UNIT 4

PART B

1.Factors affecting the pattern of sediment deposition in reservoirs?

The useful life of a reservoir gets reduced due to sediment deposition causing a decrease in its storage capacity. The factors affecting the pattern of sediment deposition in reservoirs are:

(i) sediment load (i.e., sediment inflow rate)

(ii) sediment size (i.e., gradation of silt)

(iii) compaction of sediment

(iv) river inflow pattern

(v) river valley slope

(vi) shape of reservoir

(vii) capacity of reservoir (its size and storage period)

(viii) vegetal growth at the head

(ix) outlets in the dam (their types, location and size)

(x)reservoir operation

(xi) upstream reservoirs, if any.

It has been found by experience that a low sediment inflow rate, large fraction of fine particles, steep slope, no vegetation at head of reservoir, low flow detention time in the reservoir (by operation of outlets of suitable size at different levels), possibly series of upper tanks or reservoir upstream (where deposition occurs) do not favour sediment deposition and compaction. The silt carried in the rainy season may be excluded from the reservoir by means of scouring sluices slightly above the deep river-bed, which discharge the heavily silt-laden water at high velocity. The percent of the inflowing sediment, which is retained in a reservoir is called the trap efficiency and it is a function of the ratio of reservoir capacity to total annual sediment inflow, since a small reservoir on a large stream passes most of its inflow quickly (giving no time for the silt to settle) while a large reservoir allows more detention time for the suspended silt to settle. The relation between trap efficiency of reservoir vs. capacity-inflow ratio on the basis of data from surveys of existing reservoirs.

The rate at which the capacity of a reservoir is reduced by sediment deposition depends on

(i) the rate of sediment inflow, i.e., sediment load.

(ii) the percentage of the sediment inflow trapped in the reservoir, i.e., trap efficiency.

(iii)the density of the deposited sediment.

2. Write short note on single and multipurpose reservoir with its advantages and disadvantages.

1. Irrigation Facility:

Extension of irrigation facility is one of the important objectives and advantage of multipurpose projects. These projects can stimulate the agricultural productivity for meeting the growing requirement of food and raw materials required for increasing non-farm activities.

2. Flood Control:

Another important objective of such projects is to control the occurrence of floods creating havocs on the economy.

3. Generating Electricity:

Multi-purpose projects help to generate hydro-electricity on a large scale basis, which is very much important for the development of industry.

4. Navigation:

Such projects can create navigation facility in the country by developing ferrying services for transportation, raise fleet capacity and thereby can reduce the traffic load on rail and road transport.

5. Forests and Fisheries:

These projects can help to raise forestry on the banks of the canals. Moreover, it can also encourage the development of fisheries in the reservoirs.

6. Drinking Water:

Such projects facilitate the development of safe drinking water projects for the adjoining areas.

7. Development of Industry and Employment Generation:

Such projects can create a favourable climate for the development of industry by offering the facilities like cheaper power, better water transport, availability of raw materials at cheaper rates for agro-based industries etc.

Moreover, by developing agriculture, industry and infrastructural services, these projects can generate adequate volume of employment opportunities in the farm and non-farm sector. All these would help to raise the standard of living of the people of those adjoining regions reaping benefits from such projects.

8. Recreation:

Multi-purpose projects can also facilitate to develop recreation facilities in the form of picnic resorts, holiday resorts etc. which are having much commercial viability nowadays.

Demerits of Multi-Purpose Projects:

Multi-purpose projects commissioned in India has already derived impressive results in respect of creation of irrigation potential and also in the generation of hydroelectric power. the irrigation potential so far developed by larger and medium projects has increased from 10 million hectares in 1950-51 to 34 million hectares in 1997-98.

Total installed capacity of hydro-electric project in India has also increased fron 0.6 gW in 1950-51 ro 21.7 gW in 1996-97. In spite of its achievements, the multi-purpose projects in India are subjected to the following controversies.

1. Exaggerated Benefits on Irrigation:

It has been argued that irrigation benefits derived out of multi-purpose projects are exaggerated because the actual area irrigated by these projects is much less due to delay in the construction of field channels and water routes. Moreover delay in completion of these projects has resulted in high escalation of its cost.

2. Higher Cost of Hydropower:

Although hydro power is having the advantage of low operating cost, renewable source and eco-friendly but at the same time it is also subjected to long gestation period, delay in commissioning the project resulting escalation of project cost and higher initial cost. All these have resulted in a comparatively higher unit cost of generation in respect of hydro power.

3. Least Flood Control Benefit:

The multi-purpose projects have also failed to derive maximum benefit in respect of flood control as the embankments, drainage channels and flood protection schemes have failed miserably to achieve results.

4. Adverse Environmental Impact:

Finally, the multi-purpose projects have resulted serious adverse environmental impact in respect of degradation of soil content arising out of waterlogging and soil salinity in its command areas.

Considering these negative sides, Dr. B.B. Vora has rightly observed, **"The future of major and medium irrigation is dim and the country has neither the resources nor the time for creating additional gross potential of some 26 million hectares of irrigation through this route. Hence minor irrigation, particularly through the use of ground water, must be the mainstay for all future places."** Management of big dams is also being done at exorbitant financial and ecological costs.

But the management of minor projects has resulted in maximum use of water resources and better control.

