UNIT-III

1.Expain the working principle of Hydroelectric power plant ,Advantages and Disadvantages

Ans: In ***hydroelectric power plant***, water is stored in a dam called hydroelectric dam which is located upper level from the ground especially any hilly areas. Water head is created by construction the dam across any river or lake. Hydroelectric power station needs huge amount of water at sufficient head all the time. This reservoir creates sufficient water head. A pressure tunnel is placed in between the reservoir to valve house and water is coming from reservoir to penstock via this tunnel. An automatic controlling sluice valve is placed in valve house and it controls water flow to the power station and the letter cuts off supply of water in case the penstock bursts.

Penstock is a huge steel pipe in which water is taken from valve house to turbine.

Dam

Develops a reservoir to store water

Builds up head for power generation

Spillway

To safeguard the dam when water level in the reservoir rises

Intake

Contains trash racks to filter out debris which may damage the turbine

Forebay

Enlarged body of water just above the intake

Conduits

Headrace is a channel which lead the water to the turbine

Tailrace is a channel which carries water from the turbine

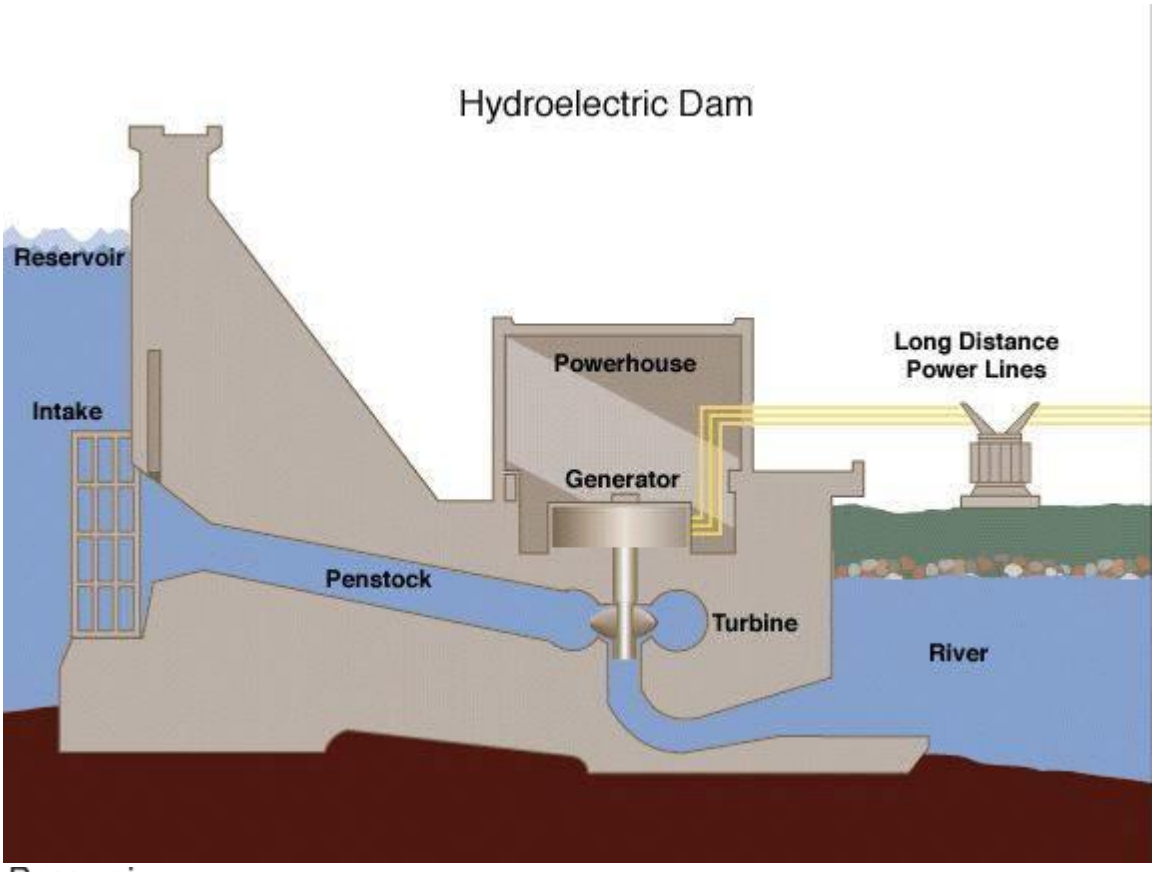
A canal is an open waterway excavated in natural ground following its contour.

