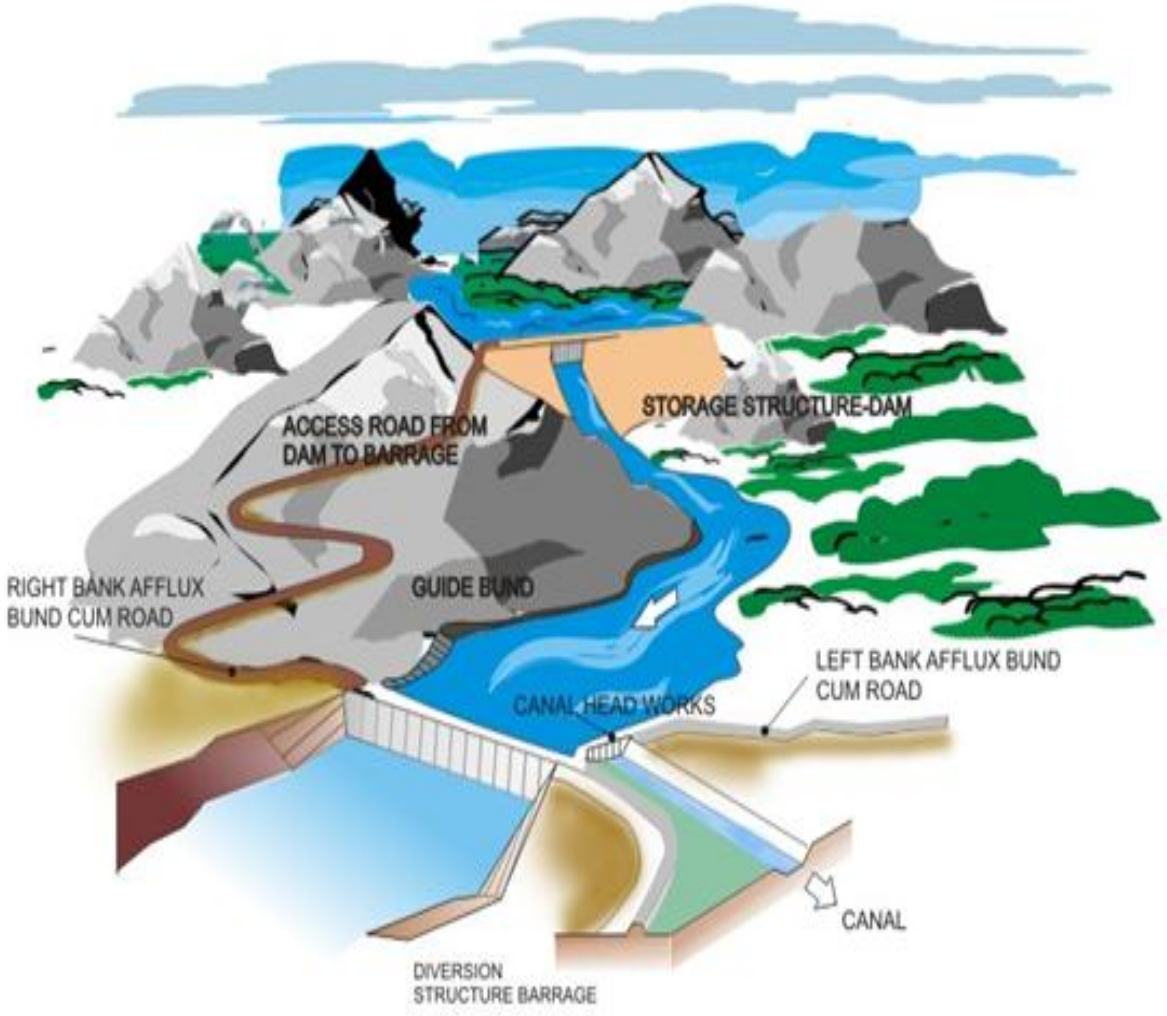


FIGURE 1. Structures for harnessing water resources potential of a river

Water is often more useful to people when it is properly controlled, conveyed, and contained. Hydraulic structures are designed and built to serve these purposes.

