below the canal. It flows under siphonic action. So, it is known as siphon aqueduct. This structure is suitable when the bed level of canal is below the highest flood level.



Type-II: Drainage Passes over the irrigation Canal.

Super Passage

The hydraulic structure in which the drainage is taken over the irrigation canal is known as super passage. The structure is suitable when the bed level of drainage is above the full supply level of the canal. The water of the canal passes clearly below the drainage.



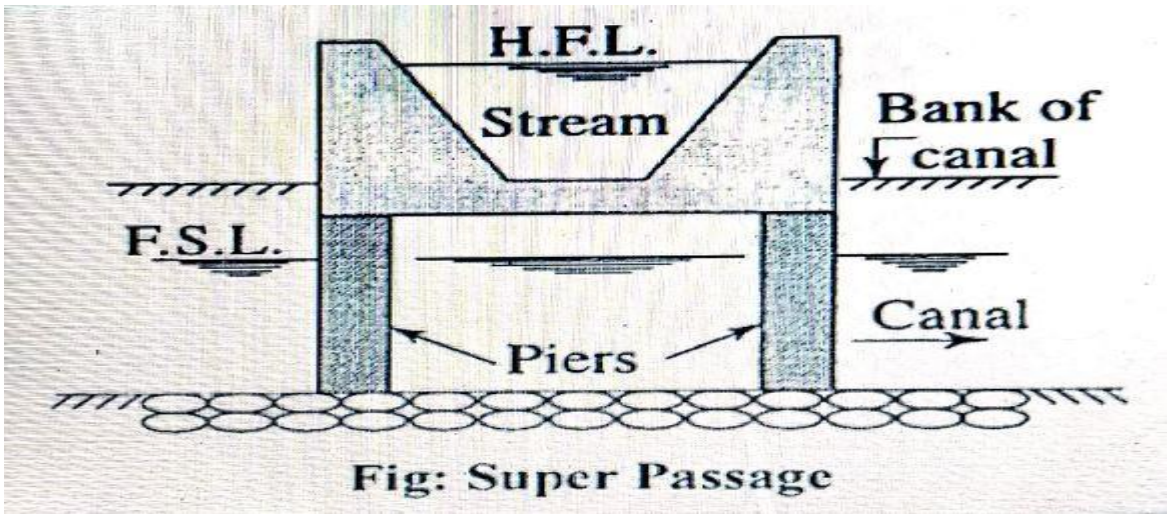
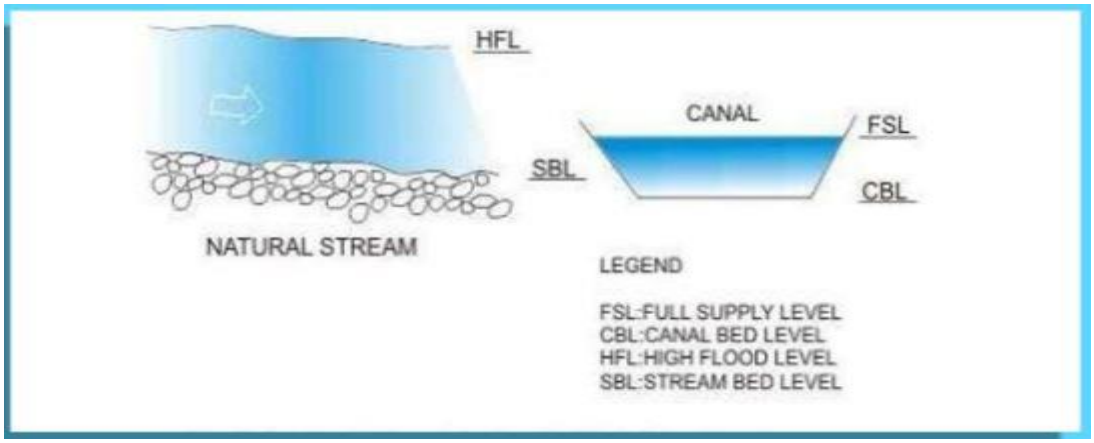


Fig: Super Passage

Siphon Super Passage

The hydraulic structure in which the drainage is taken over the irrigation canal, but the canal water passes below the drainage under siphonic action is known as siphon super passage. This structure is suitable when the bed level of drainage is below the full supply level of the canal.