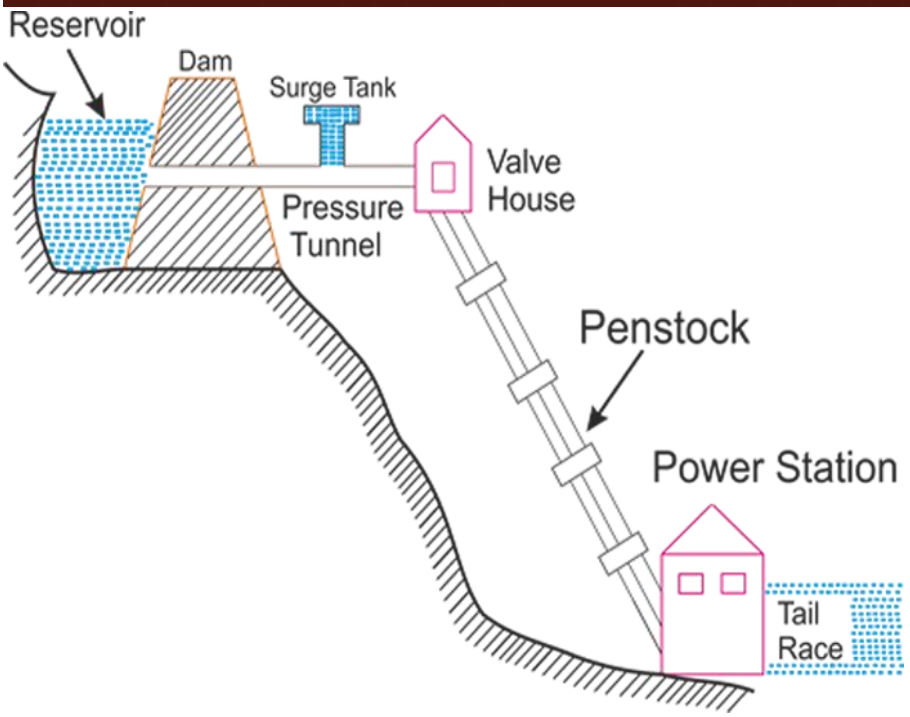
A flume is an open channel erected on a surface above ground.

A tunnel is a closed channel excavated through an obstruction.

A pipeline is a closed conduit supported on the ground.

A **surge tank** is also provided just before the valve house for better regulation of water pressure in the system. This type of water head store huge potential energy. The water fall into water turbine and the potential energy of water is converted into kinetic energy. This kinetic energy is converted into mechanical energy at the turbine shaft. A hydroelectric generator or alternator is coupled with turbine shaft to convert mechanical energy into electrical energy. The power is developed-


Hydroelectric Dam
Reservoir
Intake
Powerhouse
Generator
Long Distance
Power Lines
Penstock
Turbine
River


Reservoir
Dam
Surge Tank
Valve
House
Pressure
Tunnel
Penstock
Power Station
Tail
Race

There are lots of advantages in Hydroelectric Power Plant:

1. Since water is the main source of energy,so no fossil fuels are required.
2. This plant is neat and clean and no smoke or as disposal is required.

3.It is the cheapest operating and maintenance cost as compared to the other power plants because water is freely available in the world.

4.It is very reliable, robust and has a longer life app rocks 45 to 60 years.

5.This plant can start instantly.

6.It can start hydroelectric power with fluctuating load demand.

7.The efficiency does not fall at the age of this plant.

8.There is no standby loss in this plant.

9.At the initial time of construction highly skilled engineers are required and after that only few experience persons can run the plant.

10.This plant also serves to help in irrigation and Flood control etc.

11.Since this plants are located remote area so land is available and competitively cheaper rates.

Disadvantages

1.Such plant requires large area

2.High construction cost is required due to construction of dam.

3.When experience skilled engineers are required to build this plant

4.Scenes such plant is located as from the load areas, long transmission line is required to transmit this hydroelectric power.

5.It doesn't supply constant hydroelectricity due to the availability of water. In transition, power supply is most affected.

