Canal Irrigation

Irrigation canal is an artificial channel that is the main waterway that brings irrigation water from a water source to the area to be irrigated.

They can be lined with concrete, brick, stone or a flexible membrane to prevent seepage and erosion.

Classification of Canals based on Different Factors

A canal is an artificial channel constructed to convey water from rivers, reservoirs, etc. for several purposes like power generation, navigation, irrigation, etc. Canals are classified into different types based on factors such as nature of supply source, functions, type of boundary surface, financial output, discharge capacity and alignment of the canal.

Classification of Canals based on Different Factors

Canals are classified into different types based on factors which are as follows:

1. Based on the nature of the supply source
2. Based on functions
3. Based on the type of boundary surface soil
4. Based on the financial output
5. Based on discharge
6. Based on canal alignment

Based on the Nature of Supply Source

1. Permanent Canal
2. Inundation Canal

1. Permanent Canal

A Permanent canal is a type of canal in which water is available throughout the year. This type of canal is generally directed from a permanent source of supply water bodies. Several Permanent hydraulic structures are constructed in this type of canal for water regulation and distribution. A Permanent canal can also be called as a perennial canal.

Fig 1: Permanent or Perennial Irrigation Canal

2. Inundation Canal

Inundation canal is a type of canal in which water is available only during the flood periods. These type of canals are taken off from rivers to control the water level in rivers during floods. A canal head regulator is provided to regulate the flow into the canal.

Based on Functions of Canal

1. Irrigation canal
2. Power canal
3. Feeder canal
4. Carrier canal
5. Navigation canal

1. Irrigation canal

A canal aligned along the boundaries of cultivatable areas in order to supply water for the purpose of agriculture is said to be an irrigation canal.

Fig 2: Irrigation Canal

2. Power canal

A canal constructed especially for the generation of hydraulic power is termed as power canal.


Fig 3: Power Canal of Lake Tekapo, Newzeland

3. Feeder canal

As the name says, a feeder canal is constructed to feed two or more other canals or branch canals.


Fig 4: Sirhind Feeder Canal, India

4. Carrier canal

A carrier canal is multi-function canal which serves the purposes of both irrigation canal and feeder canal. It means the carrier canal feeds the other canals as well as provides water for direct irrigation.

Fig 5: Carrier Canal

5. Navigation canal

A canal which is constructed especially for navigational purposes is known as navigation canal. The water level required in a navigation canal is generally a lot higher to accommodate large ships, vessels, etc.

Fig 6: Panama Navigation Canal, Panama

Based on Type of Boundary Surface of Canal

1. Alluvial canal
2. Non-alluvial canal
3. Rigid Surface canal

1. Alluvial canal

If the canal is excavated in alluvial soils such as silt, sand, gravel, etc. then it is said to be an alluvial canal.

Fig 7: Alluvial Canal

2. Non-alluvial canal

If the boundary surface of the canal is of non-alluvial soils such as loam, clay, rock, etc. then it is said to be a non-alluvial canal.

Fig 8: Non-alluvial Canal

3. Rigid Surface canal

Rigid surface canals also come under non-alluvial canals but here the boundary surface of the canal is lined artificially with a hard layer of lining material such as cement, concrete, stones, etc.


Fig 9: Rigid Surface Canal or Lined Canal

Based on Financial Output

1. Protective canal
2. Productive canal

1. Protective Canal

Protective canals are relief work projects which are constructed to protect a particular area from the shortage of water. The main objective of a protective canal is to fulfill the requirements of cultivators during the period of famine.


Fig 10: Protective Canal

2. Productive Canal

Productive canals are those which will produce enough revenue for its maintenance and running costs and also to recover the initial investment made on the construction of the canal. It is said to be good if it recovers 6% of its initial investment per annum.