Thus, in recent times, basic questions have been raised from various organisations about the standing conventional emphasis and grounds on the multi-purpose river valley projects. It is time to re-evaluate the irrigation policy of the country in a judicious manner and to formulate the policy with new directives and emphasis

3.Enumerate the different types of spillway?

1. Free Over-Fall Spillway:

As the name of the spillway indicates, the flow drops freely from the crest of a free over-fall spillway. At times, the crest is extended in the form of an overhanging lip to direct small discharges away from the downstream face of the overflow section. The underside of the falling water jet is properly ventilated so that the jet does not pulsate. Such a spillway is better suited for a thin arch dam whose downstream face is nearly vertical.

Since the flow usually drops into the stream bed, objectionable scour may occur in some cases and a deep plunge pool may be formed. If erosion cannot be tolerated, a plunge pool is created by constructing an auxiliary dam downstream of the main dam. Alternatively, a basin is excavated and it is provided with a concrete apron.

When tail water depth is sufficient, a hydraulic jump would form when the water jet falls upon a flat apron. Free over-fall spillways are restricted only to situations where the hydraulic drop from reservoir level to tail water level is less than about six metres.

2. Ogee (Overflow) Spillway:

An ogee spillway has a control weir whose profile is as shown in Fig. 11.9. The upper part of the spillway surface matches closely to the profile of the lower nappe of a ventilated sheet of water falling freely from a sharp-crested weir. The lower part of the spillway surface is tangential to the upper curve and supports the falling sheet of water.

The downstream end of the spillway is in the form of a reverse curve, which turns the flow onto the apron of a stilling basin or into the spillway discharge channel. Ogee spillway is generally used for concrete and masonry dams. It is ideally suited to wider valleys where sufficient crest length may be provided.

The profile of an ogee spillway is designed for a given design discharge (or corresponding design surcharge head). When the flowing discharge equals the design discharge, the flow adheres to the spillway surface with minimum interference from the boundary surface and no access of air to the underside of the water sheet.

The discharge efficiency is maximum under such condition and the pressure along the spillway surface is atmospheric. If the flowing discharge exceeds the design discharge, the water sheet tends to pull away from the spillway surface and, thus, produces sub-atmospheric pressure along the surface of the spillway.

While negative pressure may cause cavitation and other problems, it increases the effective head as well as the discharge. On the other hand, positive hydrostatic pressure will occur on the spillway surface, if the flowing discharge is less than the design discharge.

An upstream overhang, known as corbel, is added to the upstream face of the spillway as shown in Fig. 11.9. The effect of the corbel is to shift the nappe (and, hence, the spillway profile) backward which results in saving of concrete.

If the height of the vertical face of the corbel is kept more than 0.3 times the head over the crest, the discharge coefficient of the spillway will be practically the same as if the vertical face of the corbel extended for the full height of the spillway.

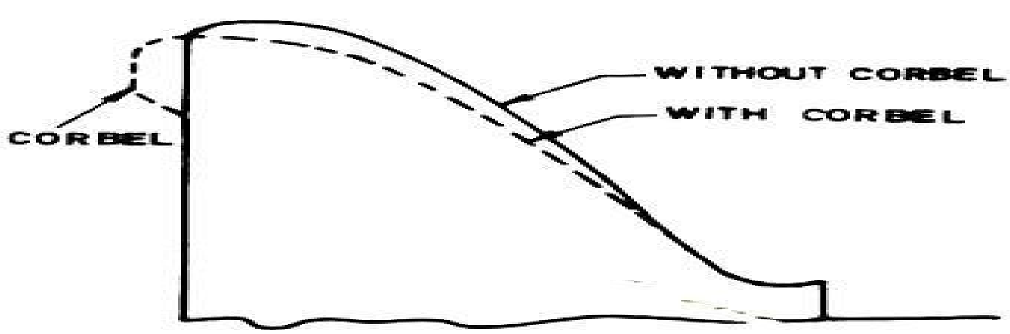


Fig. 11.9 Ogee spillway

3. Side Channel Spillway:

The control weir of a side channel spillway (Fig. 11.10) is located alongside and approximately parallel to the upstream portion of the spillway discharge channel which itself may be either an open channel or a closed conduit or an inclined tunnel. The spillway discharge flows over the weir crest and falls into a narrow trough (i.e., the upper reach of the discharge channel), and takes an approximately 90° turn before continuing into the spillway discharge channel.