2 What is the criteria for Site selection of Hydro Electric power plant

Ans: 1.**Water Availability:**

Main fuel of this plant is water. So, such plant should be located nearer to river, canal etc. where sufficient water is available all the time.

2. **Water Storage:**

Storage of water in a suitable reservoir or dam has to be placed by a careful geological study of the area to get the maximum advantage of that water.

Dam should be located across the river to get continuous water supply throughout the year specially in a dry season. The storage capacity of dam can be determined by hydrograph or mass curve or using analytical method. Adequate facilities of erection a dam and storage of water are two important matters for site selection of hydro electric power plant.

3. **Water Head:**

It is an important point for site selection of hydroelectric power plant.

Water head is directly related to the cost of generation of electric power. If effective head is increased, water storage has to be reduced as well as capital cost of the plant is reduced.

4. **Distance from the load centre:**

Since it is located away from the load centre , more transmission line is required to supply the power. To avoid the line loss and economical power supply, distance of such plant should need more attention.

5.**Transportation Facilities:**

Good transportation facilities must be available to any hydro electric power plant, so that necessary equipment should be reached easily.

6 .**Availability of land:**

Hydro electric power plant needs enough space. It should be kept in mind that land cost must be cheap.

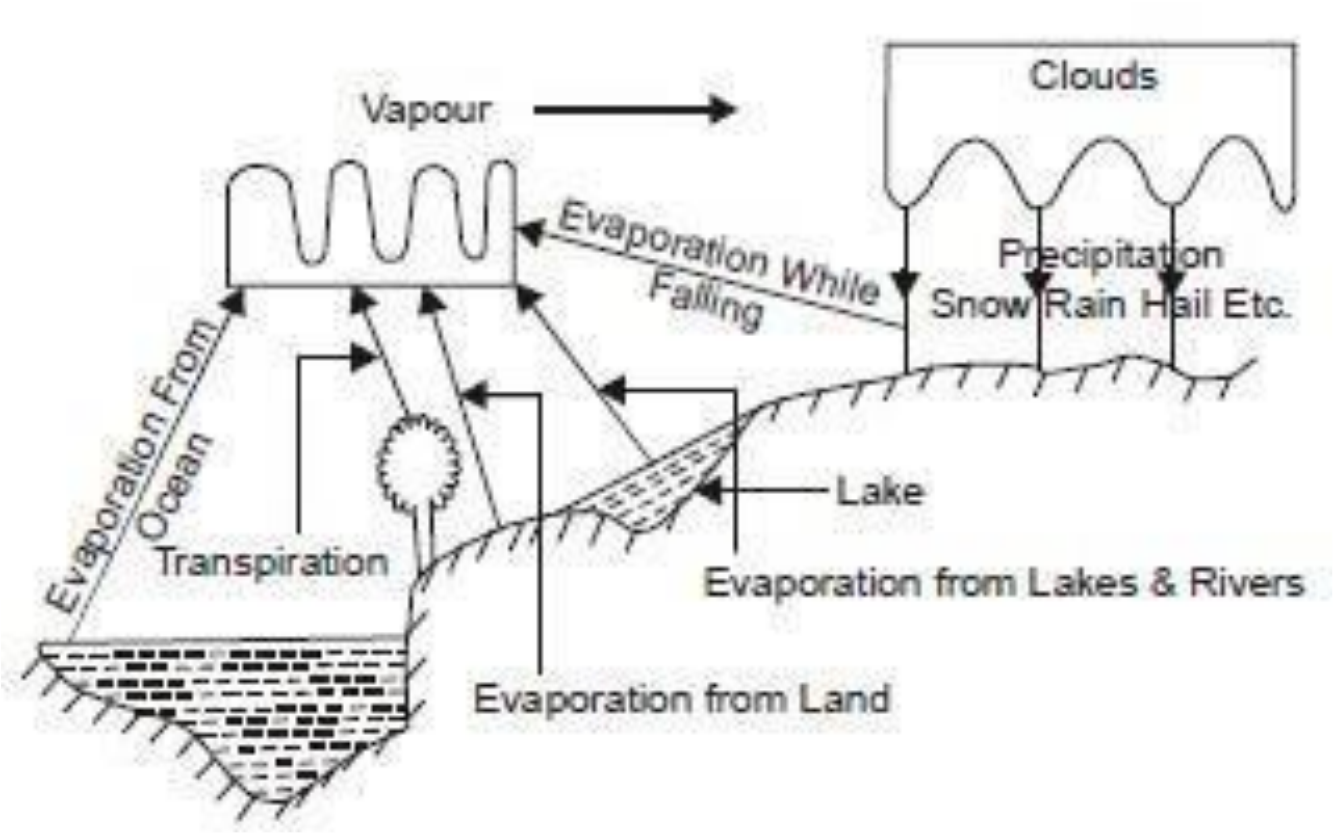
3 Explain Hydrological Cycle:

