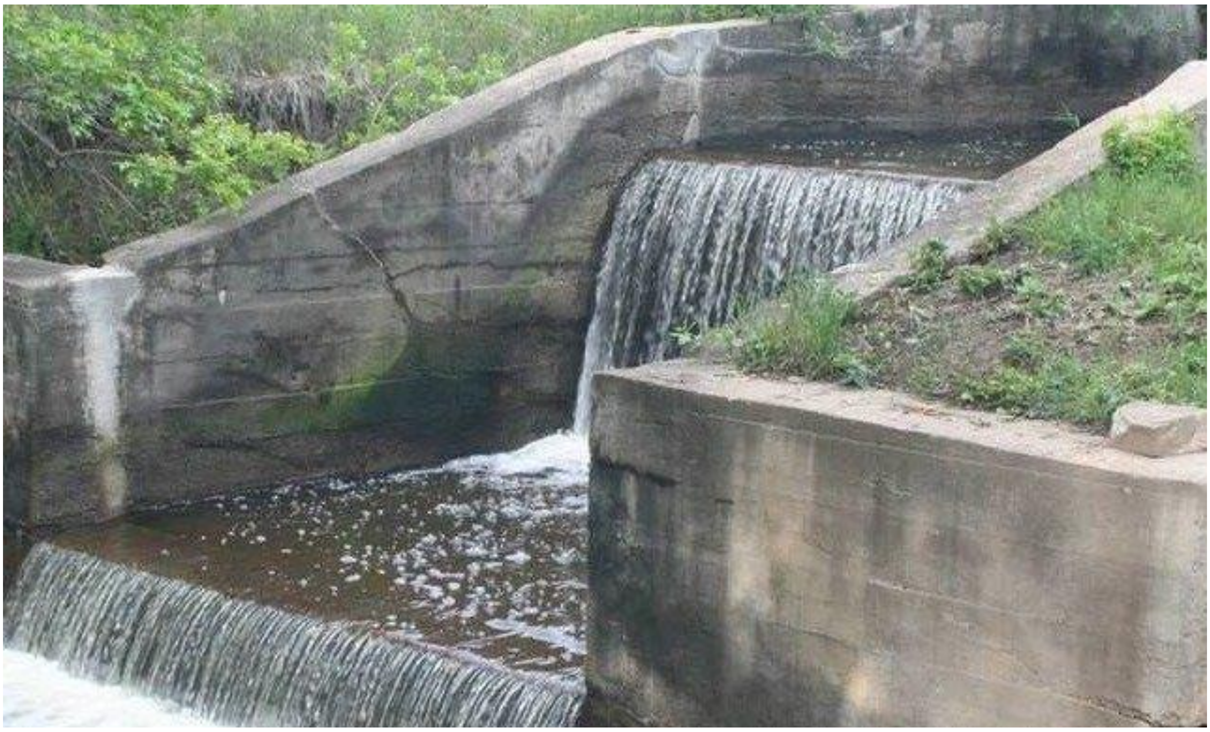
1. **Canal Falls – Their Types and Importance**

What is Canal Fall?

Canal fall is a solid masonry structure which is constructed on the canal if the natural ground slope is steeper than the designed channel bed slope. If the difference in slope is smaller, a single fall can be constructed. If it is of higher then falls are constructed at regular suitable intervals.



Location of Canal Falls

Location of canal fall depends upon the following factors

1. Topography of canal
2. Economy of excavation or filling

The above two will decide the location of canal fall across canal. By understanding topographic condition we can provide the required type of fall which will give good results. At the same time, the provided falls is economical and more useful. So, economical calculation is also important. Unbalanced earth work on upstream and downstream result the project more uneconomical.