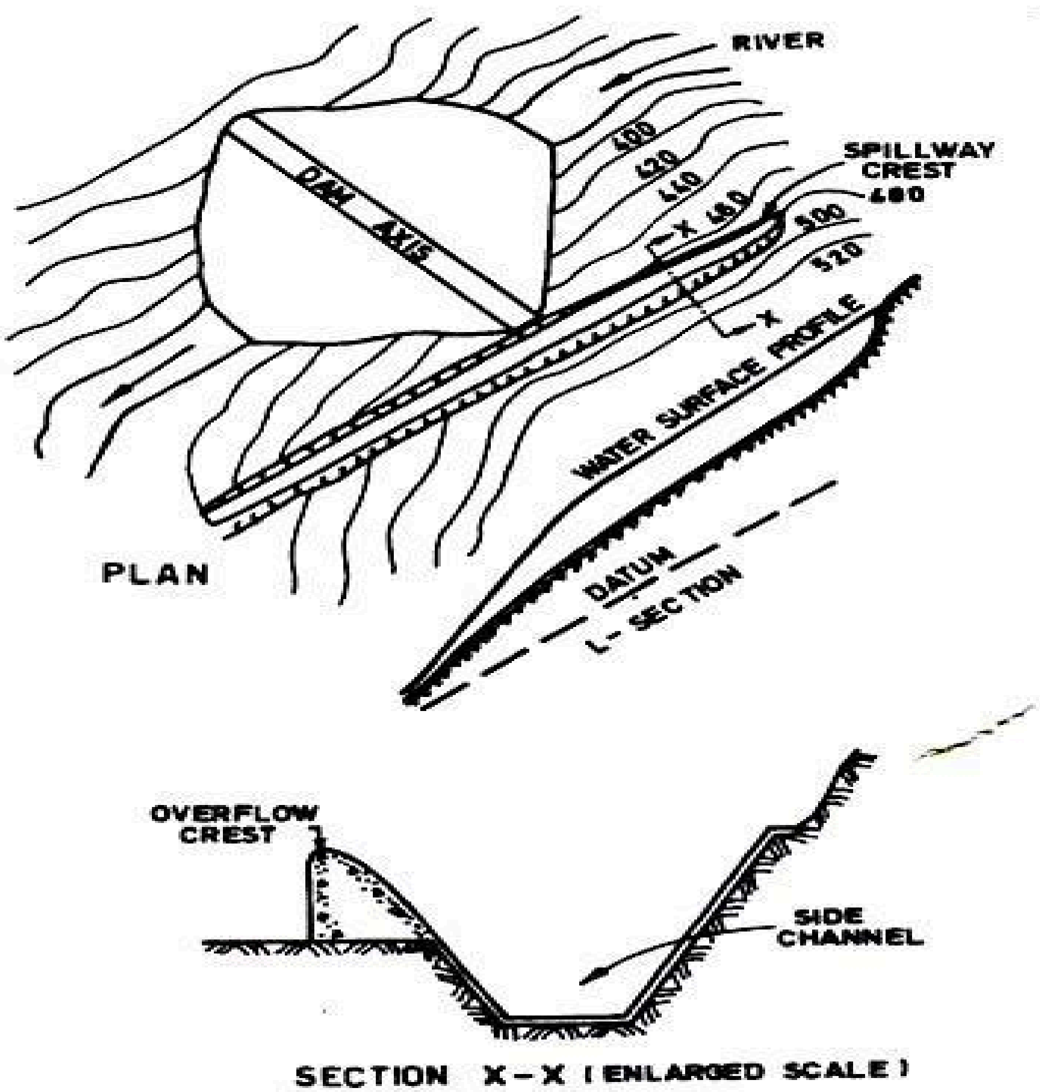


Fig. 11.10 Side channel spillway

The control structure of a side channel spillway generally consists of an ogee crest which, in plan, may be straight, curved, semicircular or U-shaped. The overflow section may be broad-crested instead of ogee-shaped.

Side channel trough is usually of trapezoidal cross-section with minimum width to depth ratio. Higher width to depth ratio would result in poor diffusion of the increasing incoming flow with the channel flow due to relatively shallow depth. Moreover, the amount of excavation would also increase for larger bed widths.

While the flow in the side channel trough should preferably be subcritical, the flow in the discharge channel is supercritical, and a control section downstream of the trough is provided by either constricting the channel width or raising the channel bottom- Because of spatial flow conditions, the depth of flow in the side channel trough would never be the same at different sections.

Type # 4. Chute Spillway:

In a chute (or trough) spillway, the spillway discharge flows in an open channel (named as 'chute' or 'trough') right from the reservoir to the downstream river. The open channel can be located either along the abutment of the dam or through a saddle (Fig. 11.11). The channel bed should always be kept in excavation and its side slopes must be designed to be stable with sufficient margin of safety. As far as possible, bends in the channel should be avoided.