Ans: When rain water falls over the earth‘s surface, it possesses potential energy relative to sea or ocean towards which it flows. If at a certain point, the water falls through an appreciable vertical height, this energy can be converted into shaft work.

As the water falls through a certain height, its potential energy is converted into kinetic energy and this kinetic energy is converted to the mechanical energy by allowing the water to flow through the hydraulic turbine runner. This mechanical energy is utilized to run an electric generator which is coupled to the turbine shaft.

The generation of electric energy from falling water is only a small process in the mighty heat power cycle known as ―Hydrological cycle‖ or rain evaporation cycle‖.

It is the process by which the moisture from the surface of water bodies covering the earth‘s surface is transferred to the land and back to the water bodies again. This cycle is shown in Fig. The input to this cycle is the solar energy. Due to this, evaporation of water takes place from the water bodies. On cooling, these water vapors form clouds.



Hydrological Cycle

3.Define Runoff, water table

Run off ,in hydrology, quantity of water discharged in surface streams.

Runoff also includes groundwater that is discharged into a stream; streamflow that is composed entirely of groundwater is termed base flow, or fair-weather **runoff**, and it occurs where a stream channel intersects the water table.

Water table is an underground boundary between the soil surface and the area where groundwater saturates spaces between sediments and cracks in rock

4 Explain the Flow Measurement in Hydroelectric power plants

Ans: a)Nature of Precipitation. Short, hard showers may produce relatively little run-off.

b)Rains lasting a longer time results in larger run-off.

c)The soil tends to become saturated and the rate of seepage(the slow escape of a liquid or gas through porous material or small holes.). decreases. Also, the humid atmosphere lowers evaporation, resulting in increased run- off.

2. Topography of Catchments Area. Steep, impervious areas will produce large percentage of total run-off. The water will flow quickly and absorption and evaporation losses will be small.

3 Geology of Area. The run-off is very much affected by the types of surface soil and sub-soil, type of rocks etc. Rocky areas will give more run-off while pervious soil and sub-soil and soft and sandy area will give lesser run-off.

4 Meteorology. Evaporation varies with temperature, wind velocity and relative humidity. Runoff increases with low temperature, low wind velocity and high relative humidity and vice versa.

5. Vegetation. Evaporation and seepage are increased by cultivation. Cultivation opens and roughens the hard, smooth surface and promotes seepage. Thick vegetation like forests consumes a portion of the rain fall and also acts as obstruction for run-off.

6. Size and Shape of Area. Large areas will give more run-off.

A wide area like a fan will give greater run-off, whereas, a narrow area like a leaf will give lesser run-off.

Measurement of Run-Off or Flow : The run-off or stream flow can be determined with the help of three methods:

1. **From Rain-Fall Records.** The run-off can be estimated from rain-fall records by multiplying the rain fall with run-off coefficient‖ for the drainage area .

The run-off coefficient takes into account the various losses and will depend upon the nature of the catchment area,

Run-off = Rain fall × run-off co-efficient This is not an accurate method of measuring run-off since the estimation of run-off co- efficient cannot be very accurate.

2. Empirical Formulas. Empirical relations to determine the stream flow relate only to a particular site and cannot be relied upon for general use.

3 Actual Measurement. Direct measurement by stream gauging at a given site for a long period is the only precise method of evaluation of stream flow. The flow is measured by selecting a channel of fixed cross-section and measuring the water velocity at regular intervals, at enough points in the cross-section for different water levels. The velocity of flow can be measured with the help of current meter or float method. By integrating the velocities over the cross-section for each stage, the total flow for each stage can be calculated.