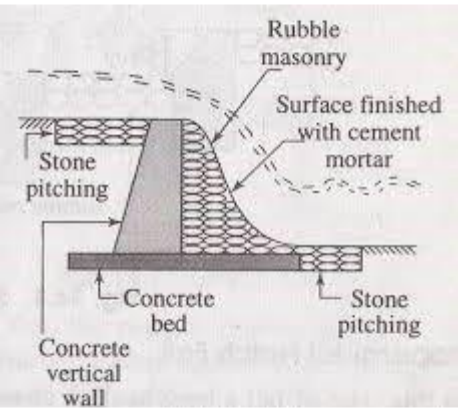
Types of Canal Falls and their Importance

The important types of falls which were used in olden days and those which are being used in modern days are described below:

- Ogee falls
- Rapids
- Stepped falls
- Trapezoidal notch falls
- Well type falls
- Simple vertical drop falls
- Straight glacis falls
- Montague type falls
- English falls or baffle falls

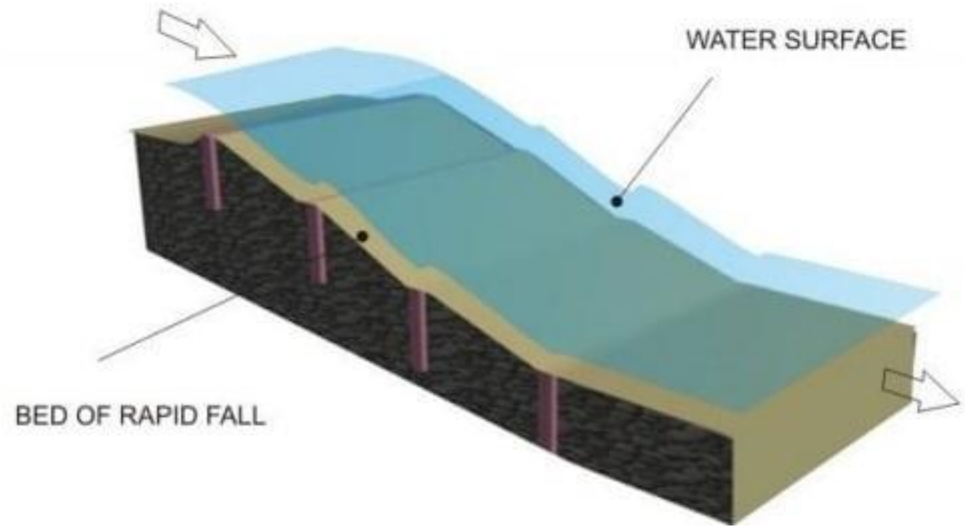
Ogee Canal Falls

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.



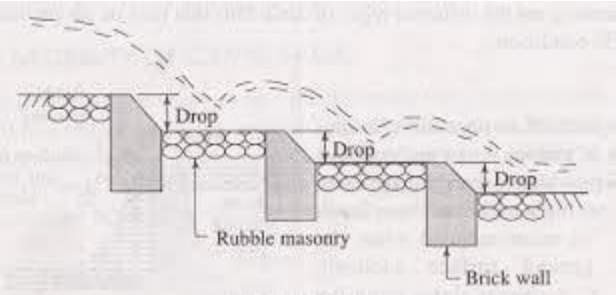
Rapid Canal Falls

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.



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.

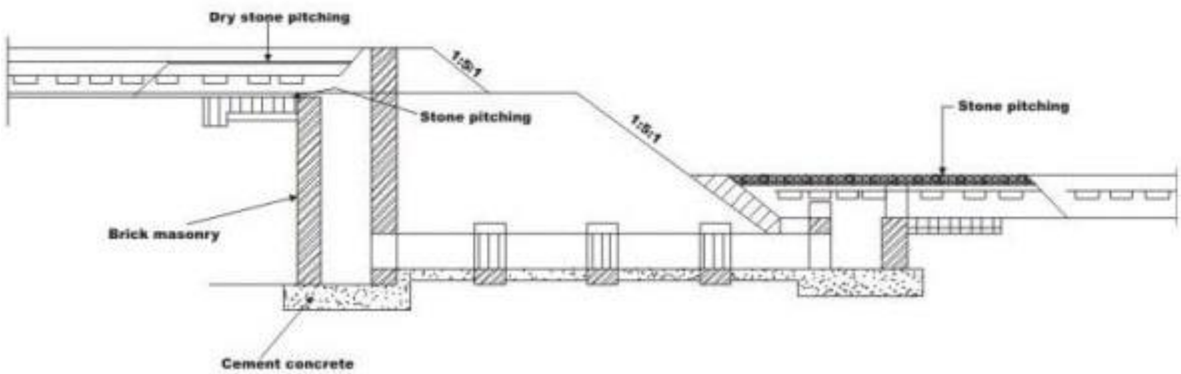


Trapezoidal Notch Canal Falls

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. Now a days this type of falls are using widely because of their simplicity and popularity.