The common Kinds and functions of hydraulic structures and the basic design criteria are as follows:-

1. ***Storage structures*:** designed to store water under hydrostatic condition.
2. ***Conveyance structures:*** designed to transport water from one place to another, by deliver a given discharge with minimum consumption of energy.
3. ***Waterway and navigation structures:*** designed to support water transportation.
4. ***Measurement or control structures:*** used to quantify the discharge in a particular conduit.
5. ***Energy conversion structures:*** designed to transform hydraulic energy into mechanical or electrical energy (e.g. hydraulic turbine – hydraulic pumps).
6. ***Sedimentation or fish control structures:*** designed to direct or regulate the movement of non-hydraulic elements in water.
7. ***Energy dissipation structures:*** used to control and disperse excess hydraulic energy to prevent channel erosion.
8. ***Collection structures:*** designed to gather and admit water to a conduit or system (e.g. surface drainage inlet used to collect surface runoff for a storm sewer system).

Storage structures

The following examples can be classified as a storage structures :

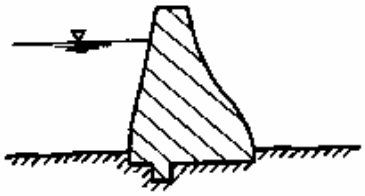
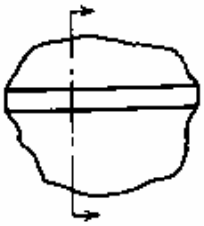
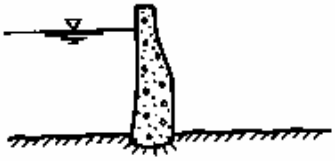
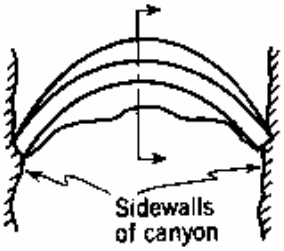
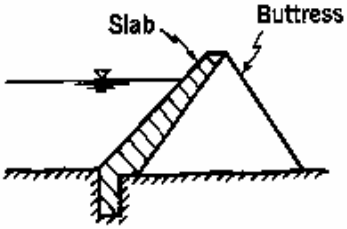
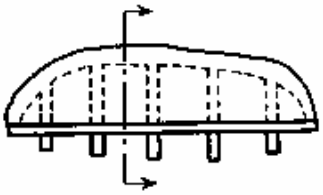
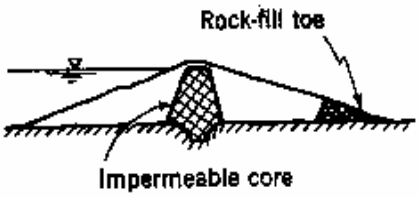
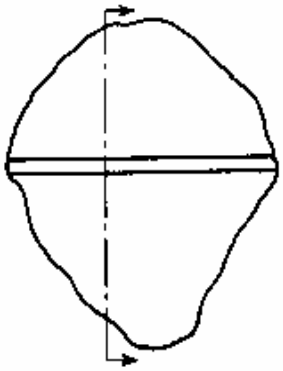
(A) Dams and Barriers

