

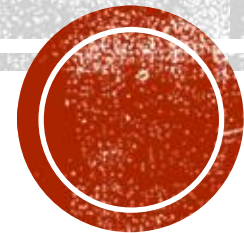
# LECTURE 2

## HYDROELECTRIC POWER PLANT

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# Classification of Hydro-Electric PP

Hydroelectric power plants can be classified in the following way.

(a) **According to the availability of head**

1. High head power plants
2. Medium head power plants
3. Low head power plants

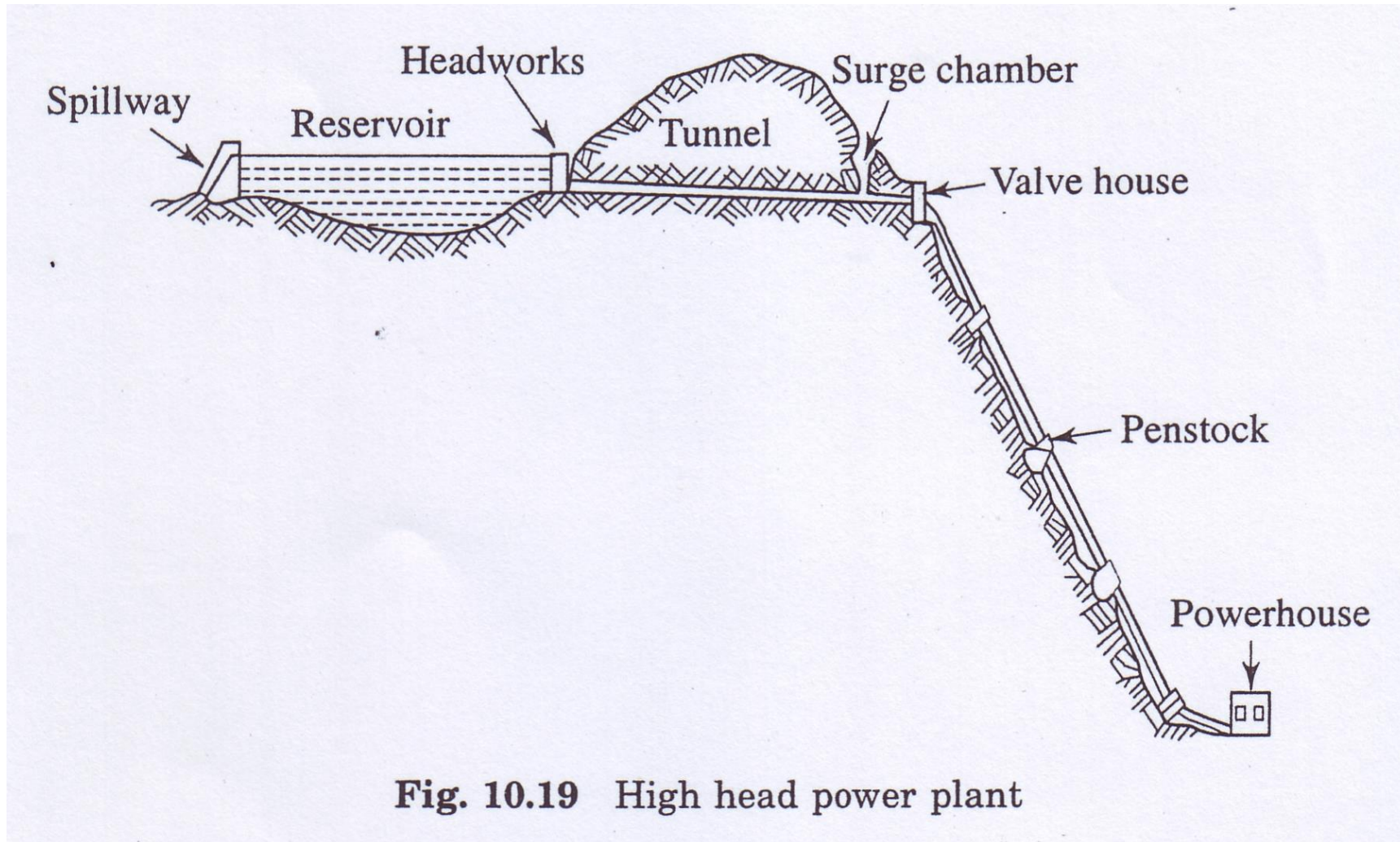
(b) **According to the nature of load**

1. Base load plants
2. Peak load plants

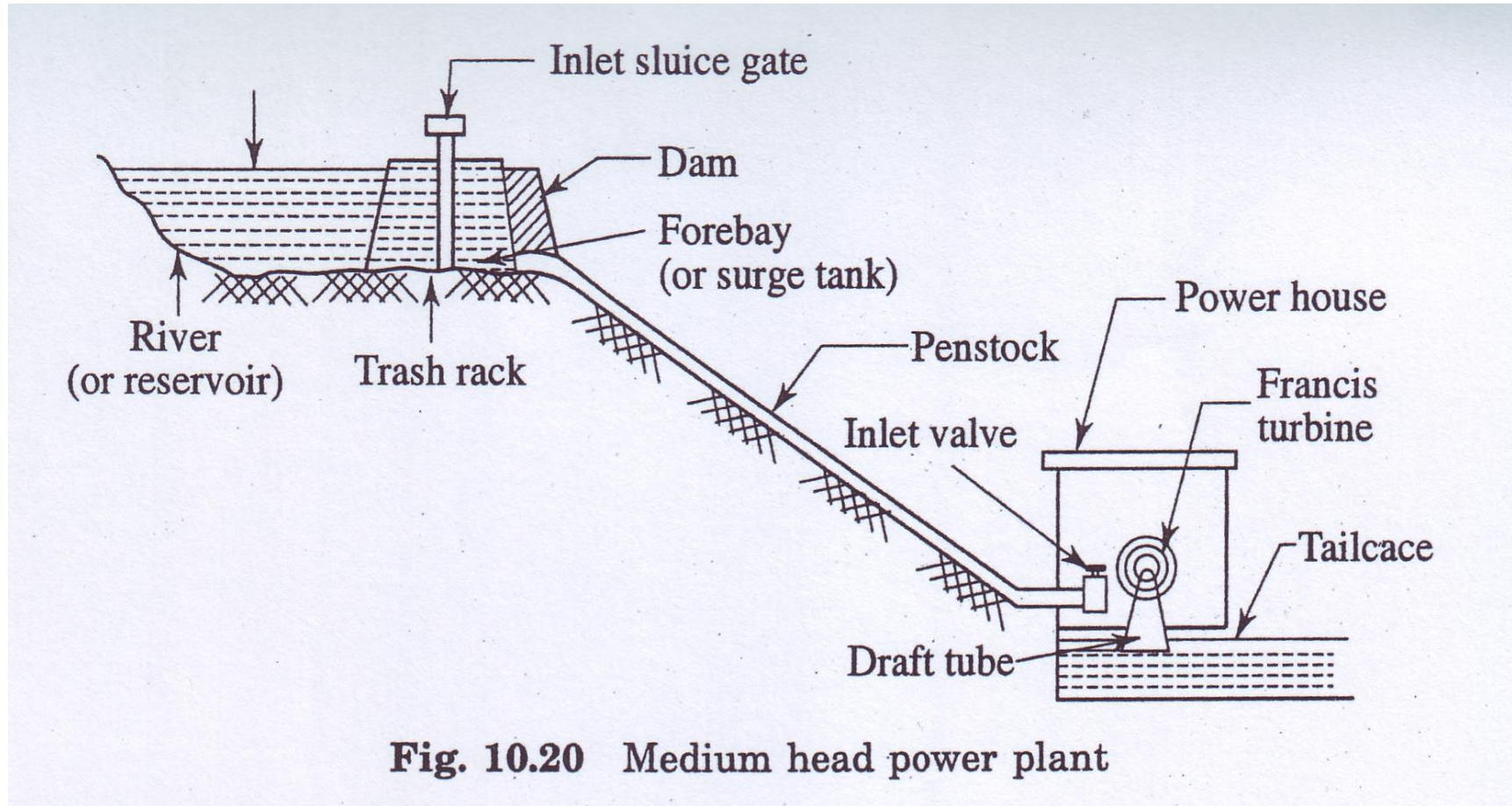
(c) **According to the quantity of water available**