Fig 11: Productive Canal, South-North Water Transfer Project, China

Based on Discharge

1. Main canal
2. Branch canal
3. Major distributary canal
4. Minor distributary canal
5. Field canal

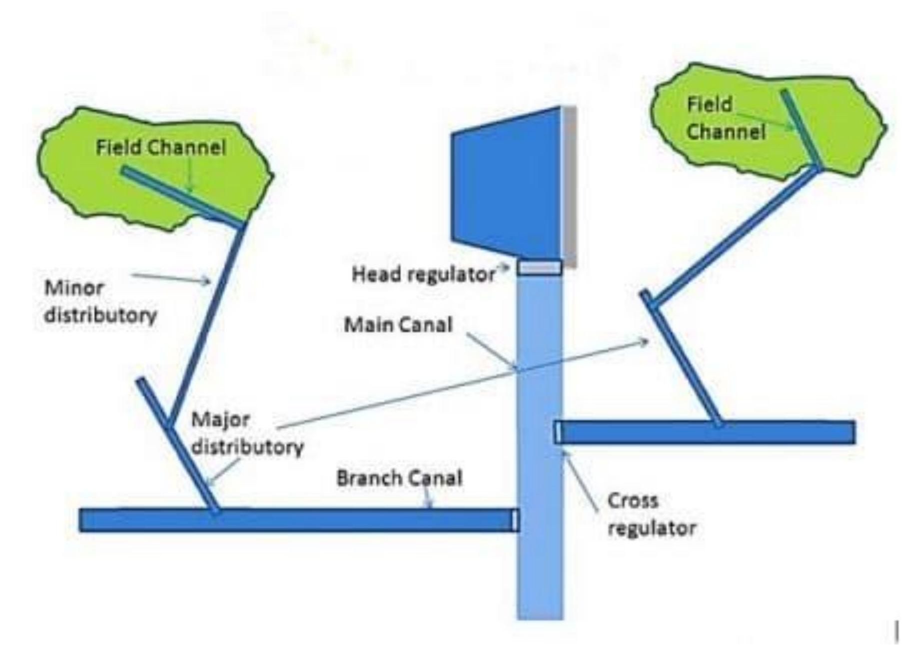


Fig 12: Canal Classification based on Discharge

1. Main canal

The main canal takes off directly from a river or reservoir. It carries water in large amounts to feed the branch and distributary canals. Due to conveying of very high discharge through the main canal it is not recommended to do direct irrigation from it.

2. Branch Canal

The branch canal takes off from main canals at regular intervals. These canals supply water to major and minor distributary canals. The discharge of the branch canal is generally over 5 m^3/sec. In the case of branch canals also, direct irrigation is not recommended unless their water carrying capacity is very low.

3. Major Distributary Canal

Major distributary canal takes off from the branch canal or in some cases from the main canal. They supply water to minor distributaries and field channels. A canal is said to be major distributary when its discharge lies between 0.25 to 5 m^3/sec.

4. Minor Distributary Canal

Minor distributary canal takes off from major distributaries and sometimes directly from branch canals depending upon the discharge of canals. Their discharge is generally below 0.25 m^3/sec. These canals supply water to the field channels.

5. Field Channels

Field channels also known as watercourses are small channels excavated by cultivators in the irrigation field. These channels are fed by the distributary canals and branch canals through canal outlets.

Based on Canal Alignment

1. Ridge canal
2. Contour canal
3. Side-slope canal

1. Ridge Canal

A canal aligned along the ridgeline or watershed line of an area is said to be ridge canal or watershed canal. Since it is running at the peak altitude of the area, irrigation on both sides of the canal up to a larger extent of the area is possible. There is no interception of natural drains on ridge lines hence, no cross drainage works are required for this type of canal.

