LECTURE 10

Canal Falls

Irrigation canals are constructed with some permissible bed slopes so that there is no silting or scouring in the canal bed. But it is not always possible to run the canal at the desired bed slope throughout the alignment due to the fluctuating nature of the country slope.

Generally, the slope of the natural ground surface is not uniform throughout the alignment. Sometimes, the ground surface may be steep and sometimes it ma be very irregular with abrupt change of grade. In such cases, a vertical drop is provided to step down the canal bed and then it is continued with permissible slope until another step down is necessary. This is done to avoid unnecessary huge earth work in filling. Such vertical drops are known as ***canal falls or simply falls***.

Necessity / Importance of Canal Falls:

When the slope of the ground suddenly changes to steeper slope, the permissible bed slope can not be maintained. It requires excessive earthwork in filling to maintain the slope. In such a case falls are provided to avoid excessive earth work in filling when the slope of the ground is more or less uniform and the slope is greater than the permissible bed slope of canal.

Types of Canal Falls - Classification of fall

The following are the different types of canal falls that may be adopted according to the site condition:

Ogee fall

In this type of fall, an ogee curve (a combination of convex curve and concave curve) is provided for carrying the canal water from higher level to lower level. This fall is recommended when the natural ground surface suddenly changes to a steeper slope along the alignment of the canal.

- The fall consists of a concrete vertical wall and concrete bed.
- Over the concrete bed the rubble masonry is provided in the shape of ogee curve.
    - The surface of the masonry is finished with rich cement mortar (1:3).
    - The upstream and downstream side of the fall is protected by stone pitching with cement grouting.
    - The design consideration of the ogee fall depends on the site condition.

Rapid fall

The rapid fall is suitable when the slope of the natural ground surface is even and long. It consists of a long sloping glacis with longitudinal slope which varies from 1 in 10 to 1 in 20.

- Curtain walls are provided on the upstream and downstream side of the sloping glacis.
- The sloping bed is provided with rubble masonry.
- The upstream and downstream side of the fall is also protected by rubble masonry.
- The masonry surface is finished with rich cement mortar (1: 3).

Stepped fall

Stepped fall consists of a series of vertical drops in the form of steps. This fall is suitable in places where the sloping ground is very long and requires long glacis to connect the higher bed level with lower bed level.

- This fall is practically a modification of the rapid fall.
    - The sloping glacis is divided into a number of drops so that the flowing water may not cause any damage to the canal bed. Brick walls are provided at each of the drops.
    - The bed of the canal within the fall is protected by rubble masonry with surface finishing by rich cement mortar (1:3).

Trapezoidal Notch Fall

In this type of fall a body wall is constructed across the canal. The body wall consists of several trapezoidal notches between the side piers and the intermediate pier or piers. The sills of the notches are kept at the upstream bed level of the canal.

SPILL WAY

Spillway: The spillways are openings provided at the body of the dam to discharge safely the excess water or flood water when the water level rises above the normal pool level.
Definition: Spillways are structures constructed to provide safe release of flood waters from a dam to a downstream are, normally the river on which the dam has been constructed.

Necessity of Spillways

- The height of the dam is always fixed according to the maximum reservoir capacity. The normal pool level indicates the maximum capacity of the reservoir. The water is never

stored in the reservoir above this level. The dam may fail by over turning so, for the safety of the dam the spillways are essential.

- The top of the dam is generally utilized by making road. The surplus water is not be allowed to over top the dam, so to stop the over topping by the surplus water, the spillways become extremely essential.
- To protect the downstream base and floor of the dam from the effect of scouring and erosion, the spillways are provided so that the excess water flows smoothly.

Location of Spillway Generally, the spillways are provided at the following places

- Spillways may be provided within the body of the dam.
- Spillways may sometimes be provided at one side or both sides of the dam.
- Sometimes by-pass spillway is provided which is completely separate from the dam.