1. Run-of-river plant without pondage
2. Run-of-river plant with pondage
3. Hydroelectric plants with storage reservoirs
4. Pump storage plants
5. Mini and micro hydel plants

# Classification of Hydro-Electric PP....

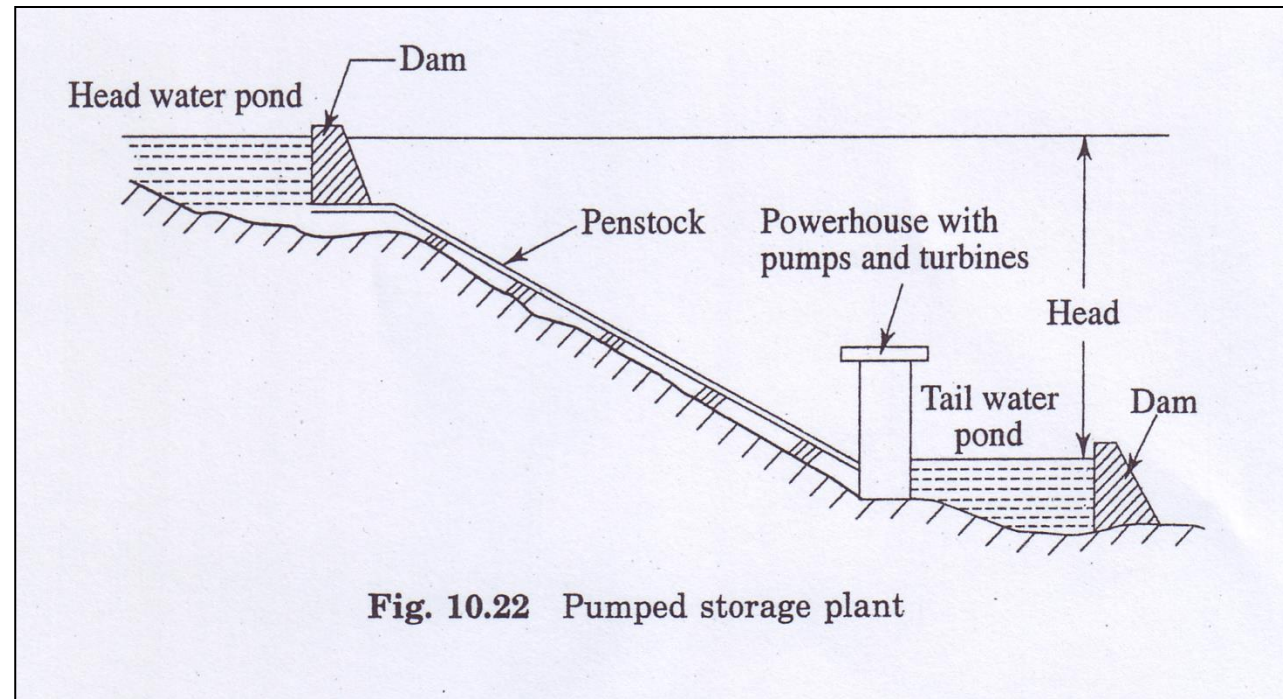
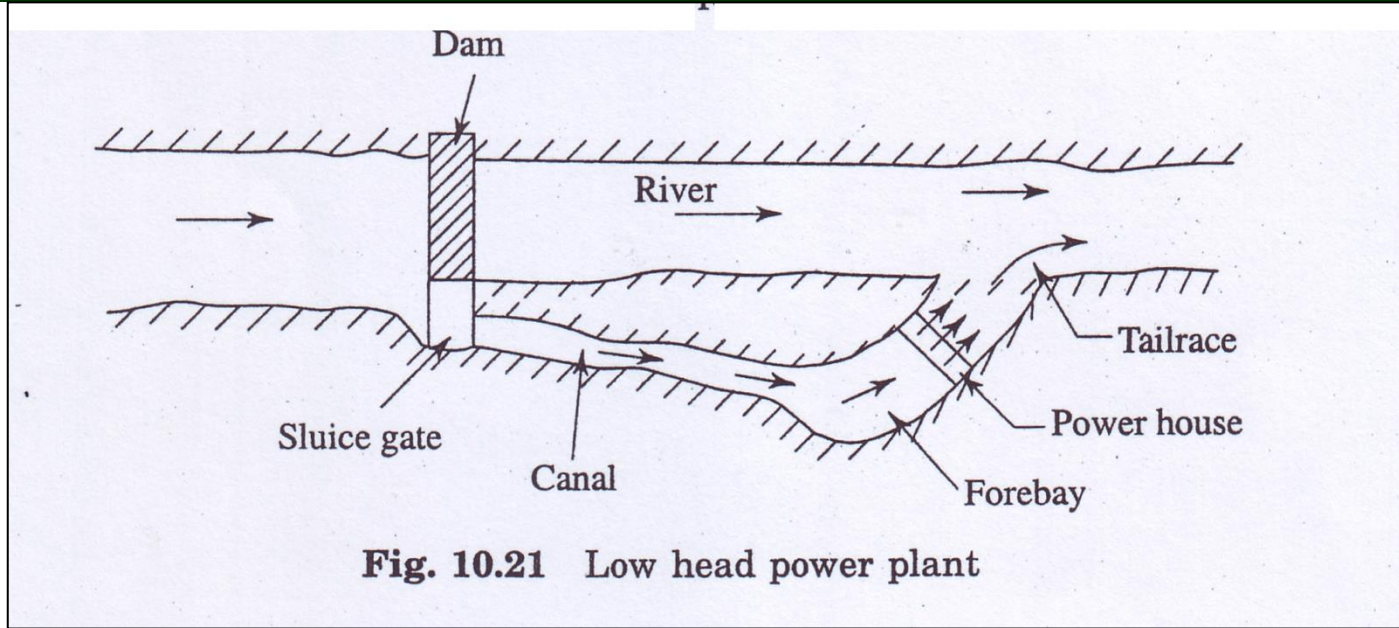