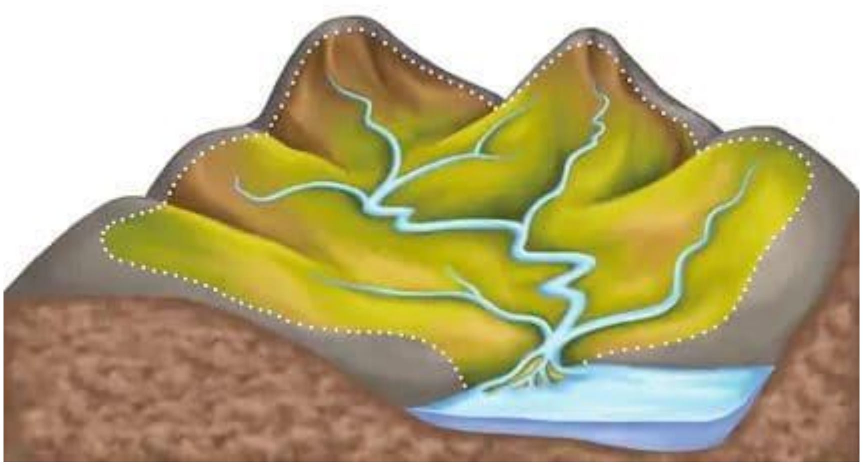


Fig 13; Ridge Canal

2. Contour Canal

A canal aligned roughly parallel to the contours of the area is called a contour canal. This type of canal can be seen in hilly regions. Since it is parallel to the contour line, the ground on one side of the canal is higher and hence irrigation is possible only on the other side of the canal. A contour canal has to pass the drainage and hence cross drainage works are required to be provided.

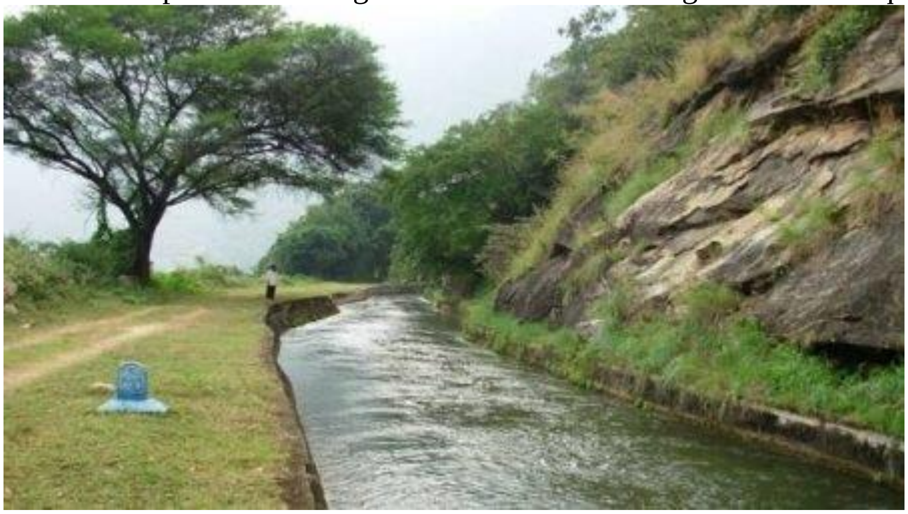


Fig 14: Contour Canal

3. Side-slope Canal

A canal aligned nearly perpendicular to the contour of the area is called a side-slope canal. It is located neither on the ridgeline nor on the valley line but is approximately in between them. It is parallel to the natural drainage line and hence no cross drainage works are required. The bed slope of side slope canal is very steep.

Losses of water in canals

When water continuously flow through a canal, losses takes place due to seepage, deep percolation and evaporation. These losses should be properly accounted for , otherwise lesser quantity of water will be available for agriculture. Water loss in canal can be broadly classified under 3 categories.

a) Evaporation loss
b) Transpiration loss(through the weeds and vegetation on the bank of the channels)
c) Percolation loss

(a)Evaporation Losses

The loss due to evaporation is generally a small percentage of total loss in canal. It hardly exceeds 1 to 2 % of total water entering into a canal. The evaporation loss depends upon

(i) Climatic factor :-Temperature, humidity, wind velocity etc.
(ii) Canal factors:-Water surface area ,water depths, velocity of flow etc.

Maximum losses in there summer season , when temperature is high and wind velocity are also high. Similarly losses are maximum in canals due to wider surface area ,swallower water depths and low velocity. The average evaporation loss per day may vary from 4 mm to 10 mm.

(b) Transpiration Loss

There is a little loss of water through the plants, vegetation and the weeds on the bank of the canal. However this can be controlled by keeping the banks clean from the growth of vegetation and the weeds.

(c) Percolation losses

Percolation loss constitute major portion of loss in a canal. The seepage losses are due to

- Permeability of the soil in the bed and on the banks of the canal
- The depth of the water in the canal
- Velocity of the flow
- Amount of silt in the water
- Temperature of water
- Age of the canal
- The depth of the ground water

Perennial irrigation

In perennial system of irrigation, constant and continuous water supply is ensured to the crop in accordance with the crop requirements, throughout the crop period. In this system of irrigation, water is supplied through storage canal head works and canal distribution system.