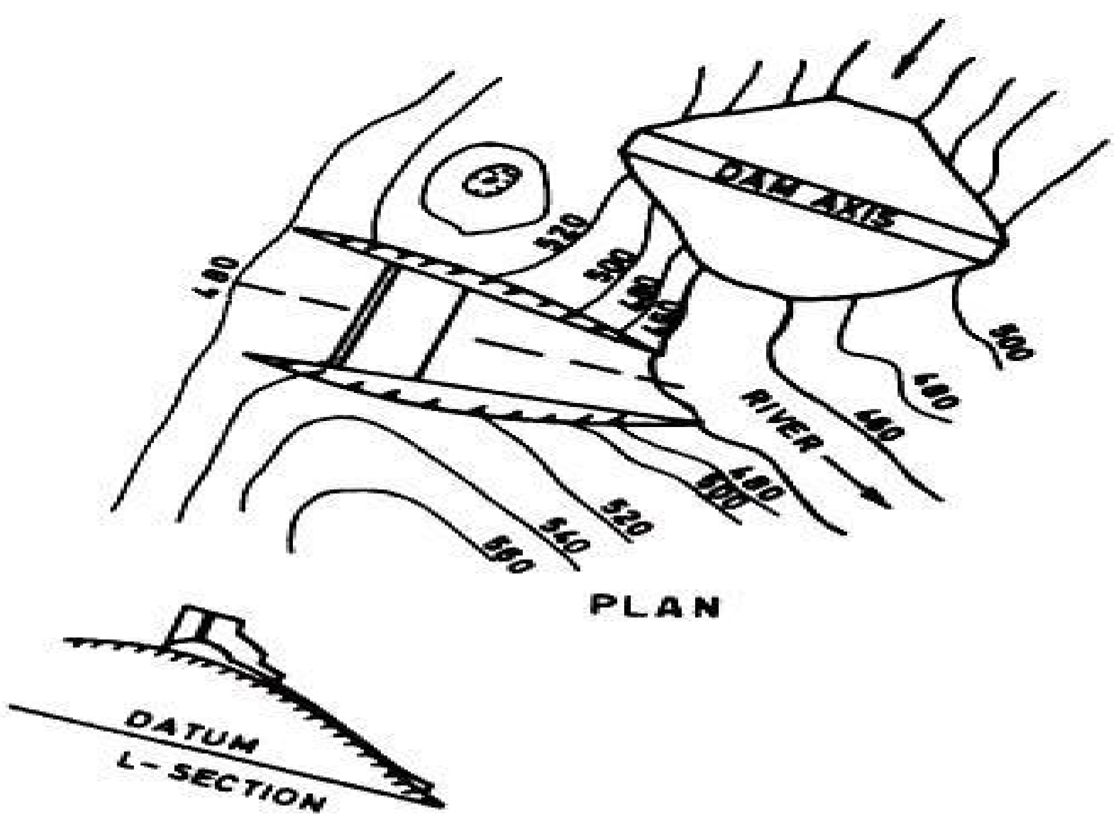


Fig. 11.11 Chute spillway

If it becomes necessary to provide a bend, it should be gentle. The spillway control structure can be an overflow crest, or a gated orifice or some other suitable control device. The control device is usually placed normal or nearly normal to the axis of the chute. The simplest form of a chute spillway is an open channel with straight centre line and constant width.

However, very often the axis of either the entrance channel or the discharge channel is curved to suit the topography of the site. The flow condition varies from subcritical upstream of the controlling crest to critical at the crest and supercritical in the discharge channel.

The chute spillway is ideally suited with earth-fill dams because of:

(i) The simplicity of their design and construction,

(ii) Their adaptability to all types of foundation ranging from solid rock to soft clay, and

(iii) Overall economy usually obtained by the use of large amounts of spillway excavation for the construction of embankment. The chute spillway is also suitable for concrete dams constructed in narrow valleys across a river whose bed is erodible for which ogee spillway becomes unsuitable.

Type # 5. Shaft Spillway:

In a shaft spillway (Fig. 11.12), water enters a horizontal crest, drops through a vertical or sloping shaft and then flows to the downstream river channel through a horizontal or nearly horizontal conduit or tunnel. A rock outcrop projecting into the reservoir slightly upstream of the dam would be an ideal site for a shaft spillway.

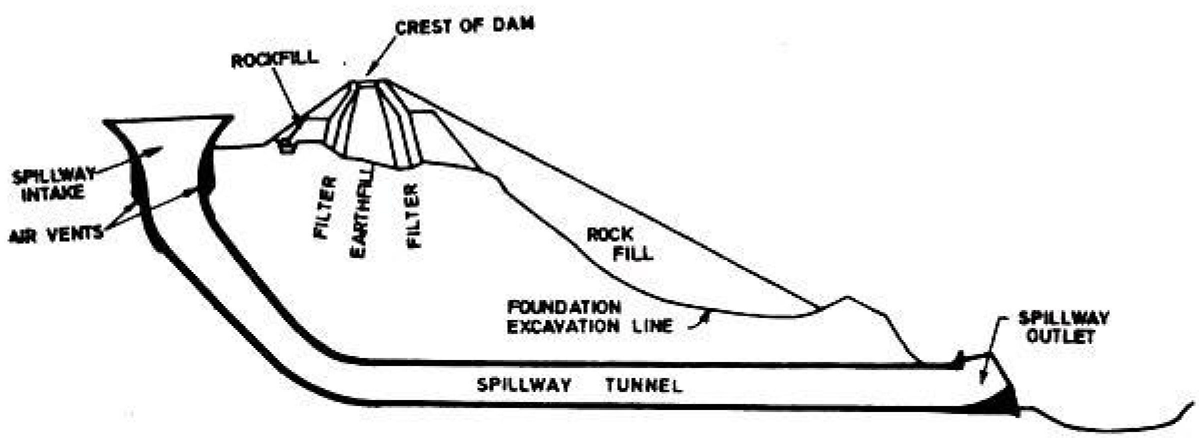


Fig. 11.12 Shaft spillway

Depending upon the level of the rock outcrop and the required crest level, spillway may have to be either constructed or excavated. The diversion tunnels, if used for river diversion purposes during construction, can be utilised for discharge tunnels of the spillway. Radial piers provided on the spillway crest ensure radial flow towards the spillway, and also provide support to the bridge which would connect the spillway with the dam or the hill.

Shaft spillway with funnel-shaped inlet is called “morning glory” or “glory hole” spillway. One of its distinguishing characteristics is that near- maximum capacity of the spillway is attained at relatively low heads. Therefore, shaft spillway is ideal when maximum spillway discharge is not likely to be exceeded.