# Classification of Hydro-Electric PP....



**Fig. 10.20** Medium head power plant

# Classification of Hydro-Electric PP....



# Factors of Site Selection of a HydelPP

## ***1. Availability of water***

The design and capacity of the hydro-plant greatly depends on the amount of water available at the site. The run-off data along with precipitation at the proposed site with maximum and minimum quantity of water available in a year should be made available to

- a) decide the capacity of the plant,
- b) provide adequate spillways or gate relief during flood period.

## ***2. Water storage capacity***

Since there is a wide variation in rainfall all round the year, it is always necessary to store the water for continuous generation of power. The storage capacity can be estimated with the help of mass curve.

# Factors of Site Selection of a HydelPP

## ***3. Available water head***

In order to generate the desired quantity of power it is necessary that a large quantity of water at a sufficient head should be available. An increase in effective head, for a given output, reduces the quantity of water required to be supplied to the turbines.

## ***4. Accessibility of the site***

The site should be easily accessible by rail and road. An inaccessible terrain will jeopardize the movement of men/materials.

## ***5. Distance from the load Center***

If the site is close to the load center, the cost of transmission lines and the transmission losses will be reduced

## ***6. Type of the land of the site***

The land of the site should be cheap and rocky. The foundation rocks of the dam should be strong enough to withstand the stresses in the structure and the thrust of water when the reservoir is full.

# HPP Site Selection: Types of Investigations

## ***1. Hydrological investigation***

- a) Water Availability
- b) Storage Capacity
- c) Water Head
- d) Load Center from the Plant
- e) Approach to the site

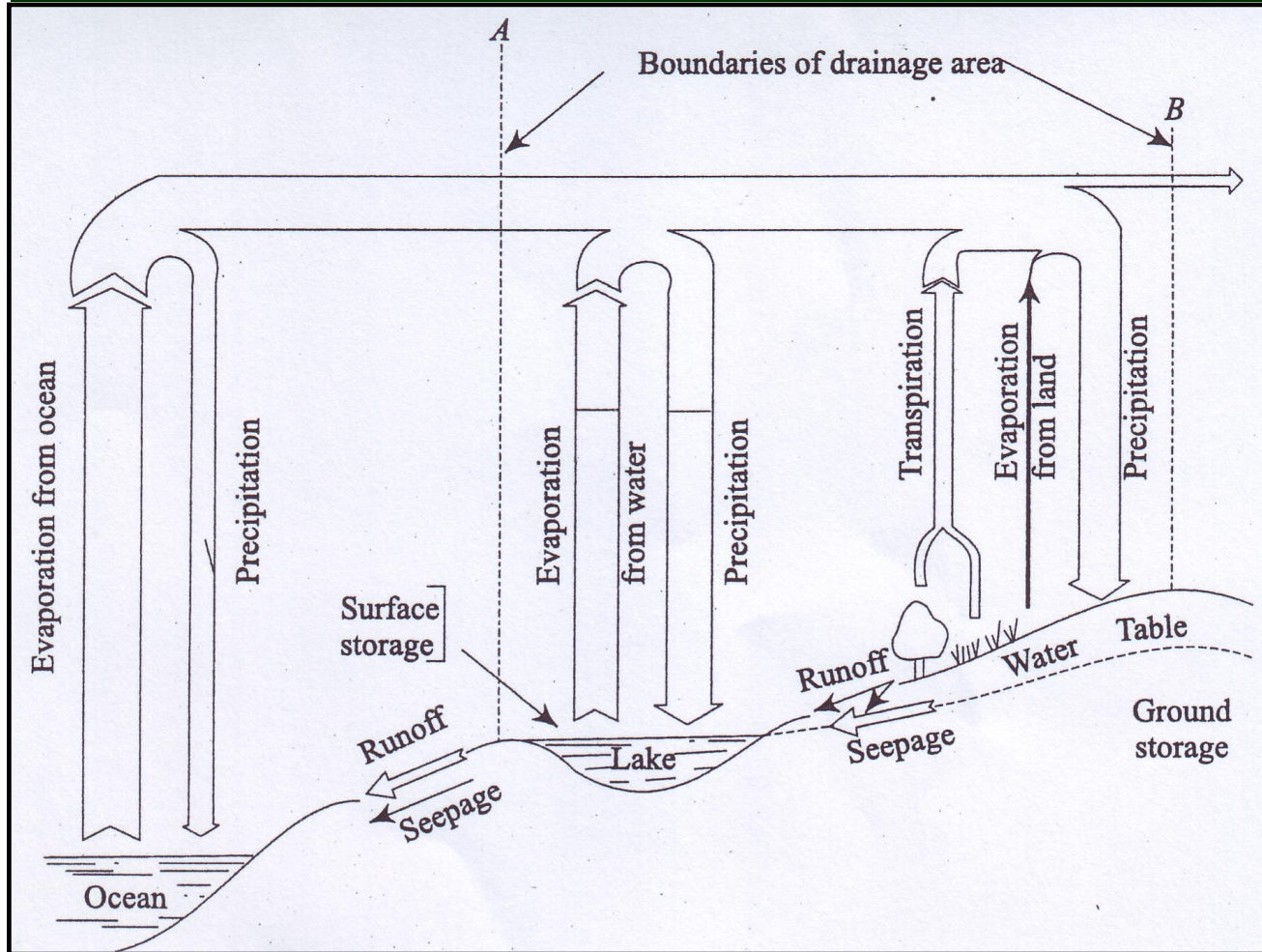
## ***2. Topographical Investigation***

- a) Survey the site to provide mapping for whole power plant area
- b) Aerial surveying or photography is popular for larger areas and difficult terrain.