Determination of discharge capacity and number of spillways

The maximum discharge capacity and the number of spillways are determined by studying the following factors:

(a) By studying the flood hydrograph of past ten years, the maximum flood discharge may be computed which is to be disposed off completely through the spillways.
(b) The water level in the reservoir should never be allowed to rise above the maximum pool level and should remain in normal pool level. So, the volume of water collected between maximum pool level and minimum pool level computed, which indicates the discharge capacity of spillways.
(c) The maximum flood discharge may also be computed from other investigation like, rainfall records, flood routing, empirical flood discharge formulae, etc.
(d) From the above factors the highest flood discharge is ascertained to fix the discharge capacity of spillways.
(e) The natural calamities are beyond the grip of human being. So, an allowance of about 25 % should be given to the computed highest flood discharge which is to be disposed off.
(f) The size and number of spillways are designed according to the design discharge.

Types of Spillways - Classification of Spillways

There are different types of spillways that can be provided depending on the suitability of site and other parameters. Generally a spillway consists of a control structure, a conveyance channel and a terminal structure, but the former two may be combined in the same for certain types. The more common types are briefly described below.

The common types of spillway in use are the following:

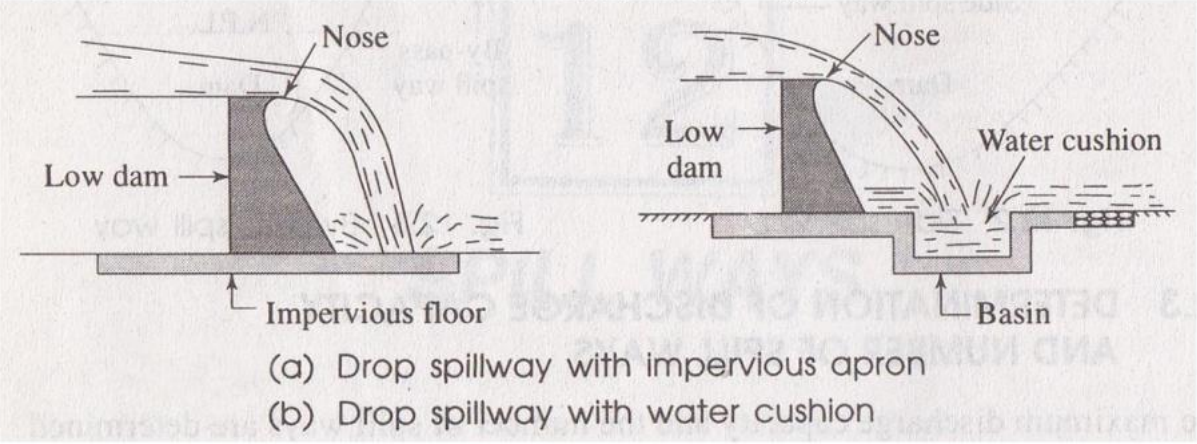
1. Free Overfall (Straight Drop) Spillway
2. Overflow (Ogee) Spillway
3. Chute (Open Channel/Trough) Spillway
4. Side Channel Spillway
5. Shaft (Drop Inlet/Morning Glory) spillway
6. Tunnel (Conduit) spillway
7. Siphon spillway

The water flowing down from the spillways possess a large amount of kinetic energy that is generated by virtue of its losing the potential head from the reservoir level to the level of the

river on the downstream of the spillway. If this energy is not reduced, there are dangers of scour to the riverbed which may threaten the stability of the dam or the neighboring river valley slopes. The various arrangements for suppressing or killing of the high energy water at the downstream toe of the spillways are called **Energy Dissipaters**.

(a) Drop Spillway

In drop spillway, the over flowing water falls freely and almost vertically on the downstream side of the hydraulic structure. This type of spillway is suitable for weirs or low dams. The crest of the spillway is provided with nose so that the water jet may not strike the downstream base of the structure. To protect the structure from the effect of scouring horizontal impervious apron should be provided on the downstream side. Sometimes a basin is constructed on the downstream side to form a small artificial pool which is known as water cushion. This cushion serves the purpose of energy dissipater



(a) Drop spillway with impervious apron
(b) Drop spillway with water cushion

(b) Ogee Spillways

The ogee spillway is a modified form of drop spillway. Here, the downstream profile of the spillway is made to coincide with the shape of the lower nappe of the free falling waterjet from a sharp crested weir. In this case, the shape of the lower nappe is similar to a projectile and hence downstream surface of the ogee spillway will follow the parabolic path where "0" is the origin of the parabola. The downstream face of the spillway forms a concave curve from a point "*T*" and meets with the downstream floor. This point "*T*" is known as point of tangency. Thus the spillway takes the shape of the letter "*S*" (i.e. elongated form). Hence, this spillway is termed as ogee spillway.