Because of this feature, however, the spillway becomes unsuitable when a flow larger than the selected inflow design flow occurs. This disadvantage can be got rid of by providing an auxiliary or emergency spillway and using shaft spillway as service spillway.

Type # 6. Siphon Spillway:

A siphon spillway (Fig. 11.13) is essentially a closed conduit system which uses the principle of siphonic action. The conduit system is in the shape of an inverted U of unequal legs with its inlet end at normal reservoir storage level. When the reservoir water level rises above the normal level, the initial flow of water is similar to the flow over a weir.

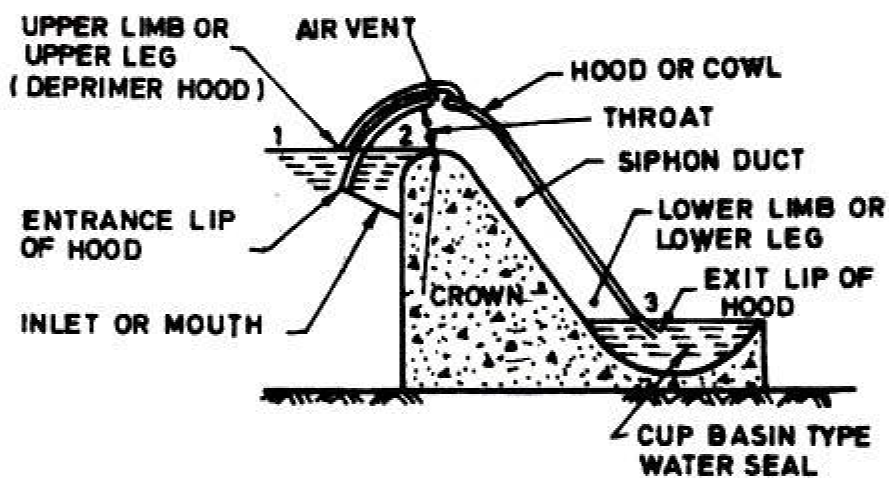


Fig. 11.13 Siphon spillway

When the air in the bend has been exhausted, siphonic action starts and continuous flow is maintained until air enters the bend. The inlet end of the conduit is placed well below the normal reservoir water level to prevent ice and drift from entering the conduit. Therefore, once the siphonic action starts, the spillway continues to discharge even when the reservoir water level has fallen below the normal level.

As such, a siphon-breaker air vent is always provided so that siphonic action can be broken once the reservoir water level has been drawn down to the normal level in the reservoir. Siphon spillways can be either constructed of concrete or formed of steel pipe. The thickness of the wall of the siphon structure should, however, be sufficiently strong to withstand the negative pressures which develop in the siphon.

Besides being an expensive structure and of limited capacity, siphon spillway has a serious disadvantage due to the occurrence of sudden surges and stoppages of outflow as a result of erratic siphonic action, thus causing severe fluctuations in the downstream river stage.

A minor crack in the cover of the siphon would interfere with the siphon. Therefore, spillways are usually constructed in batteries so that the entire spillway is not affected even if cracks have developed in one or few units.

In addition, the structure and foundation have to be strong enough to resist vibration stresses. Further, there exists a possibility of clogging of the siphon due to debris and floating material. Like other types of closed conduit spillways, siphon spillway too is incapable of handling flows appreciably greater than the designed capacity.

As such, siphon spillway, whenever provided, is used as a service spillway in conjunction with an auxiliary or emergency spillway. In canyons of small width and small flood discharge, the suitability of a siphon spillway should always be examined.

Type # 7. Cascade Spillway:

In case of very high dams, the kinetic energy at the toe of the dam will be very high and the tail water depth in the river may not be adequate for a single-fall hydraulic jump or roller bucket stilling basin.

Narrow and curved canyons consisting of fractured rock would not be suitable for trajectory buckets. In such situations, especially for high earth and rock-fill dams for which spillway is a major structure, possibility of providing a cascade of falls with a stilling basin at each fall (Fig. 11.14) must be considered.