## ***3. Geological Investigation***

This provides most accurate picture of the ground character (soil, rock, etc) on which the plant is to be constructed.

# Hydrological Cycle

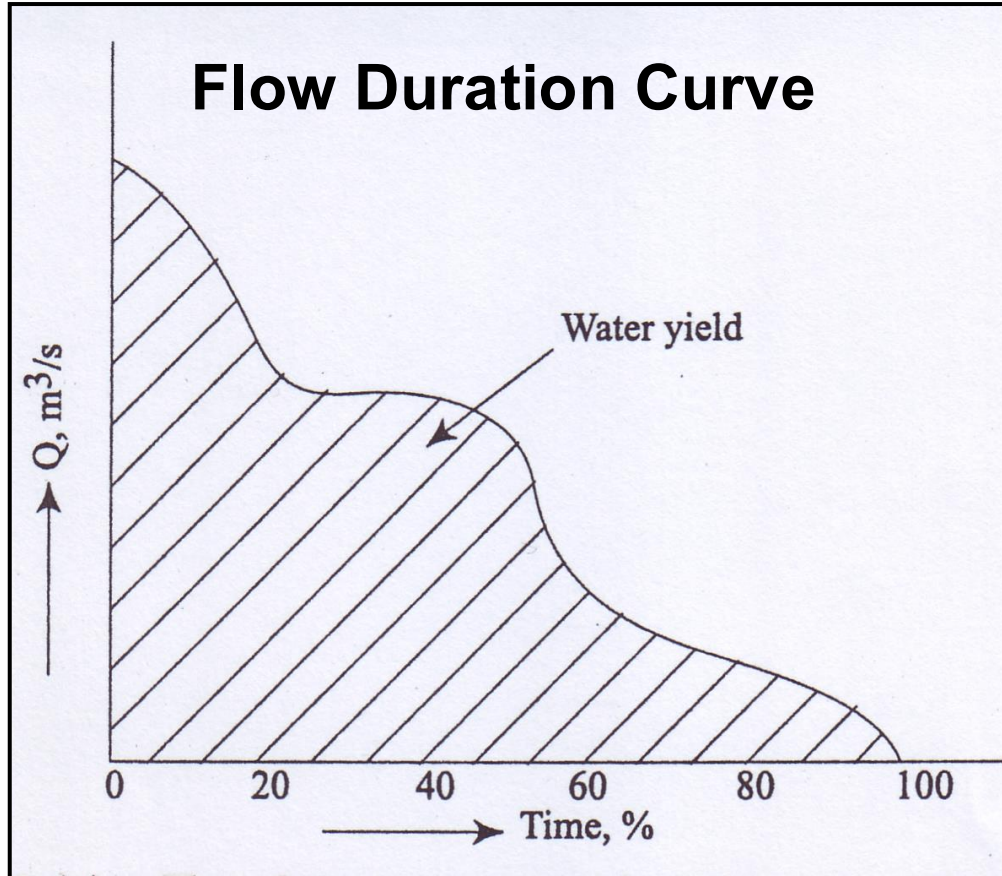


$$\text{Runoff} + \text{Seepage} + \text{Evaporation} + \text{Transpiration} = \text{Precipitation} \pm \text{Change in storage}$$

**Hydrology** is the science that deals with the processes governing depletion and replenishment of water resources over and within the earth's surface.

With the knowledge of hydrology at a certain site it is possible to design the irrigation and flood control works, power projects, water supply schemes, navigation works, etc.

# Hydrograph

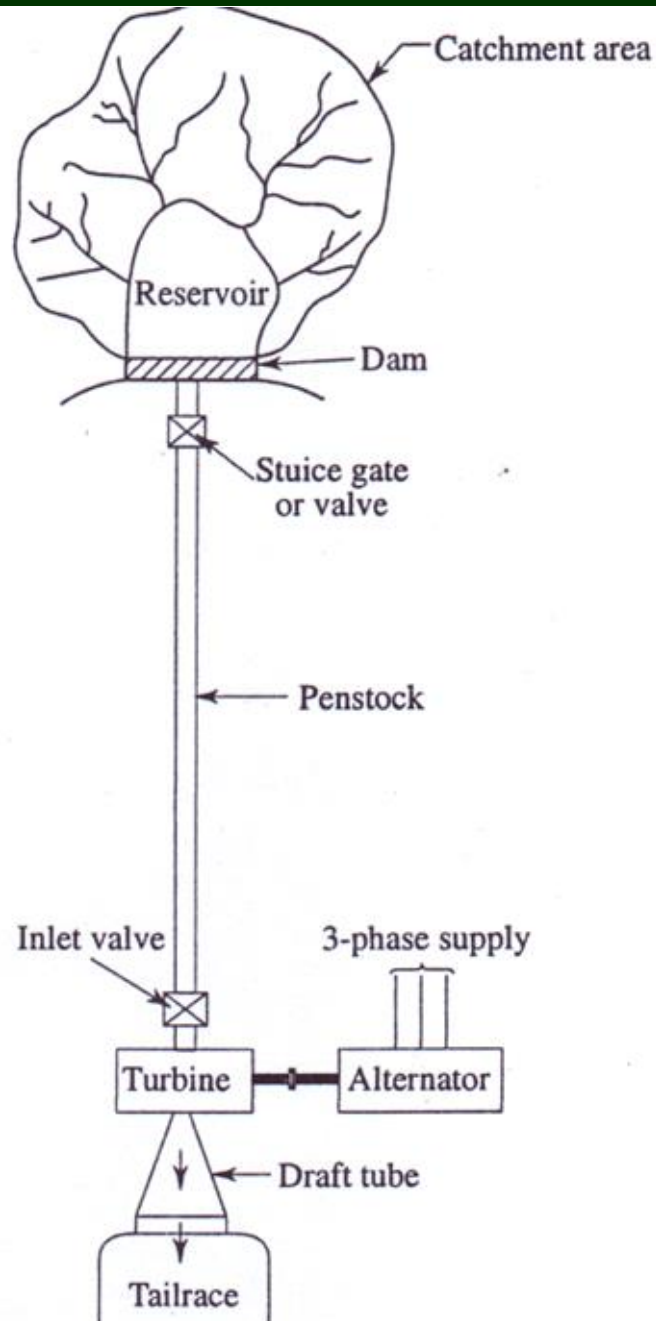


The variation of stream flow at a given site depends on the geographical, and topographical features of the drainage area feeding the river as well as the magnitude of the area rainfall.