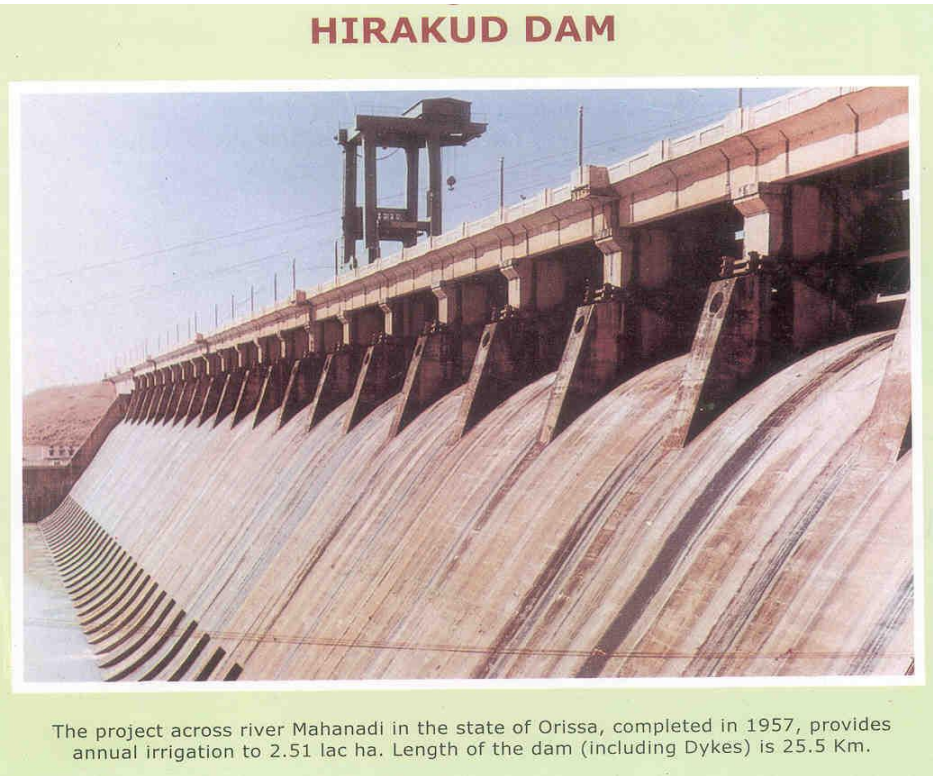
A dam is a barrier structure placed across a watercourse to store water and modify normal stream flow; dams vary in size from a few meters to in height to massive structures of over 100m in height. The large dams have multiple purposes it provide the following:

1. Dawn stream flood control.
2. Irrigation water for farm land.
3. Industrial water supply.
4. Cooling water for power plants
5. Municipal water supply.
6. Support navigation on many large rivers.

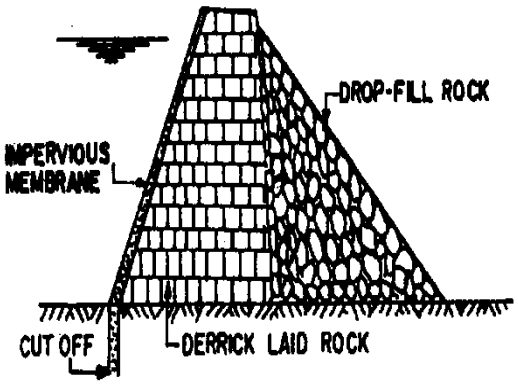
Dams can be classified as ; Gravity dam , Earth and rockfill dam , and Arch dam

(see Figures below)

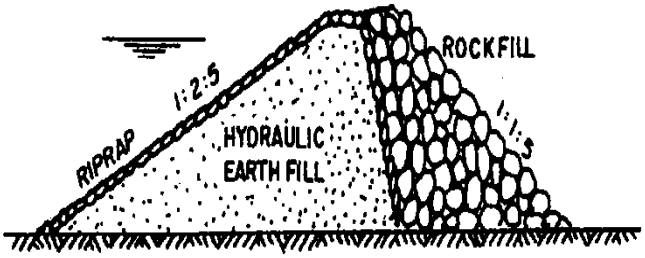
Type	Material	Sectional View	Plan (Top View)
Gravity	Concrete, rubble masonry		
Arch	Concrete		
Buttress	Concrete also timber and steel)		
Embankment	Earth or rock		


HIRAKUD DAM
The project across river Mahanadi in the state of Orissa, completed in 1957, provides annual irrigation to 2.51 lac ha. Length of the dam (including Dykes) is 25.5 Km.