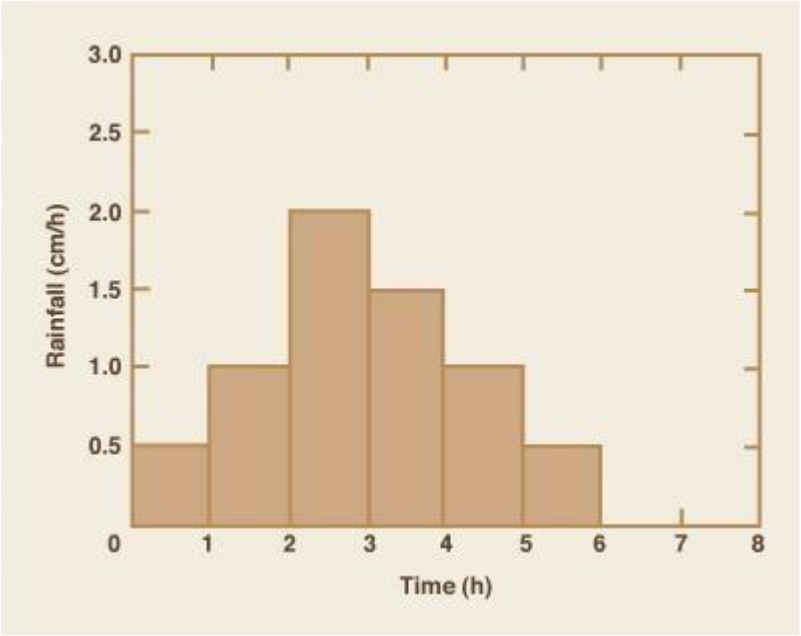
5 What is meant by Hydrograph

Ans: A hydrograph indicates the variation of discharge or flow with time.

It is plotted with flows as ordinates and time intervals as abscissas.

The flow is in m3/sec and the time may be in hours, days,weeks,months

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6.Explain Various types of Dams

Ans: Primary purpose of a dam is to provide for the safe retention and storage of water.

Structurally, a dam must be stable against overturning and sliding, either or within the foundations.

The rock or soil on which it stands must be competent to withstand the superimposed loads without crushing or undue yielding.