Sketches of different canal cross section

3·8. Typical Cross-sections of Irrigation Canals

The irrigation canal sections are designed and constructed in such a fashion that the FSL* of the canal generally remains above the NSL† of the area. This will help in maintaining gravity flow from the canal to the adjacent natural fields.

Now, the ground levels along the selected alignment of a canal are not uniform, and it may be high at some places and low at others. Sometimes the available ground slope may be steeper than the designed canal slope. In order to maintain the water level in the canal above the field level, the canal may have to be constructed, (*i*) eithers in full cutting ; or (*ii*) in full embankment ; or (*iii*) in partial cutting and partial embankment,

A typical and the most desired section of a canal, which is partly in cutting and partly in filling is shown in Fig. **3·7.** Such a section will be adopted when the NSL of the area lies in between the FSL of the canal and the bed level of the canal. However, when the NSL is lower than the bed level of the canal, the entire canal section shall have to be constructed fully in filling (*i.e.* in embankment), as shown in Fig. 3·8. Similarly, when the NSL is higher than the FSL of the canal, the canal section will have to be cut entirely, as shown in Fig. 3·9.

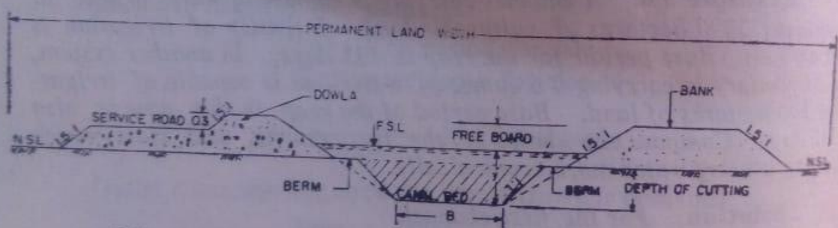


Fig. 3·7. Typical section of a canal distributary in partial cutting and partial filling (*i.e.* NSL lies in between FSL and bed level.

*. FSL means full supply level.

†. NSL means natural surface level.

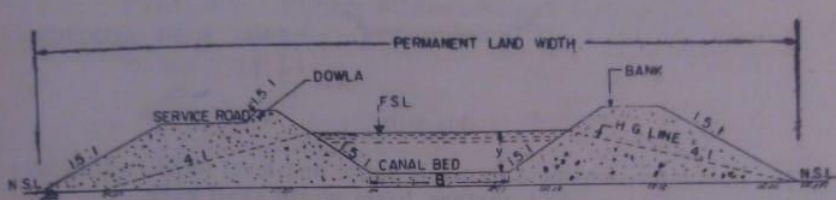
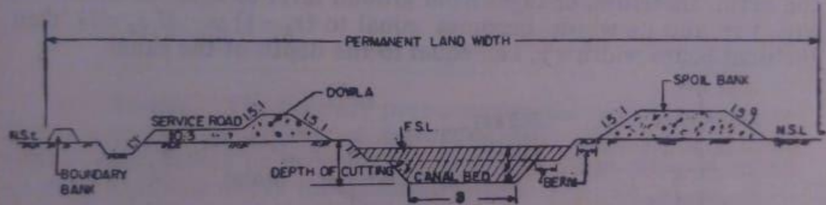


Fig. 3·8. Typical section of a distributary canal in full embankment (*i.e.* NSL is lower than the bed level of the canal).



Fig' 3·9. Typical section of a canal distributary in full cutting (*i.e.* NSL lies above the FSL).

Canal Alignment

A canal has to be aligned in such a way that it covers the entire area proposed to be irrigated, with shortest possible length and at the same time its cost including cost of drainage works is minimum. A shorter length of canal ensures less loss of head due to friction and smaller loss of discharge due to seepage and evaporation, so that additional area may be brought under cultivation. A canal may be aligned as a contour canal, a side slope canal or a ridge canal according to the type of terrain and culturable area.