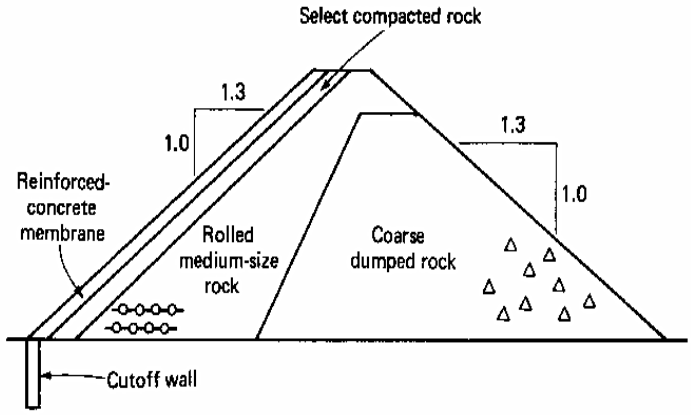
Earth Dam



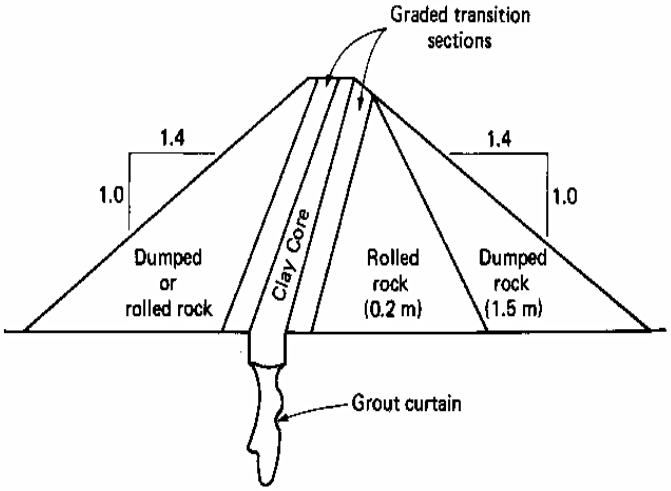
ROCKFILL DAM



COMBINED EARTH AND ROCKFILL DAM



(a) Impermeable face



(b) Impermeable earth core

Arch Dam

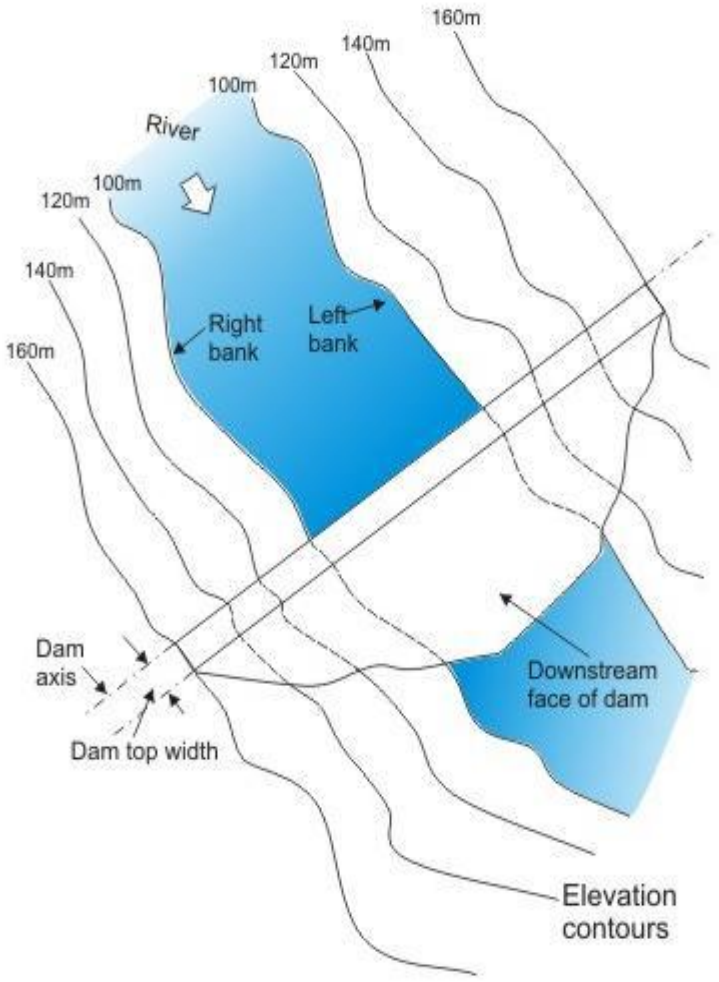


FIGURE 6. A typical layout of a concrete gravity dam in plan.