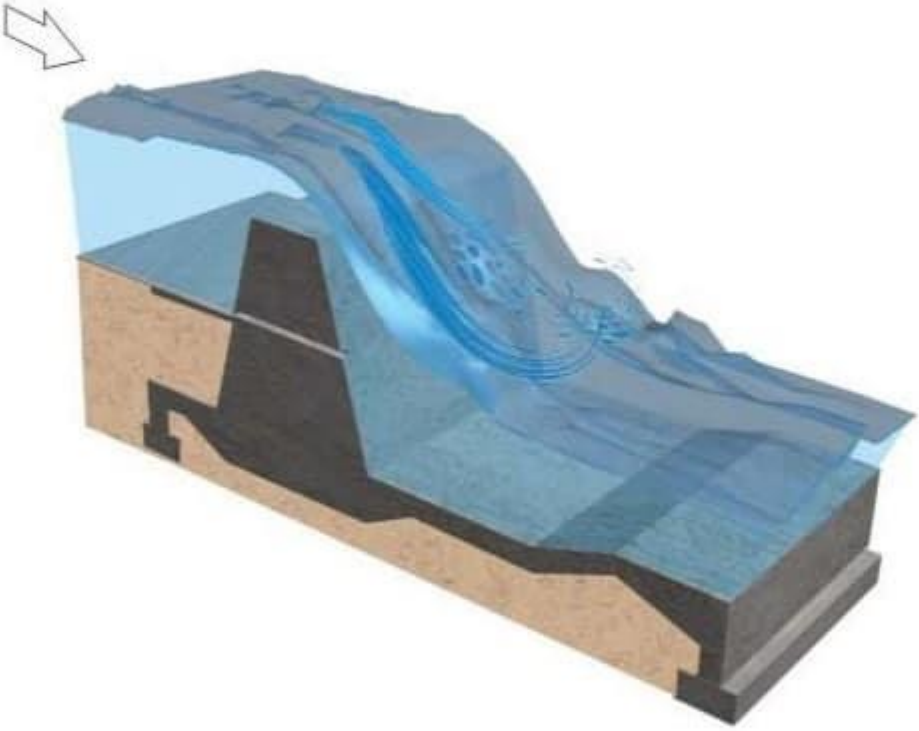
Well Type Canal Falls

Well type falls are also called as syphon drop falls. In this case, an inlet well with pipe at its bottom is constructed in upstream. The pipe carries the water to downstream well or reservoir. If the discharge capacity is more than 0.29 cumecs then downstream well is preferred otherwise reservoir is suitable.



Simple Vertical Drop Falls (Sarda Type 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.

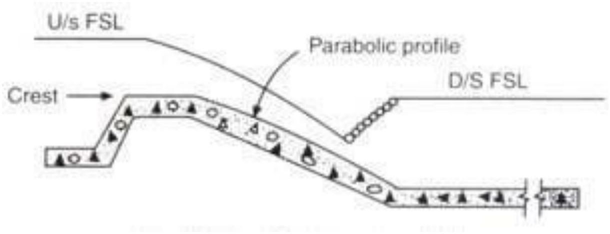


Straight Glacis Canal Falls

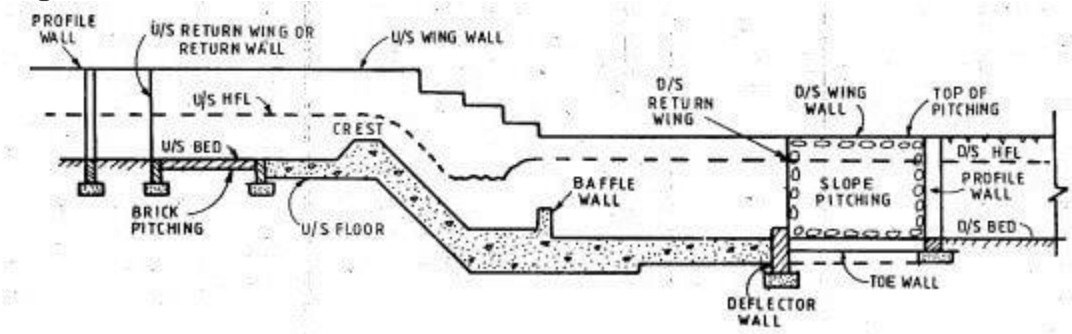
This is the modern type of construction, in which a raised crest is constructed across the canal and a gentle straight inclined surface is provided from raised crest to the downstream. The water coming from upstream crosses the raised crest and falls on inclined surface with sufficient energy dissipation.