*Hydrographs* show the variation of river flow (discharge) with time.

Runoff may be plotted as *flow duration curves*. The area under the flow duration curve represents the average yield from the stream.

# Elements of Hydro-Electric PP



1. Catchment area
2. Reservoir
3. Dam
4. Spillways
5. Conduits
6. Surge tanks
7. Draft tubes
8. Powerhouse

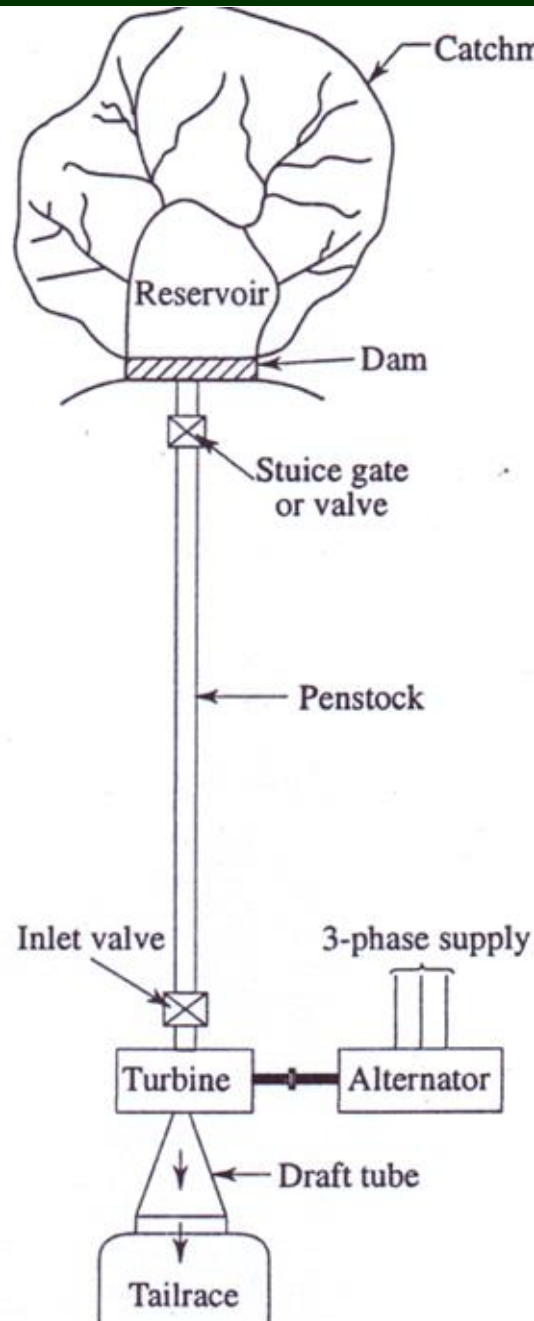
## 1. Catchment Area

The whole area behind the dam draining into a stream or river across which the dam has been constructed is called the catchment area.

The characteristics of the catchment include its size, shape, surface, orientation, altitude, topography and geology. The bigger the catchment, steeper is the slope, higher is the altitude.

# Elements of HydelPP

## 2. Reservoir



- Storage during times of plenty for subsequent use in times of scarcity is fundamental to the efficient use of water resources.
- The management of reservoirs and the lands which supply them is, therefore, a matter of great importance.
- Water stored is not only used for power generation, but also for irrigation, flood control, water supply and navigation.
- A reservoir may be natural, like a lake on a mountain or artificially built by erecting a dam across a river. Water held in upstream reservoir is called *storage*, whereas water behind the dam at the plant is called *pondage*.