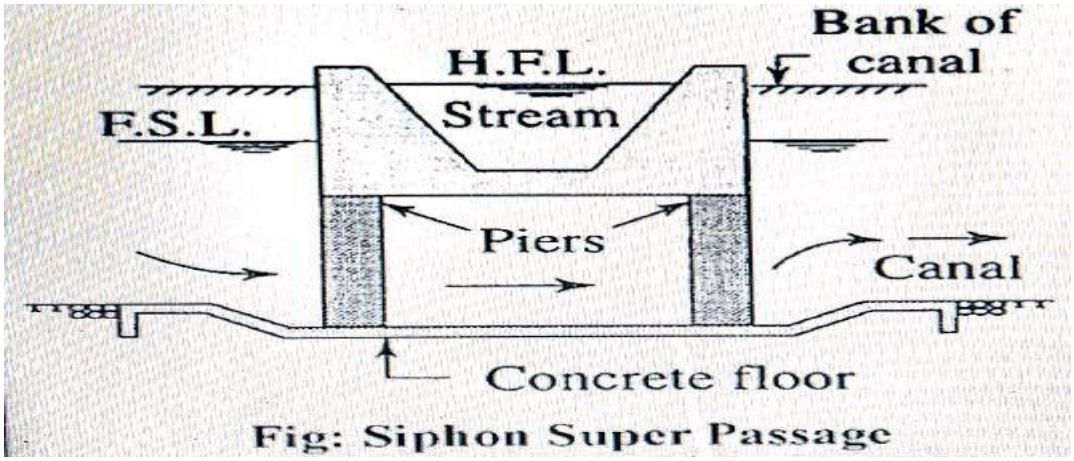
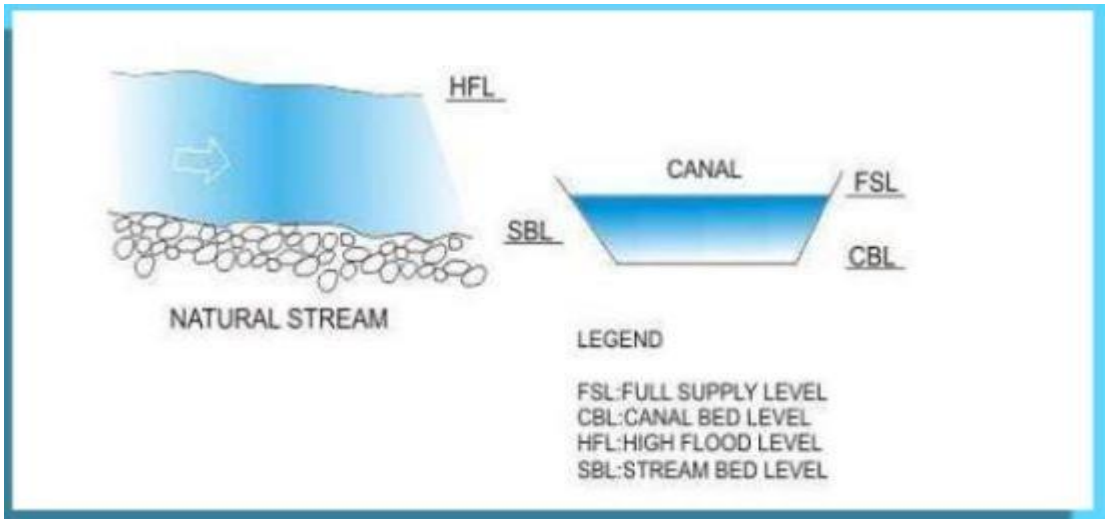


Fig: Siphon Super Passage

Type III: Drainage and Canal intersect each other at the same level.

Level Crossings

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. With the help of regulators both in canal and stream, water is disposed through canal and stream in required quantity. Level crossing consists of following components (i) crest wall (ii) Stream regulator (iii) Canal regulator.