Montague Type Canal Falls

Montage fall is similar to straight glacis fall but in this case the glacis is not straight. It is provided in parabolic shape to introduce the vertical component of velocity which improves the energy dissipation to more extent.



English or Baffle Canal Falls



In this case, straight glacis fall is extended as baffle platform with baffle wall. This is suitable for any discharge. The baffle wall is constructed near the toe of the straight glacis at required distance in designed height. The main purpose of the baffle wall is to create hydraulic jump from straight glacis to baffle platform

2.River training works

It includes guide banks, marginal bunds, spurs etc. Functions are:

- To provide and non-tortuous approach to weir.
- To prevent the river from out-flanking the weir.
- To prevent additional area to be submerged due to afflux.
- To prevent erosion of the river banks (protective works).
- To ensure smooth and axial flow of water, to prevent the river from out ------ the works due to change in its course.

Guide banks:

Guide Bank are earthen embankments with stone pitching in the slopes facing water, to guide the river through the barrage, These river training works are provided for rivers flowing in planes, upstream and downstream of the hydraulic structures or bridges built on the river. Guide banks guide the river water flow through the barrage.

Guide banks force the river into restricted channel, to ensure almost axial flow near the weir site. (embankments in continuation of G-Banks. To contain flood within flood plains)

Marginal Bunds:

Marginal bunds are flood embankments in continuation of guide banks designed to contain the floods within the flood plain of the river. Both height and length vary according to back water effect caused by the barrage. They are not provided with stone pitching and fully cover the back- water length. Provided on the upstream in order to protect the area from submergence due to rise in HFL, caused by afflux.

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3.Definition, causes, effects, detection, solution and extent of waterlogging.

Definition:

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.

The waterlogging may be defined as rendering the soil unproductive and infertile due to excessive moisture and creation of anaerobic conditions. The phenomenon of waterlogging can be best understood with the help of a hydrologic equation, which states that

Inflow = Outflow -I- Storage

Here inflow represents that amount of water which enters the subsoil in various processes. It includes seepage from the canals, infiltration of rainwater, percolation from irrigated fields and subsoil flow. Thus although it is loss or us, it represents the amount of water flowing into the soil.

The term outflow represents mainly evaporation from soil, transpiration from plants and underground drainage of the tract. The term storage represents the change in the groundwater reservoir.

Causes of Waterlogging:

After studying the phenomenon of waterlogging in the light of hydrologic equation main factors which help in raising the water-table may be recognised correctly.

They are:

i. Inadequate drainage of over-land run-off increases the rate of percolation and in turn helps in raising the water table.

ii. The water from rivers may infiltrate into the soil.

iii. Seepage of water from earthen canals also adds significant quantity of water to the underground reservoir continuously.

iv. Sometimes subsoil does not permit free flow of subsoil water which may accentuate the process of raising the water table.

v. Irrigation water is used to flood the fields. If it is used in excess it may help appreciably in raising the water table. Good drainage facility is very essential.

Effects of Waterlogging:

The waterlogging affects the land in various ways. The various after effects are the following:

1. Creation of Anaerobic Condition in the Crop Root-Zone:

When the aeration of the soil is satisfactory bacteriological activities produce the required nitrates from the nitrogenous compounds present in the soil. It helps the crop growth. Excessive moisture content creates anaerobic condition in the soil. The plant roots do not get the required nourishing food or nutrients. As a result crop growth is badly affected.

2. Growth of Water Loving Wild Plants:

When the soil is waterlogged water loving wild plant life grows abundantly. The growth of wild plants totally prevent the growth of useful crops.

3. Impossibility of Tillage Operations:

Waterlogged fields cannot be tilled properly. The reason is that the soil contains excessive moisture content and it does not give proper tilth.

4. Accumulation of Harmful Salts:

The upward water movement brings the toxic salts in the crop root-zone. Excess accumulation of these salts may turn the soil alkaline. It may hamper the crop growth.