Types

MASANORY DAMS
Solid gravity dams
Buttress dams

Arch dams

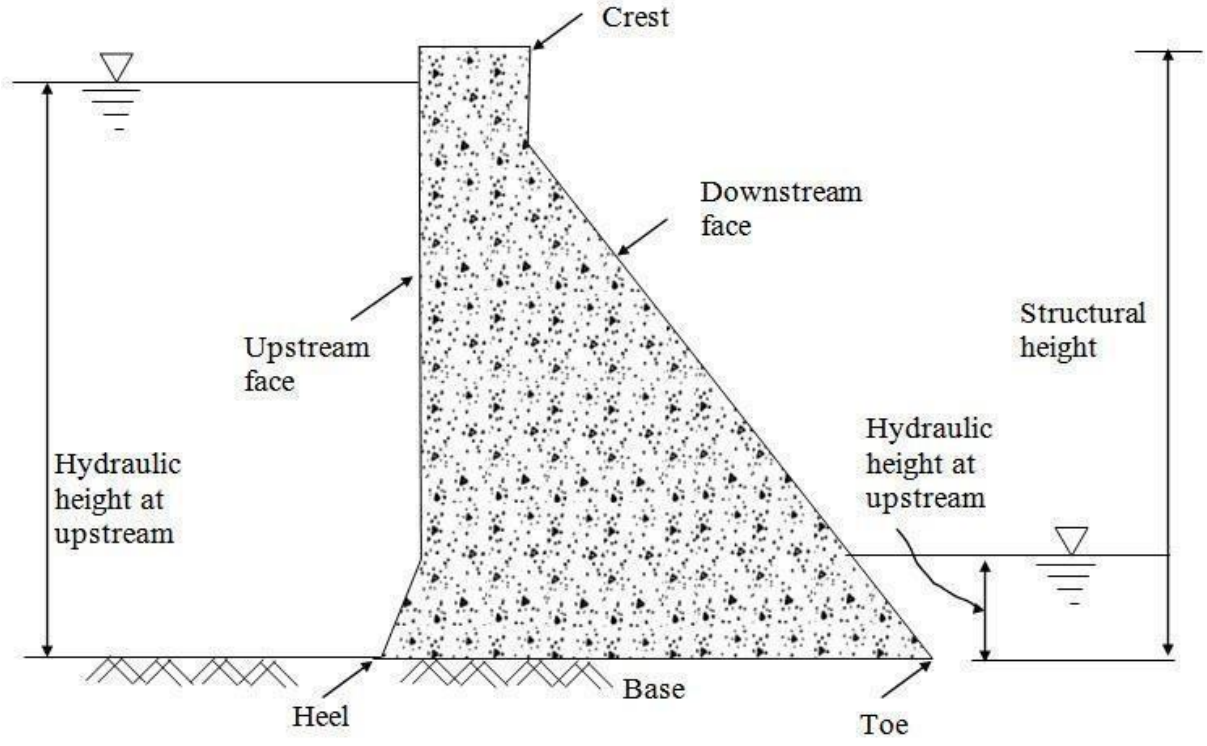
Earth fill dams

Rock fill dams

SOLID GRAVITY DAMS:

A gravity dam is one which depends entirely on its own mass for stability (Fig.).

The basic gravity profile is triangular in shape, but for practical purposes, is modified at the top. Some gravity dams are slightly curved in plan, with the curvature being towards the river upstream.

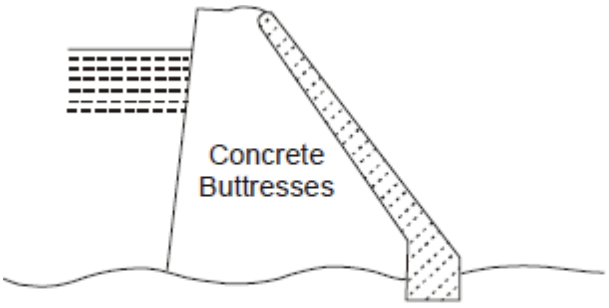


GRAVITY DAM



BUTTRESS DAMS:

A buttress dam or hollow dam is a dam with a solid, water-tight upstream side that is supported at intervals on the downstream side by a series of buttresses (a structure of stone or brick built against a wall to strengthen or support it.) or supports. The dam wall may be straight or curved. Most buttress dams are made of reinforced concrete and are heavy, pushing the dam into the ground.



Buttress Dam

ARCH DAMS:



It resists the pressure of water partly due to its weight and partly due to arch action.

An **arch dam** is a solid dam made of concrete that is curved upstream in plan.

The arch dam is designed so that the force of the water against it, known as hydrostatic pressure, presses against the arch, compressing and strengthening the structure as it pushes into its foundation or abutments.

An arch dam is most suitable for narrow gorges or canyons (**A canyon is a deep, narrow valley with steep sides.)** with steep walls of stable rock to support the structure and stresses. Since they are thinner than any other dam type, they require much less construction material, making them economical and practical in remote areas.



Earth and Rock fill dam

The Earth fill dams have become more popular in recent years owing to the development in soil mechanics and heavy earth moving machinery. The earth dams are more economical for sites where excavation of the foundation soil is considerable

Rockfill dams have characteristics midway between gravity dams and earth fill dams. Rocckfill dams are considered as economical when adequate quantity of good rock is easily available near the dam site

7 Define Hydrology, objectives, Flow duration curve , mass curve, storage, pondage

Ans: • Hydrology deals with occurrence and distribution of water over and under earth's surface.

– Surface Water Hydrology

– Ground Water Hydrology

• **Watershed, catchment area or drainage area:** length of the river, size and shape of the area it affects, lakes, reservoirs etc.

Objectives

• To obtain data regarding the stream flow of water that would be available,

• To predict the yearly possible flow

• To calculate the mean annual rainfall in the area under consideration from a record of the annual rainfall for a number of years, say 25 to 30
• To note the frequency of dry years
• To find maximum rainfall and flood frequency
• **Flow duration curve:**
– shows the percentage of time during the period when the flow was equal to greater than the given flow. – The area under FDC gives the total quantity of run-off during a period
• **Mass curve**
– indicates the total volume of run-off in cubic meters up to a certain time.
– the slope of the curve at any point shows the rate of flow at that time
– Used for estimating the capacity of storage reservoir
• **Storage:**
– to ensure water availability during deficient flow and thus increasing the firm capacity
– Storage also results in more energy production
• **Pondage:**
– Storing water in small ponds near the power plant as the storage reservoir is away from plant
– To meet the power demand fluctuations over a short period of time e.g. 24 hours

8 Explain Types of Spill ways

Ans: A spillway is a structure used to provide the controlled release of flows from a dam into a downstream area, typically being the river that was dammed. Spillways release floods so that the water does not overtop and damage or even destroy the dam.