## 3. Dam

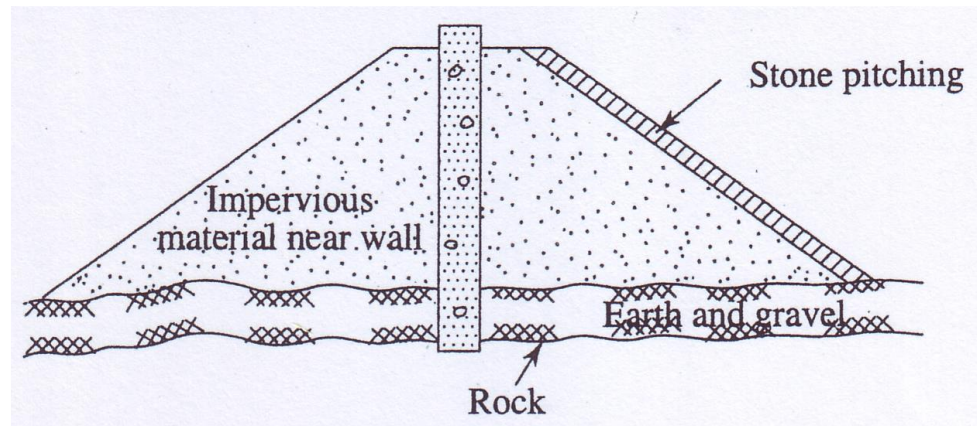
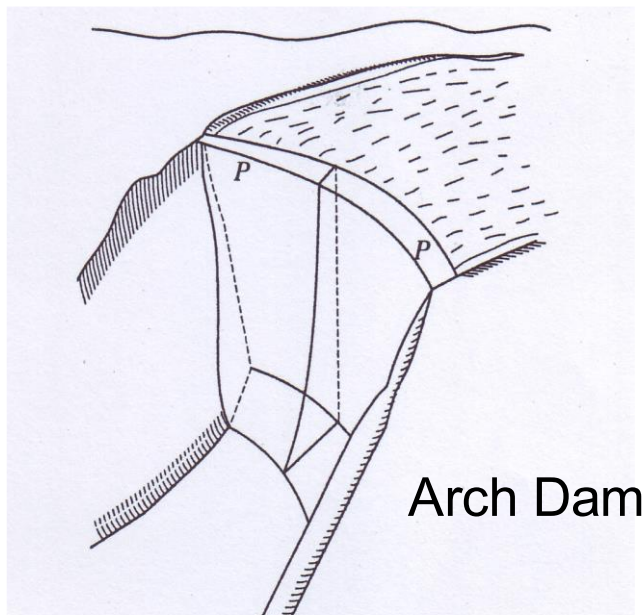
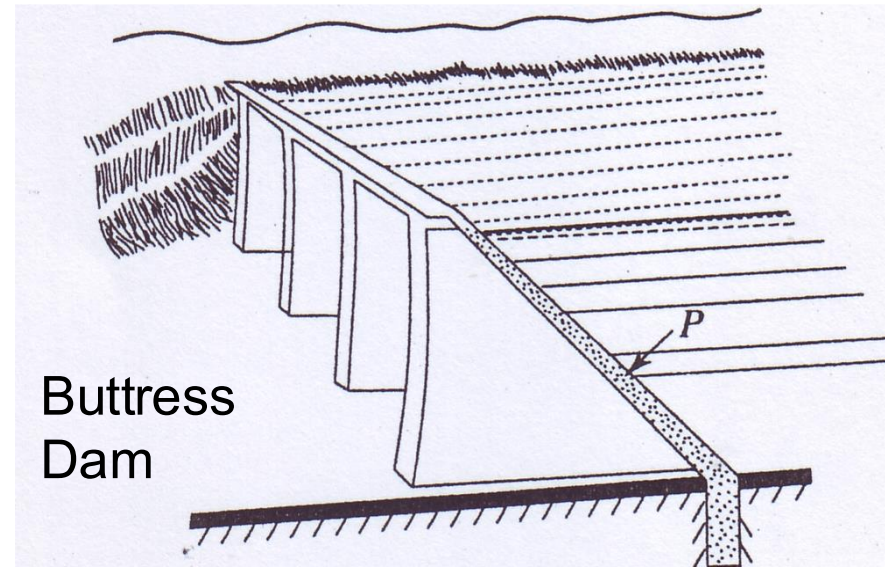
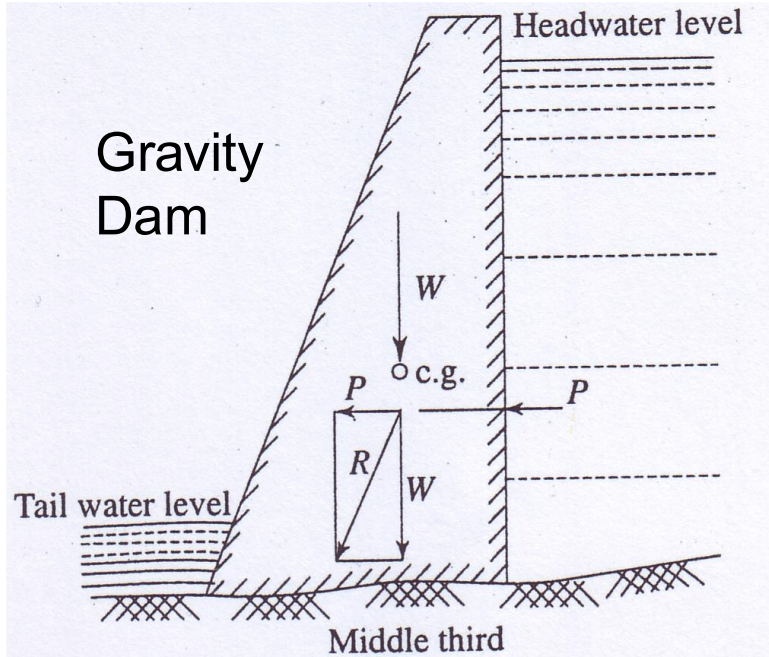
A dam performs the following two basic functions:

- (i) It develops a reservoir of the desired capacity to store water; and
- (ii) It builds up a head for power generation.

Dams can be classified in various ways based on the following:

- (i) function: Storage/Diversion/Detention Dams
- (ii) shape: Trapezoidal/arch dams
- (iii) material of construction:
  - earth/masonry/concrete/RCC/rubber Dams
- (iv) hydraulic and structural design:
  - gravity/arch/buttress Dams

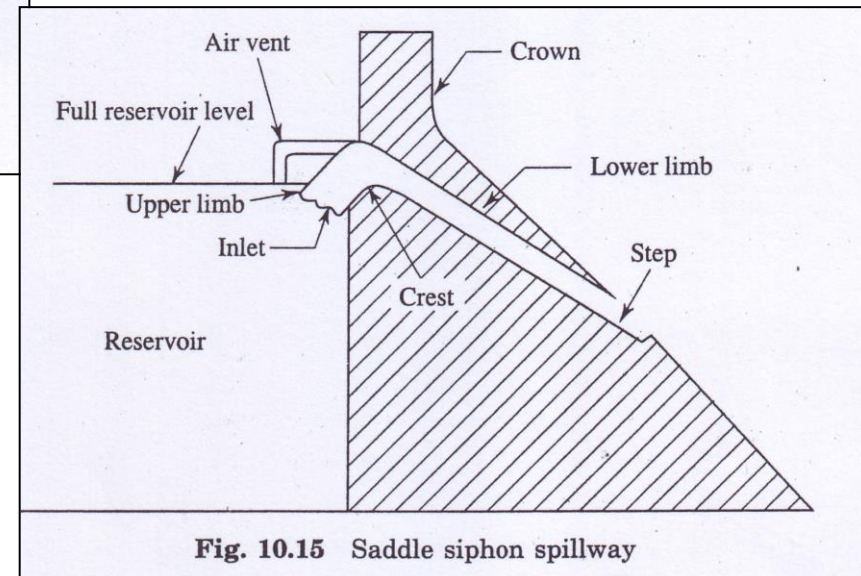
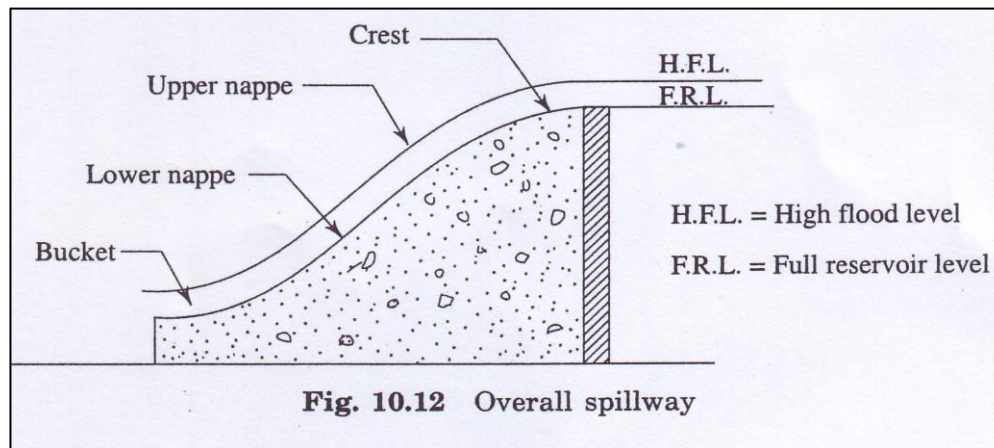
# Elements of HydelPP: Different types of Dam



# Elements of HyelPP: Spillways

When the water level in the reservoir basin rises, the stability of the dam structure is endangered. To relieve the reservoir of this excess water, a structure is provided in the body of a dam or close to it. **This safeguarding structure is called a spillway.**

It provides structural stability to the dam under conditions of floods without raising reservoir level above H.F.L. (high flood level).