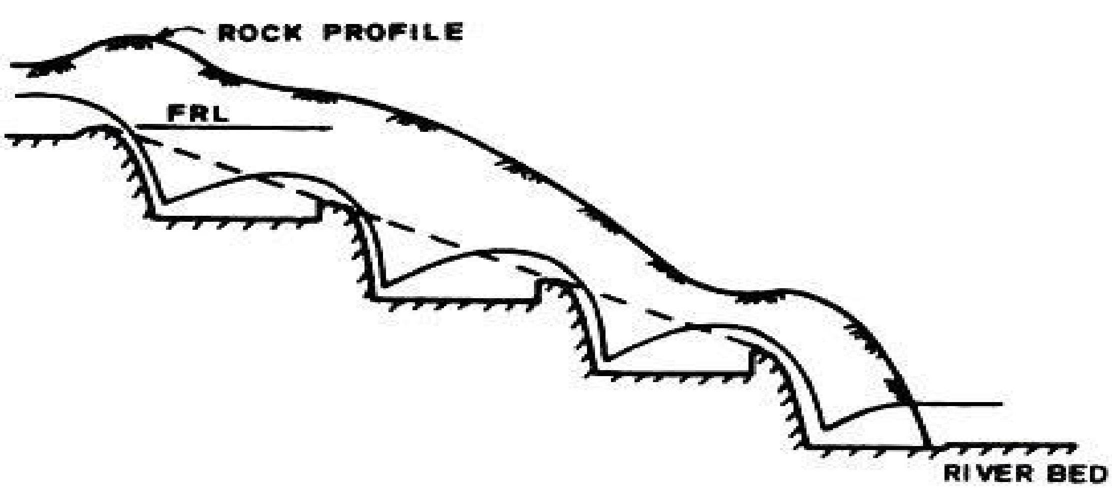


Fig. 11.14 Cascade spillway

The cascade spillway is likely to be an ideal choice for high rock-fill dam for which the material has been obtained from a quarry located downstream of the dam so that the flood waters may be discharged over the quarry face. As the quarry would usually be excavated in benches, these may as well form the steps in the cascade.

Cascade spillway is being provided at 218 m high Tehri dam on Bhagirathi river in the Ganga valley of the Central Himalayas. At Darmouth dam in Australia, the spillway to pass 2700 m^3/s of flood discharge would be an unlined cascade in granite. The benches of the cascade will be 5 m high and of varying widths to suit the topography of the site.

Although a cascade spillway, during floods, would be an attraction, it may not be always acceptable for environmental reasons which demand that the quarries be always located upstream of the dam and below the normal water surface level of the reservoir so as to cause minimum disfigurement of the land.

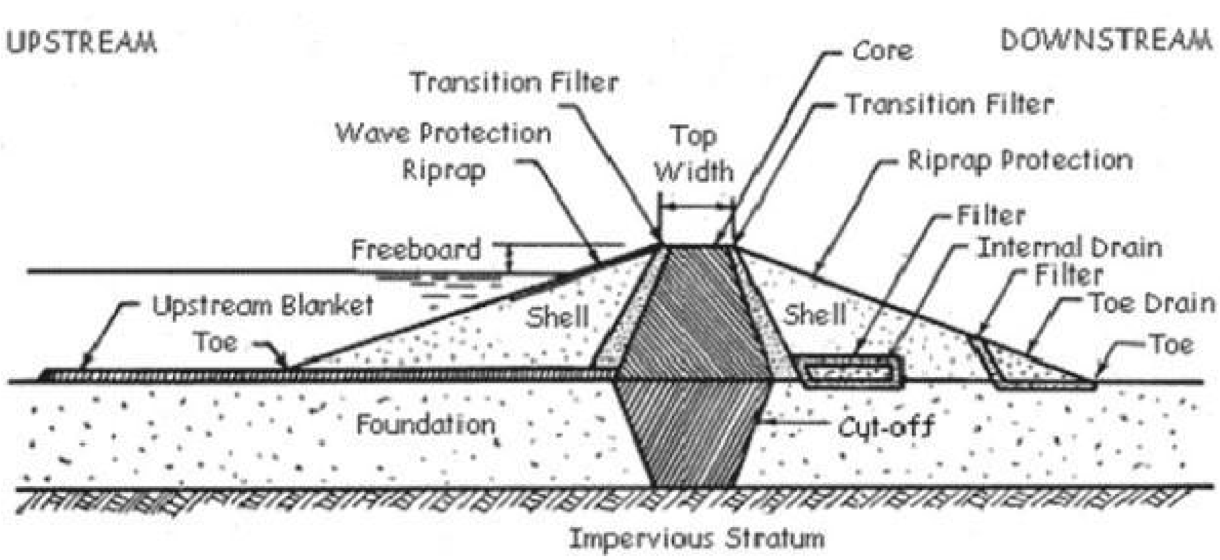
Type # 8. Tunnel Spillway:

Tunnel spillway discharges water through closed channels or tunnels laid around or under a dam. The closed channels can be in the form of a vertical or inclined shaft, a conduit constructed in an open cut and backfilled with earth materials, or a horizontal tunnel through earth or rock.

In narrow canyons with steep abutments as well as in wide valleys with abutments far away from the stream channel, tunnel spillways may prove to be advantageous. In such situations, conduit of the spillway can be easily located under the dam near the stream bed

4. Describe in detail about components of dams with neat sketch?

COMPONENT OF EARTH DAM



1. FOUNDATION

It consists of either earth or rock and provides a support for the embankment and resists both vertical and horizontal loads. It also resists under seepage on the flow of water beneath the dam.

2. CORE OR MEMBRANE

It holds back the free water of the dam reservoir. It is located either at the centre or upstream from the centre of the dam. In case of rock fill dams, the core is provided on the upstream face. To resist the under seepage, the core is extended down into the foundation till an impervious layer of sufficient thickness is reached. The extension of the core into the foundation is termed as a ***cut off***.

3. SHELL

It provides structural support for the core and distributes the load over the foundation. The dams which are constructed of the same materials are called homogeneous dams. Small dams can suitably be constructed as homogeneous dams if the available materials are suitable.

4. TRANSITION FILTER

In core dams, a ***transition filter*** between the core and shell is generally provided to prevent the migration of the fine grained core materials into the pores of the coarse grained shell materials. In case of difference in particle sizes of the materials of the core and shell is small, the transition filter is omitted but in case of clay cover and rock or gravel shell, a transition filter is necessarily provided.