5. Lowering of Soil Temperature:

The presence of excessive moisture content lowers the temperature of the soil. In low temperature the bacteriological activities are retarded which affects the crop growth badly.

6. Reduction in Time of Maturity:

Untimely maturity of the crops is the characteristic of waterlogged lands. Due to this shortening of crop period the crop yield is reduced considerably.

Detection of Waterlogging:

From the subject matter discussed above it is clear that the waterlogging is indicated when the ground water reservoir goes on building up continuously. When the storage starts building up in the initial stages the crop growth is actually increased because more water is made available for the crop growth. But after some time the waters table rises very high and the land gets waterlogged. Finally the land is rendered unproductive and infertile.

The problem of waterlogging develops in its full form slowly. Therefore its early detection is possible by keeping a close watch over the yields and also on the variations in the groundwater level. A comparative reduction in crop yields in spite of irrigation and fertilisation and early maturity of crops indicate the symptoms of waterlogging. Also when harmful salts start appearing on the fields as white incrustation or deposit it indicates that waterlogging is likely to follow. In worst cases the water-table rises so high and close to the ground surface that the fields turn into swamps and marshes.

The best way of keeping watch over the problem of waterlogging is by observing variations in the groundwater level. It can be done by measuring the depth of water levels at regular interval in the wells dug in the area. Continuous high water levels indicate that the groundwater storage is building up which may create waterlogging in the area.

Solution to the Problem of Waterlogging:

The problem of waterlogging may be attacked on two fronts. First is preventive measures, which keep the land free from waterlogging. Secondly curative measures may be adopted to reclaim the waterlogged area. But in principle both measures aim at reducing the inflow and augmenting the outflow from the underground reservoir.

Preventive Measures:

Preventive measures include the following:

(a) Controlling the loss of water due to seepage from the canals:

The seepage loss may be reduced by adopting various measures for example

i. By lowering the FSL of the canal:

Loss may be due to percolation or absorption but when FSL is lowered the loss is reduced to sufficient extent. It is course essential to see that while lowering the FSL command is not sacrificed.

ii. By lining the canal section:

When the canal section is made fairly watertight by providing lining the seepage loss is reduced to quite a good extent.**iii. By introducing intercepting drains:**

They are generally constructed parallel to the canal. They give exceptionally good results for the reach where the canal runs in high embankments.

4.Groundwater recharge

.Groundwater recharge is an important part of the hydrologic cycle, in which water from the surface works its way into the subsurface, replenishing groundwater supplies. It can be difficult to estimate groundwater recharge rates because it is challenging to track the amount of water which returns to subsurface water supplies, although several different techniques can be used to arrive at estimates. It is important to understand how much water is entering a supply of groundwater, as this influences how much water can safely be taken from groundwater supplies for human use.
In nature, groundwater recharge is supplied by rain, snowmelt, rivers, lakes, and streams. While some surface water evaporates or works its way into another watershed, other water trickles through the earth, gradually meeting up with a supply of water below the surface. It can take a long time for groundwater supplies to build up, or they can be replenished very quickly, depending on a variety of environmental factors.

Humans can also create groundwater recharge. Public works agencies can reintroduce water to the ground with techniques such as specialized reservoirs to restore groundwater to previous levels or to keep groundwater levels stable. This technique is used in areas where groundwater supplies are heavily utilized and authorities are worried about a dropping water table, an accumulation of salts in the soil, or about running out of water entirely. The earth also makes one of the best available places to store water, so groundwater recharge is utilized as a storage technique.
A number of things can impair this process. If groundwater supplies are overutilized, recharging will not make up for the water which is taken, which lowers the water table. As the water table drops, wells may go dry. Salts can also build up in the soil as the flushing action of water is taken away. Human activities such as construction and logging can also impair groundwater recharge by preventing water from entering the ground at all.

As concerns about water resources have grown around the world, many communities have begun to address the issue of groundwater recharge. Some communities have taken small steps to increase the amount of water which flows back underground, such as using permeable pavement which allows water to trickle underground, rather than allowing water to pool on the surface and evaporate. People are also concerned about pollution caused by the release of harmful chemicals; as groundwater flows past deposits of chemicals, the chemicals are picked up and they enter the water supply. Once in the water, pollution is difficult to remove.