# Elements of HyelPP: Conduits

The conduits are water channels and may be open or closed.

**Canal** is an open waterway excavated in natural ground following its contour.

**Flume** is an open channel erected on a surface above the ground supported on a trestle.

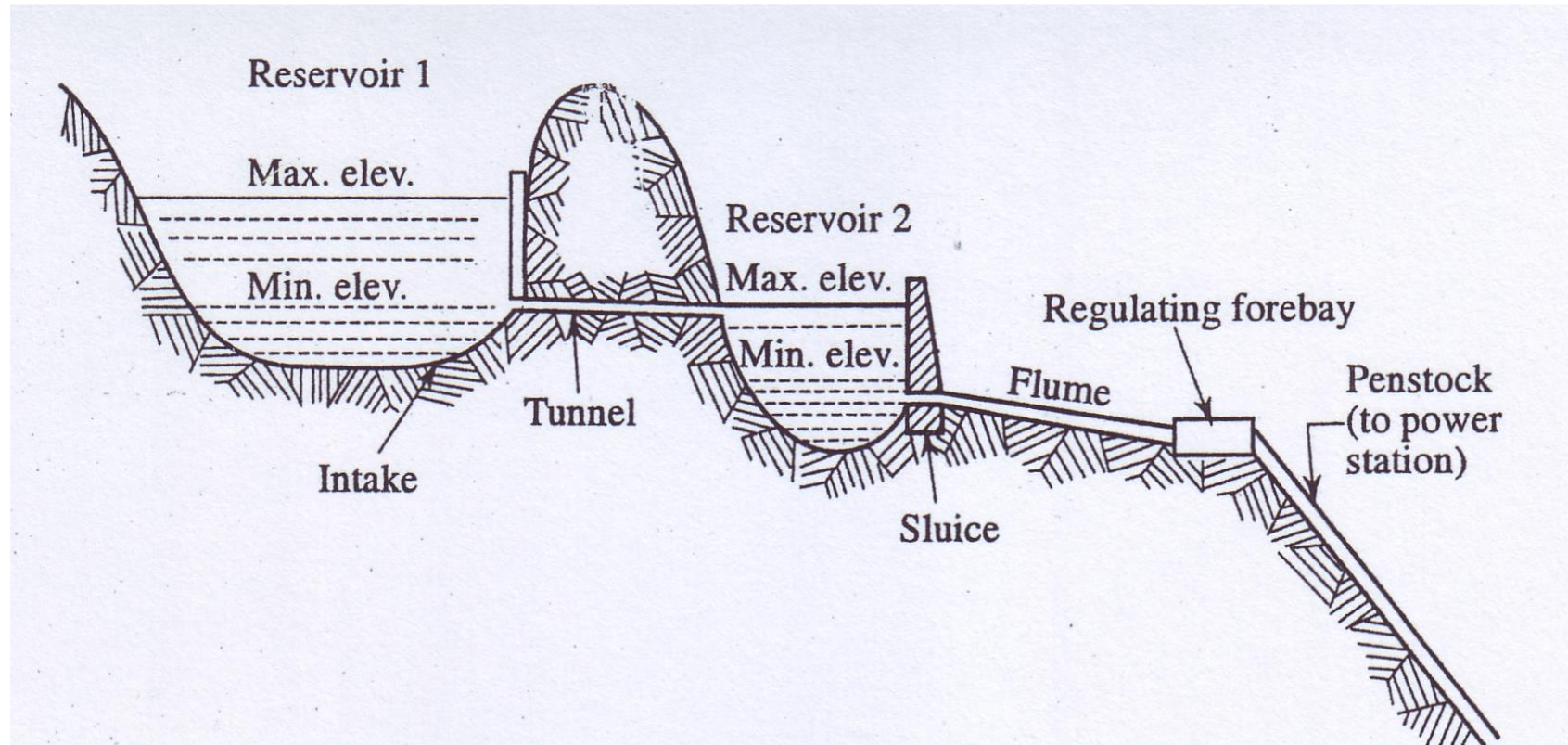
**Tunnel** is a closed channel excavated through an obstruction such as a ridge of higher land between the dam and the powerhouse. A *pipeline* is a closed conduit supported on or above the surface of the ground.

**Penstock** is a closed conduit for supplying *water under pressure* from the head pond or the forebay to the turbines.

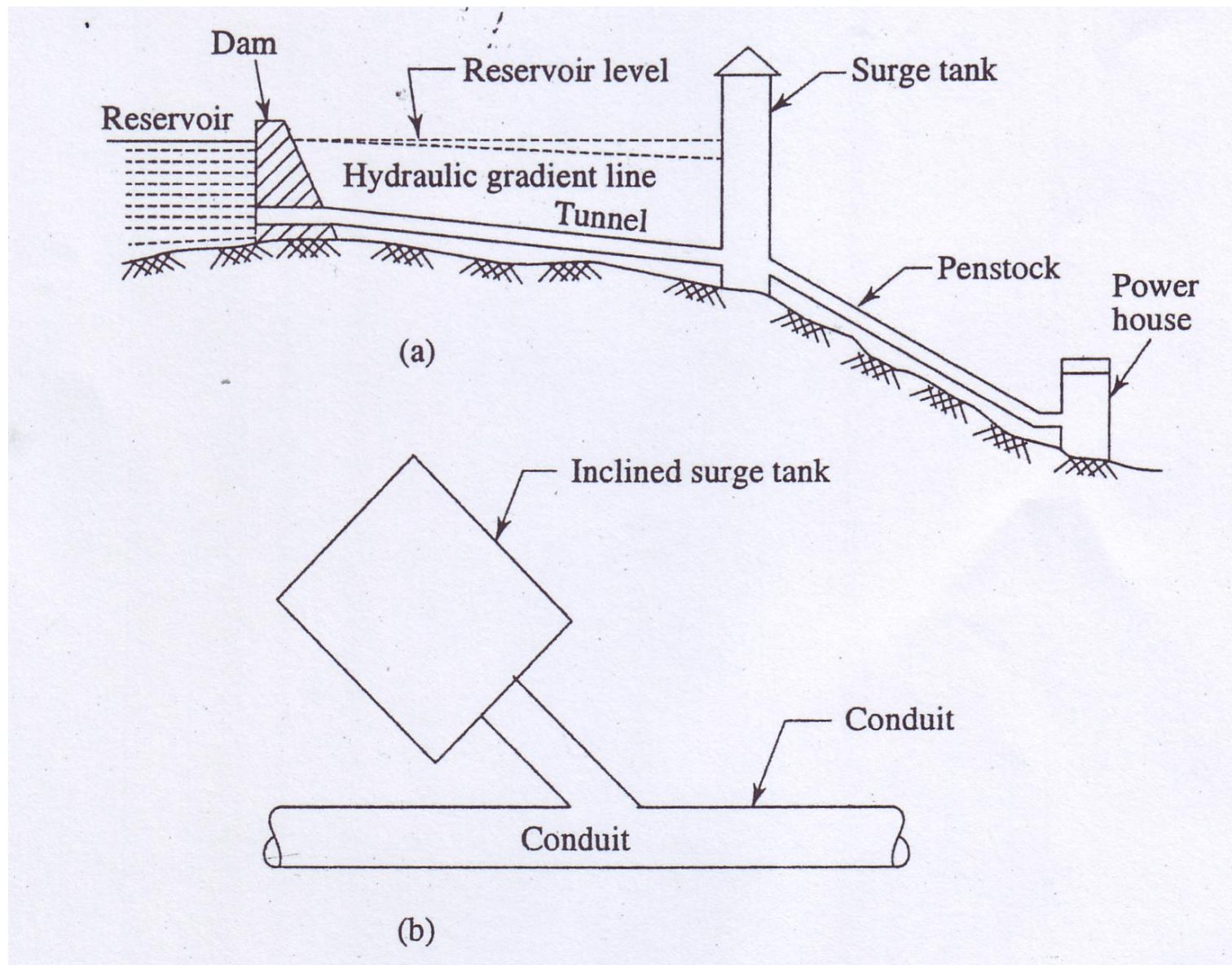
**The penstocks are the pressure conduits, while the non-pressure conduits are the canals and flumes.**