Conveyance structures

The conveyance structures represents the main item of any project of water resources . The following can be categorized as a conveyance structures :

- Canals and channels
- Pipes and Tunnels
- Inverted Siphons
- Culverts
- Aqueducts
- Drops and chutes
- Road crossing

See figures below

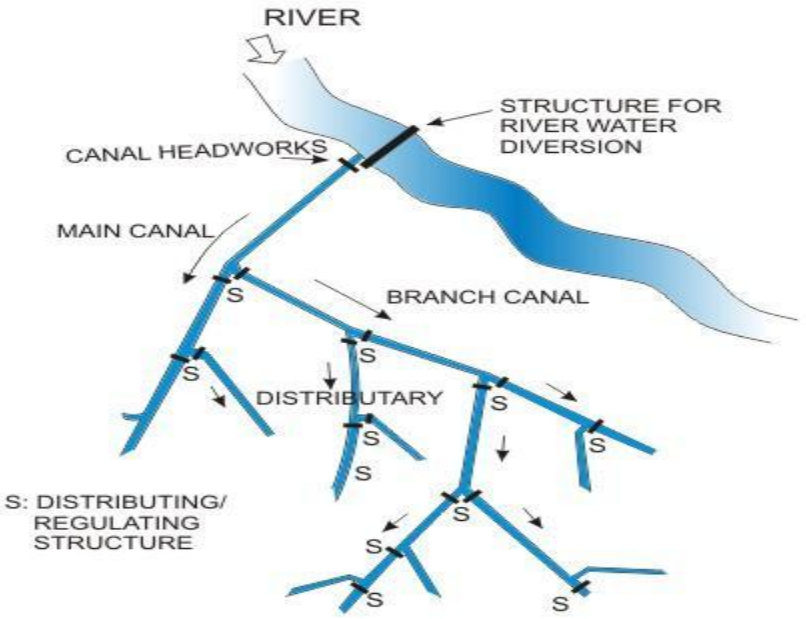