Irrigation canals can be aligned in any of the three ways:

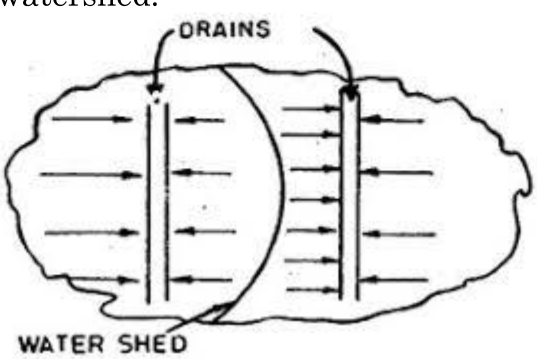
(i) Watershed Canal
(ii) Contour Canal
(iii) Side slope Canal

Watershed Canal

The dividing line between the catchment area of two drains or streams is called watershed. Thus between two major streams, there is the main watershed which divides the drainage areas of the two. Similarly , between any tributary and the main stream and also between any two tributaries there are subsidiary watersheds, dividing the drainage between the two streams on either side.

For canal system in plain areas, it is often necessary as well as advantageous to align all channels on the watersheds of the areas, they are designed to irrigate. The canal which is aligned along any natural watershed, is called a watershed canal. In such a canal, water flows by gravity, either side of the canal, directly or through small irrigation channels.

Moreover, cross drainage works avoided as the natural drainage will never cross a watershed, because all the drainage flows away from the watershed. Sometimes watershed may have to abandoned in order to bypass localities settled on the watershed.



(Alignment of a watershed canal aligned along the watershed)

Contour Canal

The above arrangement of providing the watershed is not possible in hilly areas. In the hills, the river flows in the valley, while the watershed or the ridge line may be hundreds of meters above it. It becomes uneconomical to take the canal on top of such ridge. The canal in such cases, is generally aligned parallel to the contours of the area

except that the longitudinal slopes required to generate sufficient flow velocity , are given to it.
The maximum designed slope that can be provided in the canal without generating excessive velocity, is generally less the available country slope. The difference is accommodated by providing canal falls at suitable places. A contour channel irrigates only on one side because the areas on the other side is higher.
As the drainage flow is at right angle to the ground contours, such a channel would definitely have to cross drainage lines. Suitable cross drainage works are then provided.

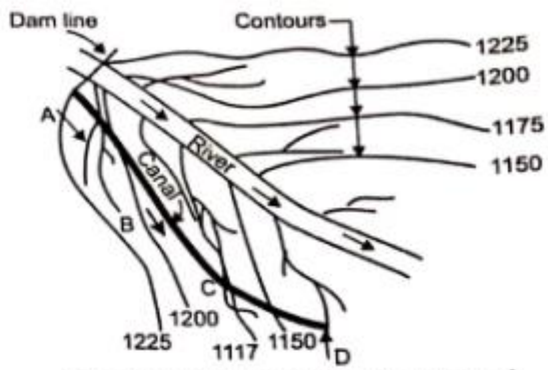
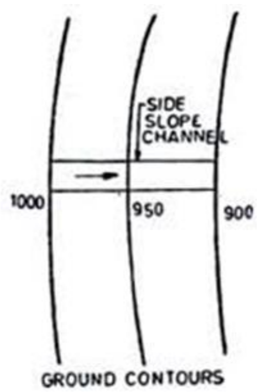


Fig. 6.2 : Alignment of Contour Canal

Side slope Canal
A side slope channel is that which is aligned at right angles to the contours. i.e. along the side slopes. Such a channel is parallel to the natural drainage flow and hence, doesn't intercept cross drainage and no cross drainage works are required.



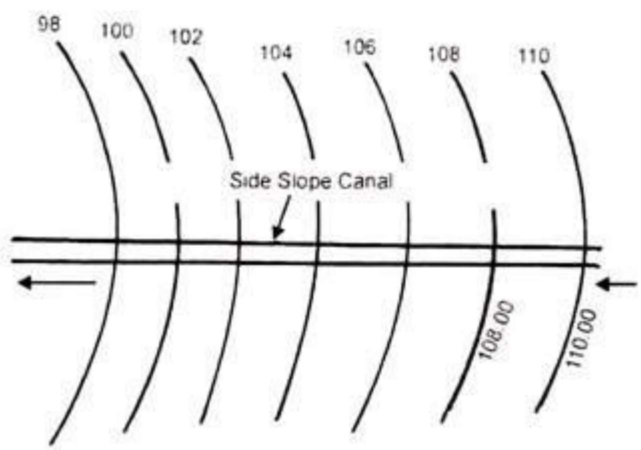


Fig. 16.3. *Side slope channel*

Canal lining
Canal Linings are provided in canals to resist the flow of water through its bed and sides. These can be constructed using impervious or fairly impervious lining material