5. INTERNAL DRAIN

An ***internal drain*** is provided on the downstream side of the dam to carry away the seepage through the core and cut off, and also to prevent the saturation of the upper part of the downstream shell by rain on the dam.

6. TOE DRAIN

A ***toe drain*** is provided at the downstream face of the shell. A ***riprap*** or ***grating*** is provided to cover the upstream face to prevent erosion or wash by waves.

Main Dam

This is the main structure built across the river. The height of a dam depends upon desired storage capacity and the site conditions. The crest length of he dam depend upon topography at the dam site. The dam may be built of many different materials. The stored water is released from the dam as per requirements.

Flanks/Abutment:

The rock mass on right & left banks of the river constitute abutments. Dam is joined with and supported by the abutments. In addition outlet tunnels, diversion tunnel, spillway are also placed in the flanks. The geology of the abutments has to be strong enough to enable placing various structural components without any risk. In addition abutments need to be of competent rock without any structural defects and lowest permeability

Saddle Dam:

The reservoir is usually formed by the main dam on one side and low/high hills on all other sides of the reservoir. In most cases the elevation of the hills along the rim of the dam is much higher than the reservoir maximum water level. In some other cases elevations of surrounding hills along a part of the rim/periphery of the reservoir is not high enough over a small section to completely contain the stored water and a saddle (low level place) is formed. Water can flow out through the saddle. A small embankment is then constructed at this low/saddle point to seal off the reservoir rim and is called as saddle dam. Example: Sukian dam and Jari dam for Mangla Dam project.

Diversion Channel/Tunnel

These channel or tunnel are constructed prior to dam construction such that river flow is passed around and away from the dam site through the diversion tunnels and that than dam site remain dry and accessible to construction at all time. The capacity of diversion structure is set such that most probable floods likely to occur during the construction period can be passed over without danger of overtopping of cofferdam and inundation of construction area. Necessary arrangements are made at d/s end for energy dissipation. These tunnels may be abandoned (plugged – Simly dam) after project completion or converted to irrigation / power / desilting tunnels. Diversion tunnel may not be provided (Mirani dam) and u/s coffer dam.

COFFERDAM

These are small temporary dams built u/s and d/s of the dam site to make the construction area dry and workable. The u/s cofferdam causes water to flow through the diversion tunnel and the d/s cofferdam prevents backwater level to inundate the construction area. Coffer dam may be dovetailed in u/s part of dam (Mangla) or abandoned. Material used earth, rock, concrete etc. Arrangemnet are required for control of seepage across the coffer dam.

1.6.6 Spillway

This is a water release/conveyance structure to pass the large flood volumes safely across the dam without danger of overtopping of the dam crest. There would be one or more spillways usually at different levels (Service, additional, emergency). The lower spillway is used to release often occurring flood and regular inflows and is called as service spillway. It has usually more elaborate arrangements and may be free flowing or gated. The auxiliary or emergency spillway is set at or above normal conservation level and has fewer arrangements and is usually free flowing. This is used only during flood

events of extra-ordinary nature. Fuse plug, rubber dam etc may be used to delay water release and possible additional storage at the reservoir.
The spillway may be a integral part of the main dam (mostly for concrete dams) or be a separate structure in the dam abutments.

1.6.7 Outlet Works

(a) Intake Structure / Tower: This is a structure to admit and control flow of water into the irrigation/power outlets. It would be a tower or inlet flush with reservoir side walls. Gates may be provided at u/s, intermediate or d/s end of the outlet tunnel. Necessary provision is made to keep the intake operation for long after sedimentation by having multiple water entry levels particularly for domestic supply purposes. Multi level inlet openings may be used.

(b) Irrigation/Power Outlet Tunnel: This is a large water conveyance structure to release water to irrigation network and/or powerhouse turbines. The outlet is in the form of a tunnel dug or formed through the abutment / flank for earth / rockfill dams or through the dam body for a concrete dam. At the u/s end an intake is provided along with gates, trash rack. The tunnel design must eliminate risk of cavitation and/or aeration. Gates may be placed at u/s, d/s or intermediate location. The power tunnel is transitioned into surge chamber, penstock/scroll case etc. Energy dissipation structure may be provided at d/s end, if needed. Irrigation outlet may release into a canal or into the river if demand site is at distance from the dam. The intake level of the tunnel is kept below or at the dead storage level. Air vent is provided to minimize cavitation. Water cushon for vortex control are also provided.

(c) Low Level Outlet: A low outlet tunnel may be provided to flush sediments, draw water from below dead storage level under very drought condition, emptying of reservoir in emergencies, draw water during repair of outlet tunnel/gates, etc. The intake level is kept much lower than the intake level main irrigation tunnel. May discharge into stilling basin for spillways/outlet works or as a separate energy dissipation structure provided. [Similar to under sluices in a barrage.]
(d) Gates/Valves/
(e) Trash Rack, air duct for cavitation control
1.6.8 Drainage System
Dams are designed to store water with least seepage through the dam embankment and the foundation but seepage do occur. The drainage/seepage water also causes tremendous uplift pressure particularly at d/s half of the dam base. Features are included in the dam design to minimize seepage through the foundation and through the dam embankment and uplift pressure. Cutoff wall, sheet piles, slurry trench, etc.
• Grout Certain: An impermeable zone is created under the dam.
• Grout Blanket: Impermeable area is created u/s of dam.
• Pressure relief / Drainage Wells: Wells are installed at d/s area to pick and remove seepage water to reduce uplift pressure in the
• Drainage gallery
foundation area.
A horizontal/inclined gallery is formed in the body of the dam (specially in concrete dams) where water

from drainage wells discharge into and is ultimately flow out of the dam body. It also intercepts leaks through dam body.