FIGURE 1 : Typical layout of an irrigation canal system

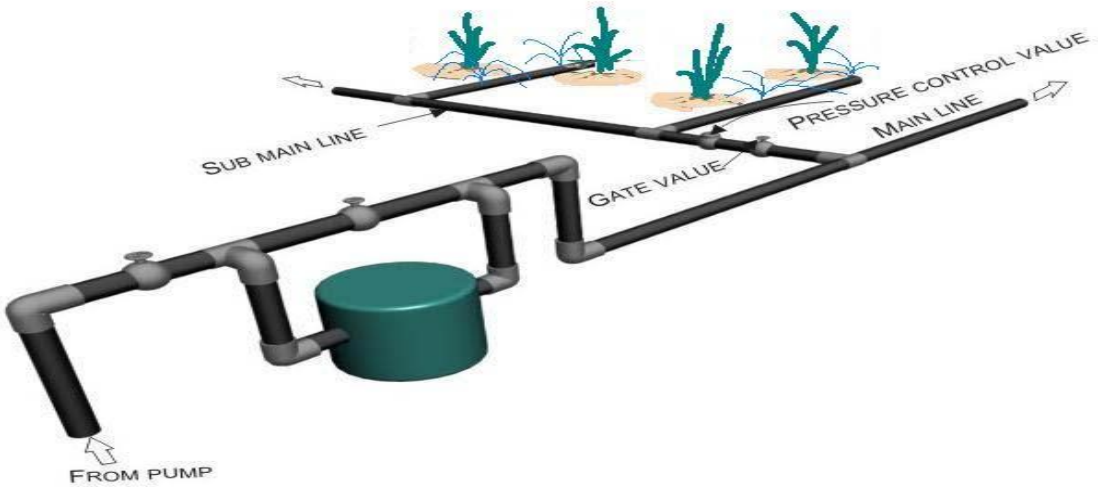


FIGURE 10. The sprinkler irrigation system

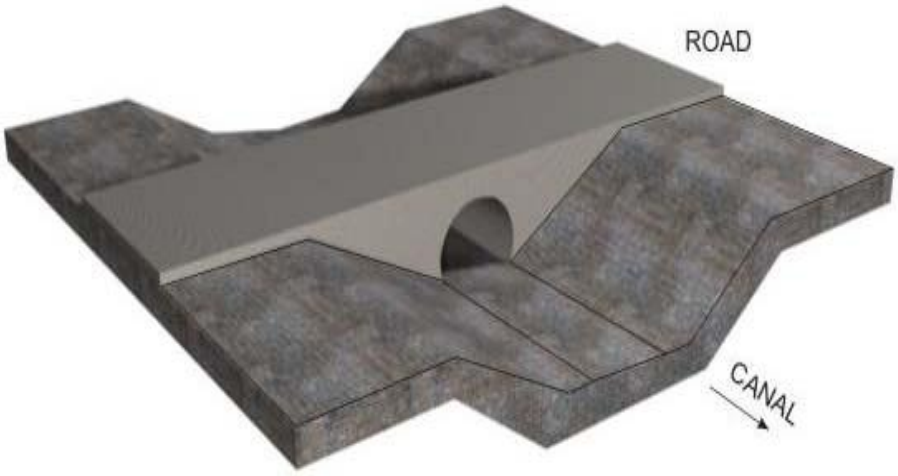


FIGURE 1. Pipe conduits for canals crossing small roads

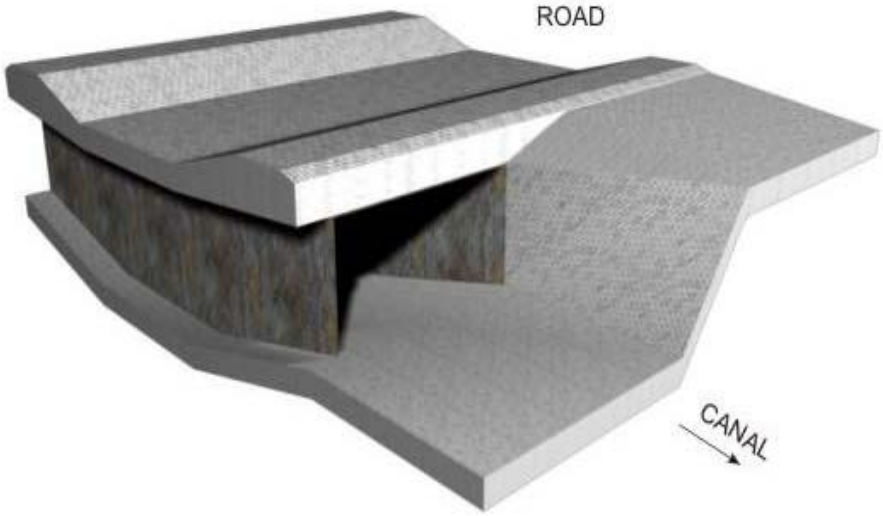


FIGURE 3. Inverted Syphon below roads showing rectangular section. Circular section also possible