of sufficient strength such as compacted earth, cement, concrete, plastics, boulders, bricks etc. The main advantage of canal lining is to protect the water from seepage loss.

Advantages of Canal Lining

- Seepage Reduction
- Prevention of Water Logging
- Increase in Commanded Area
- Increase in Channel Capacity
- Less Maintenance
- Safety Against Floods

1. Seepage Reduction

The main purpose behind the lining of canal is to reduce the seepage losses. In some soils, the seepage loss of water in unlined canals is about 25 to 50% of total water supplied. The cost of canal lining is high but it is justifiable for its efforts in saving of most of the water from seepage losses. Canal lining is not necessary if seepage losses are very small.

2. Prevention of Water Logging

Water logging is caused due to phenomenal rise in water table due to uncontrolled seepage in an unlined canal. This seepage effects the surrounding ground water table and makes the land unsuitable for irrigation. So, this problem of water logging can be surely prevented by providing proper lining to the canal sides.

3. Increase in Commanded Area

Commanded area is the area which is suitable for irrigation purpose. The water carrying capacity of lined canal is much higher than the unlined canal and hence more area can be irrigated using lined canals.

4. Increase in Channel Capacity

Canal lining can also increase the channel capacity. The lined canal surface is generally smooth and allows water to flow with high velocity compared to unlined channel. Higher the velocity of flow greater is the capacity of channel and hence channel capacity will increase by providing lining.

On the other side with this increase in capacity, channel dimensions can also be reduce to maintain the previous capacity of unlined canal which saves the cost of the project.

5. Less Maintenance

Maintenance of lined canal is easier than unlined canals. Generally there is a problem of silting in unlined canal which removal requires huge expenditure but in case of lined canals, because of high velocity of flow, the silt is easily carried away by the water.

In case of unlined canals, there is a chance of growth of vegetation on the canal surface but not in case of lined canals. The vegetation affect the velocity of flow and water carrying capacity of channel. Lined canal also prevents damage of canal surface due to rats or insects.

6. Safety against Floods
A line canal always withstand against floods while unlined canal may not resists and also there is chance of occurring of breach which damages the whole canal as well as surrounding areas or fields. But among the all concrete canal linings are good against floods or high velocity flows.

Types of Canal Linings

Canal linings are classified into two major types based on the nature of surface and they are:

1. Earthen type lining
2. Hard surface lining

1. Earthen Type lining

Earthen Type lings are again classified into two types and they are as follows:

- Compacted Earth Lining
- Soil Cement Lining

Compacted Earth Lining

Compacted earth linings are preferred for the canals when the earth is available near the site of construction or In-situ. If the earth is not available near the site then it becomes costlier to construct compacted earth lining.

Compaction reduces soil pore sizes by displacing air and water. Reduction in void size increases the density, compressive strength and shear strength of the soil and reduces permeability. This is accompanied by a reduction in volume and settlement of the surface. Proper compaction is essential to increase the stability and frost resistance (where required) and to decrease erosion and seepage losses.

Fig 2: Compacted Earth Lining

Soil Cement Lining

Soil-cement linings are constructed with mixtures of sandy soil, cement and water, which harden to a concrete-like material. The cement content should be minimum 2-8% of the soil by volume. However, larger cement contents are also used.

In general, for the construction of soil-cement linings following two methods are used.

- Dry-mix method
- Plastic mix method

For erosion protection and additional strength in large channels, the layer of soil-cement is sometimes covered with coarse soil. It is recommended the soil-cement lining should be protected from the weather for seven days by spreading approximately 50 mm of soil, straw or hessian bags over it and keeping the cover moistened to allow proper curing. Water sprinkling should continue for 28 days following installation.

(Soil Cement Lining)