Overflow spillway
Chute spillway
Shaft spillway
Siphon spillway

Overflow spillway:

Open channel spillways are dam spillways that utilize the principles of open-channel flow to convey impounded water in order to prevent dam failure.

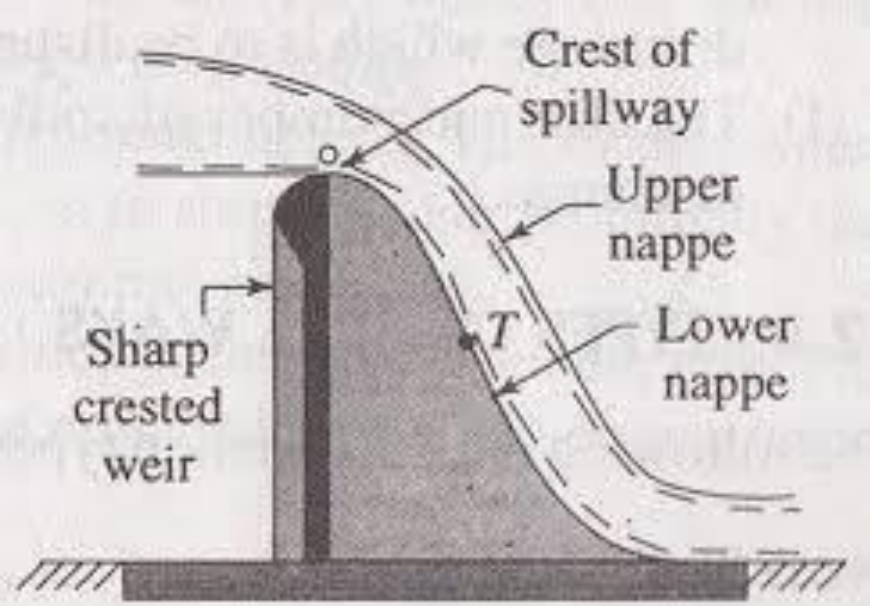


Fig: Ogee Spillway

Chute spillway:

Chute spillway is an open channel like structure, which is constructed on steep slope of the gully face with a suitable inlet and outlet. It usually consists of an inlet, vertical curve section, steep-sloped channel and outlet. The major part of the drop in water surface takes place in a channel