# Elements of HyelPP: Conduits

The conduits are water channels and may be open or closed.

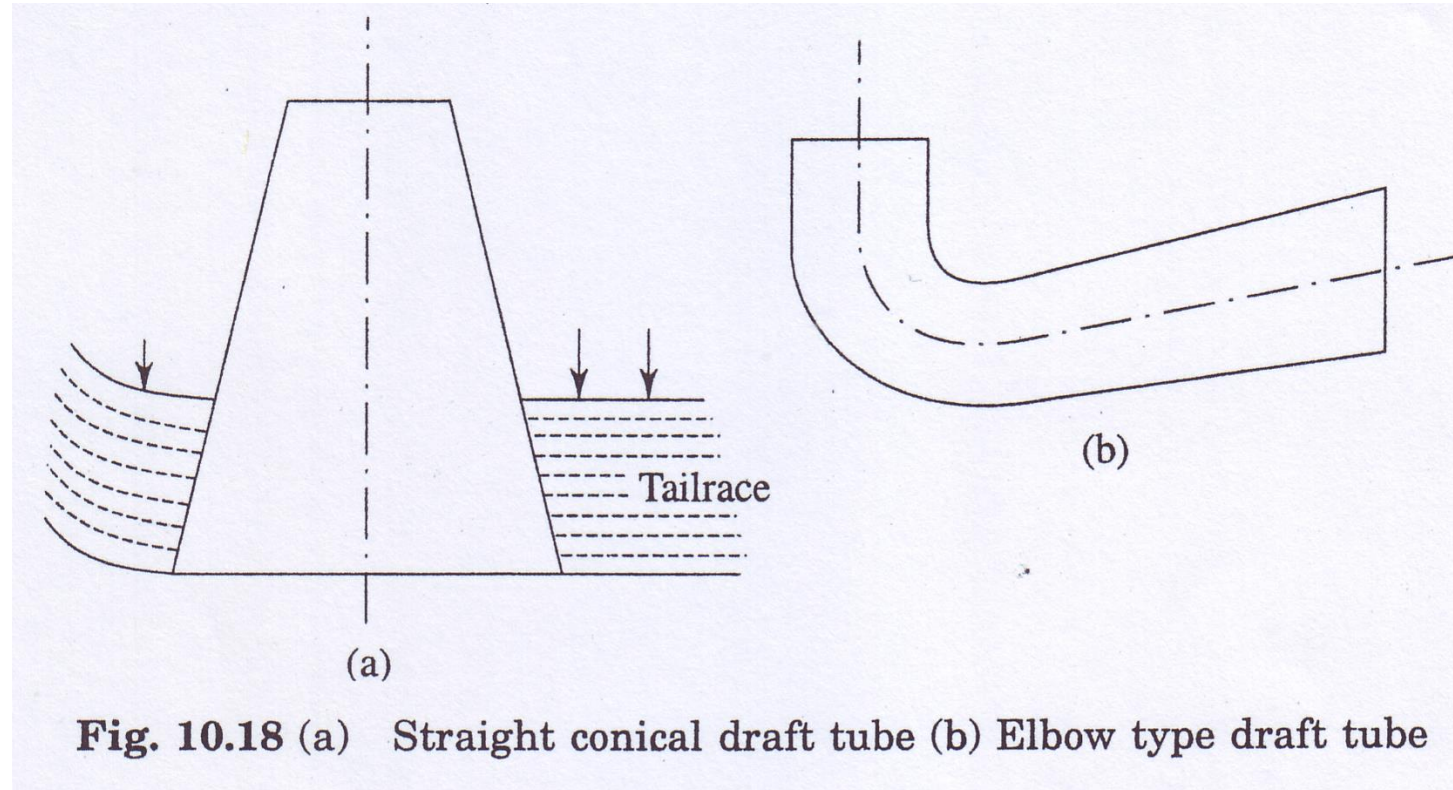


# Elements of Hydro-Electric PP...(Surge Tank)



# Elements of Hydro-Electric PP...(Draft Tube)

The draft tube allows the turbine to be set above the tailrace to facilitate inspection and maintenance and by diffuser action regains the major portion of the kinetic energy or velocity head at runner outlet, which would otherwise go waste as an exit loss.



# Elements of Hydro-Electric PP...(Power House)

A powerhouse should have a stable structure and its layout should be such that adequate space is provided around the equipment for convenient dismantling and repair. The equipment provided in the powerhouse includes the following.

- a) Hydraulic turbines
- b) Electric generators
- c) Governors
- d) Gate valves
- e) Relief valves
- f) Water circulation pumps
- g) Air duct
- h) Switch board and instruments
- i) Storage batteries
- j) Cranes