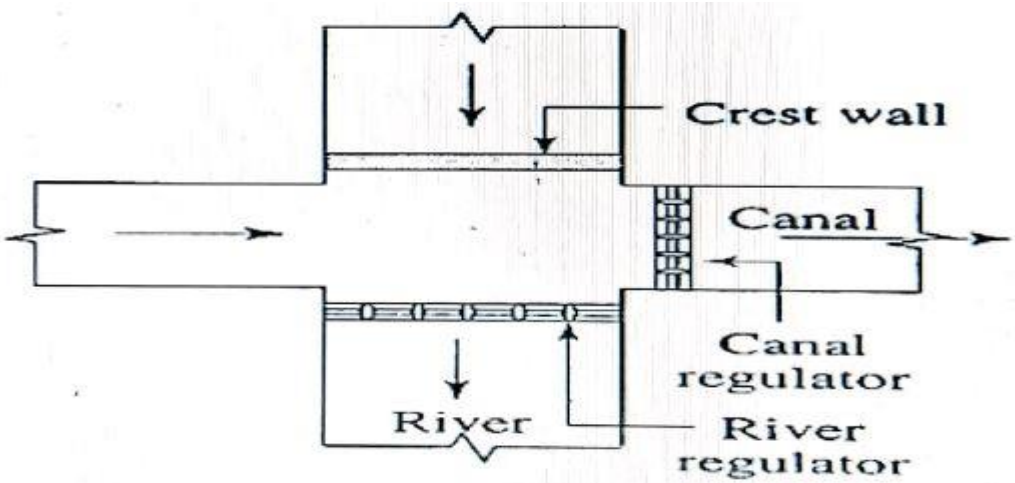


Fig: Level Crossing

Inlet and Outlet

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.

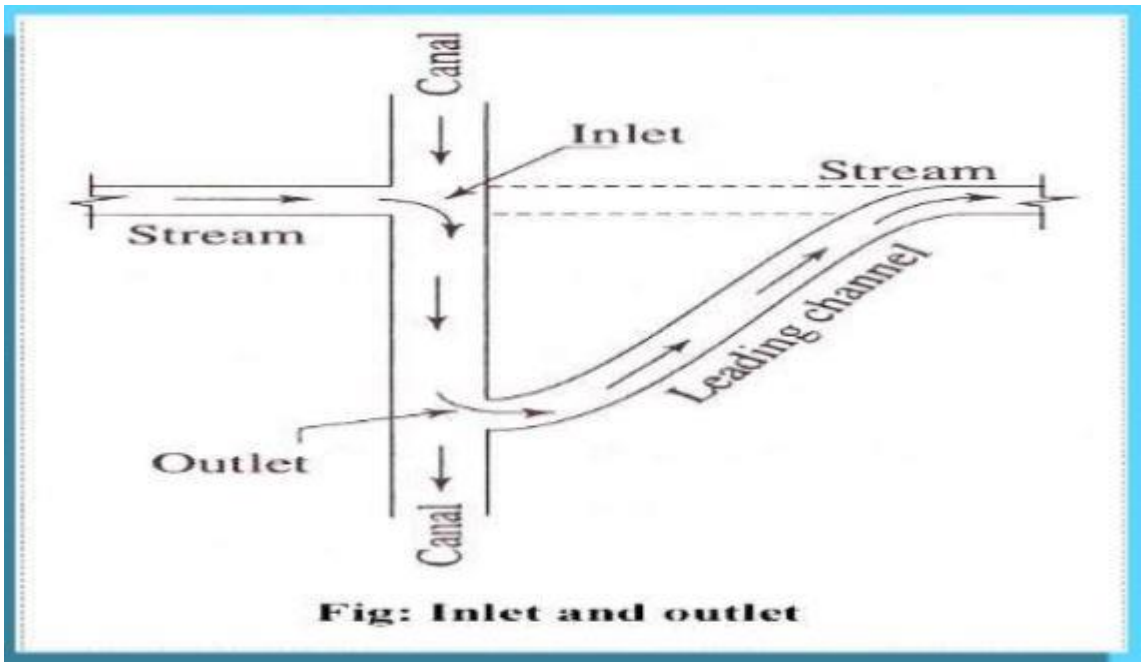


Fig: Inlet and outlet

The bed and banks between inlet and outlet are also protected by stone pitching This type of CDW is called Inlet and Outlet.