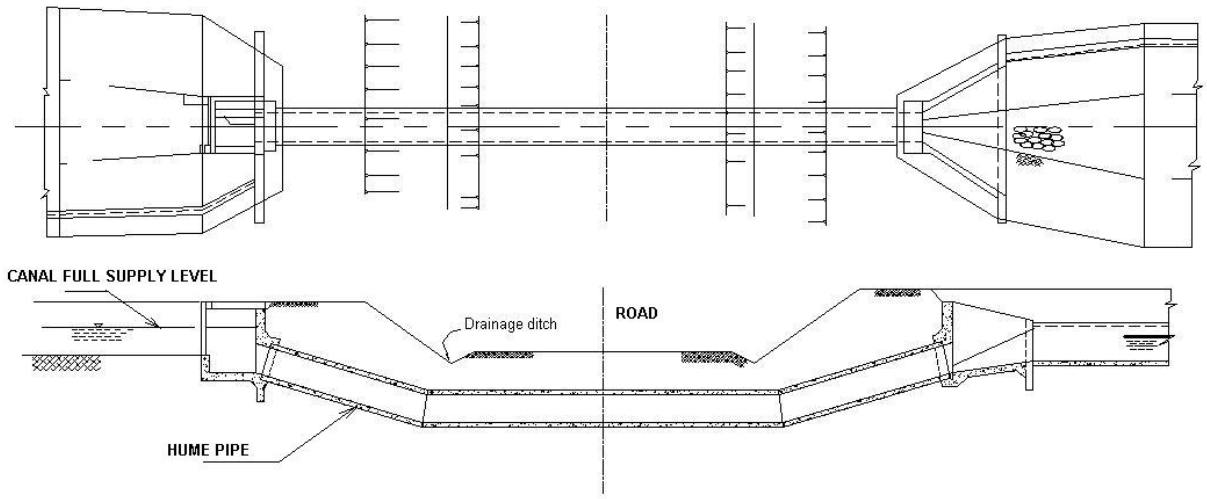


FIGURE 4b. An example of an inverted syphon of a small canal crossing a road

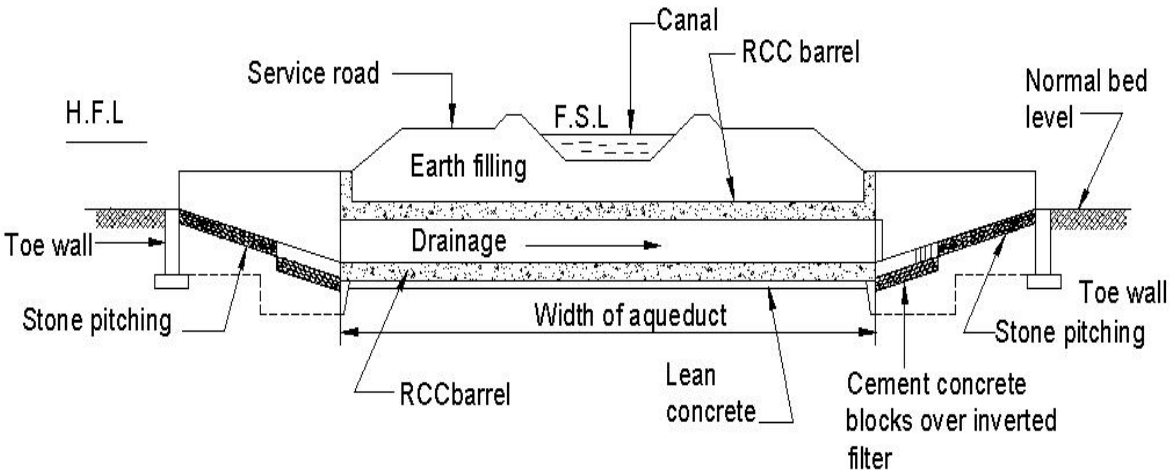


FIGURE 14. Section through a syphon aqueduct showing condition of pressured flow in natural drain