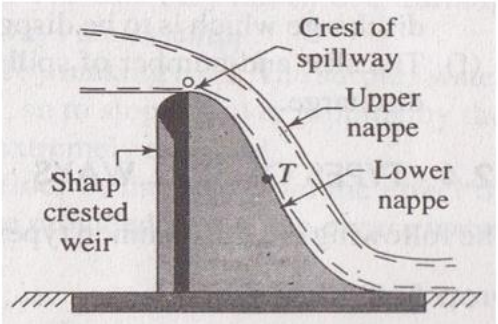
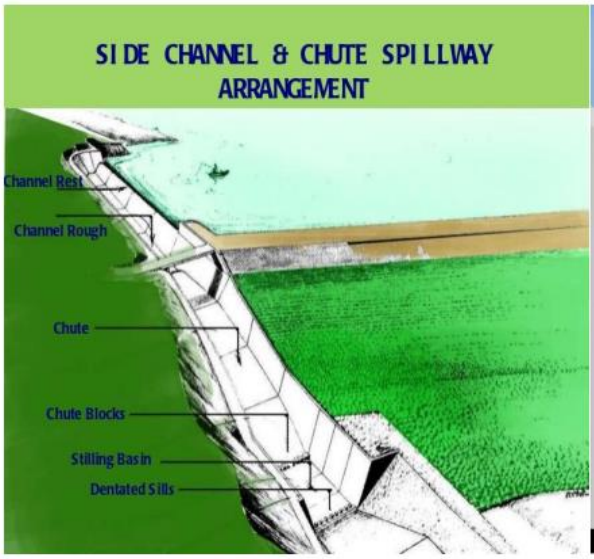


Fig: Ogee Spillway

The shape of the lower nappe is not same for all the head of water above the crest of the weir. It differs with the head of water. But for the design of the ogee spillway the maximum head is considered. If the spillway runs with the maximum head, then the overflowing water just follows the curved profile of the spillway and there is no gap between the water and the spillway surface and the discharge is maximum.

Chute (Trough) Spillway

In this type of spillway, the water, after flowing over a short crest or other kind of control structure, is carried by an open channel (called the "chute" or "trough") to the downstream side of the river. The control structure is generally normal to the conveyance channel. The channel is constructed in excavation with stable side slopes and invariably lined. The flow through the channel is super-critical. The spillway can be provided close to the dam or at a suitable saddle away from the dam where site conditions permit.



Side Channel Spillway

Side channel spillways are located just upstream and to the side of the dam. The water after flowing over a crest enters a side channel which is nearly parallel to the crest. This is then carried by a chute to the downstream side. Sometimes a tunnel may be used instead of a chute.

Shaft (Morning Glory or Glory hole) Spillway

This type of spillway utilizes a crest circular in plan, the flow over which is carried by a vertical or sloping tunnel on to a horizontal tunnel nearly at the stream bed level and eventually to the downstream side. The diversion tunnels constructed during the dam construction can be used as the horizontal conduit in many cases.

Siphon Spillway

As the name indicates, this spillway works on the principle of a siphon. A hood provided over a conventional spillway forms a conduit. With the rise in reservoir level water starts flowing over the crest as in an "ogee" spillway. The flowing water however, entrains air and once all the air in the crest area is removed, siphon action starts. Under this condition, the discharge takes place at a much larger head. The spillway thus has a larger discharging capacity. The inlet end of the hood is generally kept below the reservoir level to prevent floating debris from entering the conduit. This may cause the reservoir to be drawn down below the normal level before the siphon action breaks and therefore arrangement for de-priming the siphon at the normal reservoir level is provided.