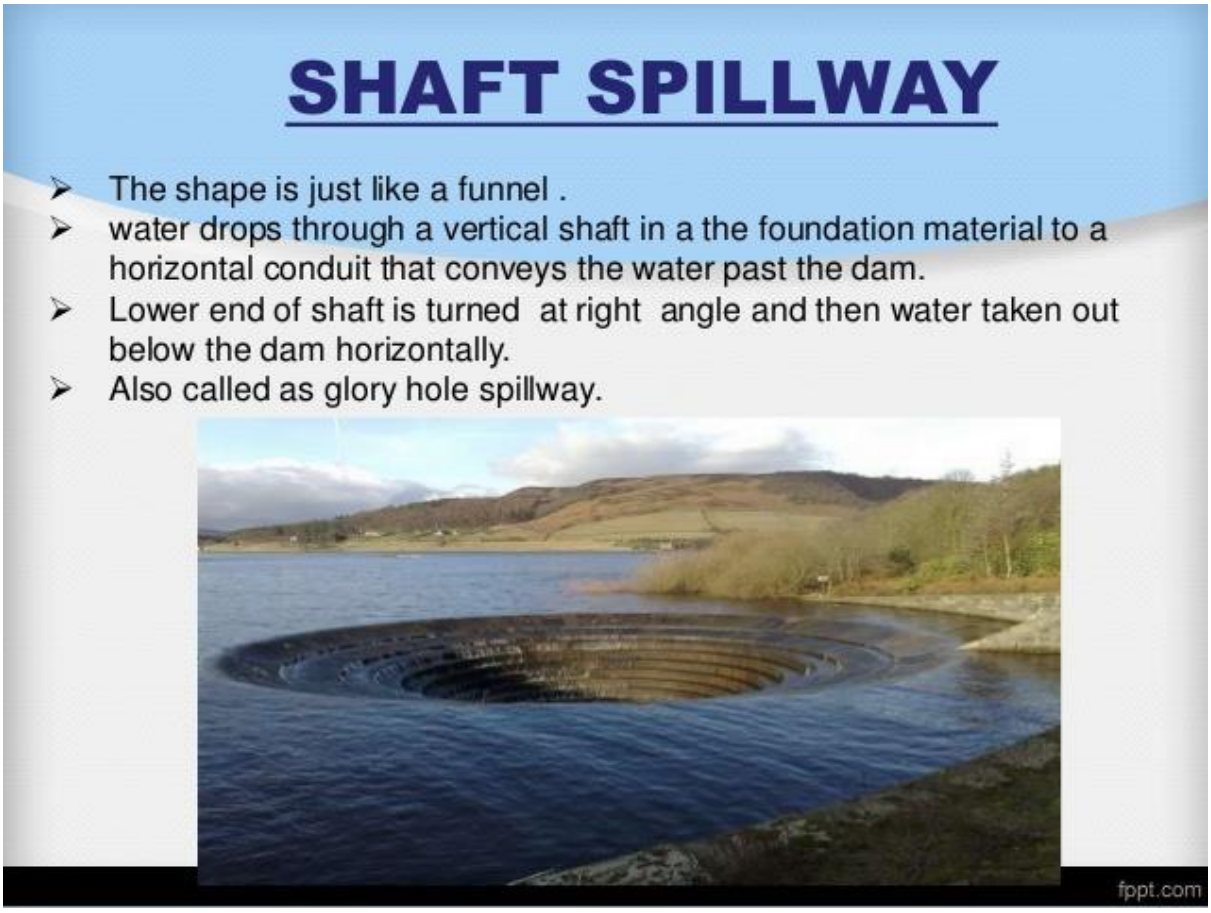
Fig. 21.1. One of Alqueva dam chute spillway. in Portugal.

. A chute spillway is a common and basic design which transfers excess water from behind the dam down a smooth decline into the river below. These are usually designed following an ogee curve. Most often, they are lined on the bottom and sides with concrete to protect the dam and topography.

Shaft Spillway:

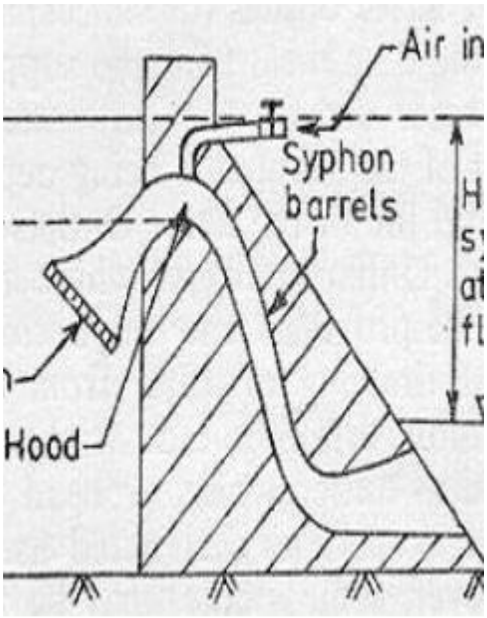
A **Shaft spillway** is a type of **spillway** which consists of a vertical **shaft** followed by a horizontal conduit. The surplus water enters into the vertical **shaft** and then to the horizontal conduit and finally reaches the downstream of the channel.

A vertical shaft which has a funnel-shaped mouth and ends in an outlet tunnel, providing an overflow duct for a reservoir.



Siphon spillway:

A siphon makes use of the difference in the height between the intake and the outlet to create a pressure difference needed to remove excess water. Siphons however require priming or the removal of air in the bend in order for them to function and most siphon spillways are designed with a system that makes use of water to remove the air and automatically prime the siphon.


Air in
Syphon
barrels
Hood