• Horizontal Blanket Drain: To intercept seepage lines at base of dam on d/s side.
• Chimney Drain:
• Toe Drain:

Vertical or inclined drainage filter layer (usually d/s of the impermeable clay core) to intercept seepage flow.

A drain is provided at toe of dam (homogeneous coarse fill) to intercept seepage flow inside the dam body.

1.6.8 Preliminary Works

Trench provided at d/s of dam to intercept seepage flow lines. gradient and seepage rate.

• D/S Trench:
• Impermeableblanket to lengthen the seepage path and lower hydraulic

Civil works, infrastructures, buildings required to be provided before start of construction of main dam work. These include offices, staff housing, community buildings, water supply, approach road, client/consultant/contractor camp, labor camp, security arrangements, rest house, rail sidings, air strip, hele-pad, etc.

1.6.9 Hydropower Development

(a) Powerhouse: Building to house turbine, generators, mechanical workshop, valves, draft tube, office, control room, visitor area, up transformer, etc for hydropower generation.

(b) Penstock: This is a large diameter pressure pipe used to deliver water to turbines.

(c) Surge chamber. To contain water hammer surge on plant load rejection / sudden shut- down.

(d) Switchyard: This is an area to install electrical equipment to change low to high tension power supply for further transmission.

1.6.10 Slope protection/Riprap

Stone is placed on u/s & d/s dam slopes for protection against damage due to wave action, rain water, burrowing animals. Parapet wall may be used to protect dam top against sudden waves generated by strong winds, tsunami, etc.

1.6.11 Dam Instrumentation

Various gages/instruments are installed in the dam body, foundations, spillway to monitor settlement, movement, stresses, pore water/uplift pressure, earthquake.

1.6.12 Stilling Basin

To dissipate excess energy of diversion tunnel, low level outlet, irrigation tunnel, spillway, etc.

1.6.13 Gallery/Shafts

These are provided in the dam body for access to interior of concrete dam body. These are horizontal, vertical (with round stair ways), sloping.

1.6.14: Operational buildings

These are buildings required for operation of the dam and works. These include Office buildings, Rest House, Security buildings, Staff residences and other community buildings, gate control room.

1.6.15: Temporary works:

These are installations required for temporary use and are removed after project completion. These include contractors camp, material processing, handling and stock area, machine room, casting yard, steel fabrication, labor camp, etc.

Core:

It is made up of impervious material and its object is to make the dam water tight. The particle size of material used in the core is small so that it can retain water and do not allow its further seepage.

Shell:

Shell is made up of pervious material (porous material). It gives strength and support to the core wall. The particle size of the materials used in shell is large i.e coarse material.

Transition filters:

As the core contains fine material and the shell contains coarse material so there is a chance that both may get mixed into each other. These filters are installed in the dam body to stop the mixing of materials from either sides into each other. Transition filters are made of material which is semi-pervious in nature.

Cut off trench:

It is a trench dug to fill it with impervious material e.g. Rich Concrete

Sheet pile wall:

Sheet pile wall is used in areas where it is required to stop water from flowing across. OR when the impervious layer is at very depth and if trench cannot be dugged out due to economic constraints then this sheet pile wall is used.

Impervious stream blanket:

Impervious stream blanket is laid in the foundation of the dam and its objective is to stop the seepage in the dam foundation.

Rip rap:

This material basically belongs to the category of geotextiles and is used to stop upstream face from erosion. It is made up of large stones which ranges from 1/2 m - 1 m.

Horizontal drainage:

It is usually used if dam body is made of impervious material. The dam body may contain moisture already or due to very loss seepage, If this water remains in the dam body, pore water pressure is developed and effective pressure is reduced, so to remove that water this zone is used.

Soil turfing / Sod:

To avoid erosion due to rain, snow fall, wind etc. soil turfing is used. It is also called sod.

Crest / top:

It is the most upper part of the dam which divides the upstream face and the downstream face. Its objective is to give access to vehicles over it.

Free board:

To avoid overtopping of dam, free board is used.

5.procedures for selection of site for reservoirs during dam surveying?

- The first point you have to consider is the geological conditions of the land.Tha percolation losses of the catchment should be less.Is should maintain maximum runoff.
- Suitable dam site should exist and the infiltration rate of soil should be less.
- The reservoir should be in a place such that the quantity of leakage should be less.
- The site should be deep as possible because less land is required, less evaporation and less reduction in water spread area.
- The rock should not have high permeability.The types of rocks such as shales, gneiss, slates are commonly selected for the dam construction.
- The price of real estate for the reservoir, including roads, relocation, dwelling must be less as possible.
- The topography of the reservoir should be such that it should maintain required capacity without submerging excessive land and other properties.
- The valley to the reservoir should avoid carrying a high percentage of silt to reservoir or dam.
- The rocks and soil should not contain any minerals or salts which are harmful to the concrete construction of the dam.
- You should have a proper idea about the chances of the earthquake .