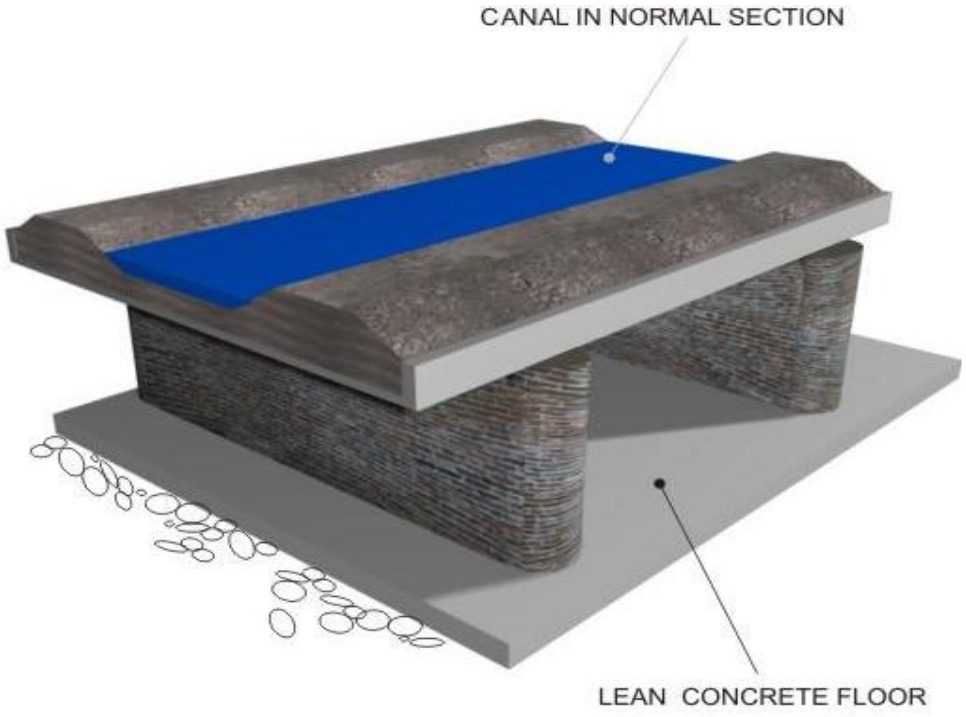


FIGURE 11. Barrel type aqueduct

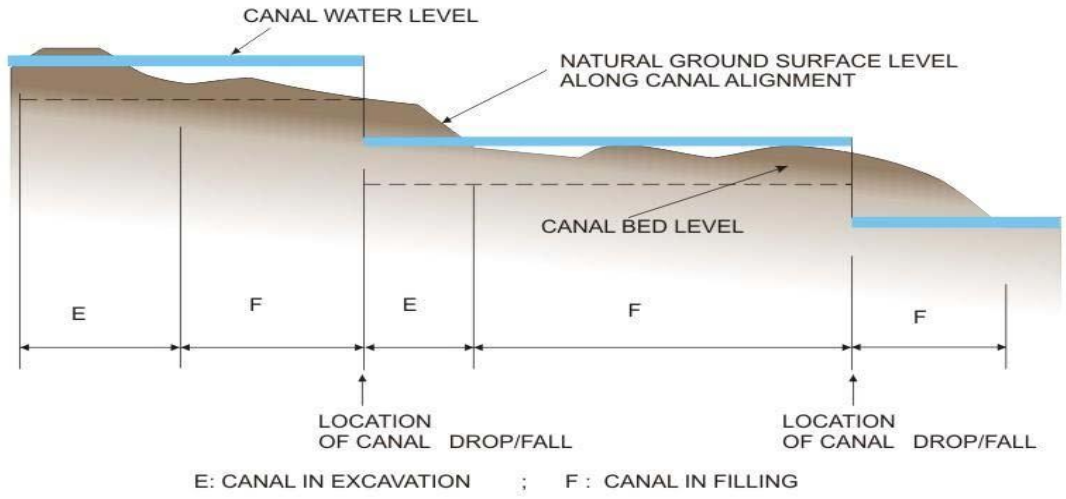


FIGURE 2 . Typical location for providing canal drop or fall

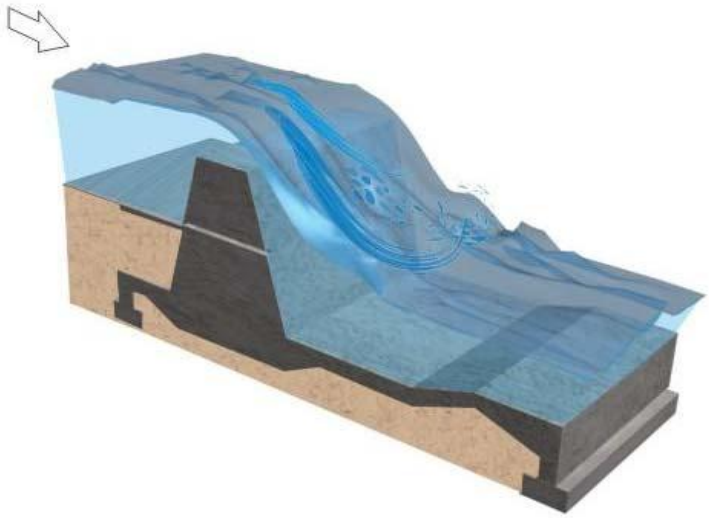


FIGURE 6 . Vertical drop fall

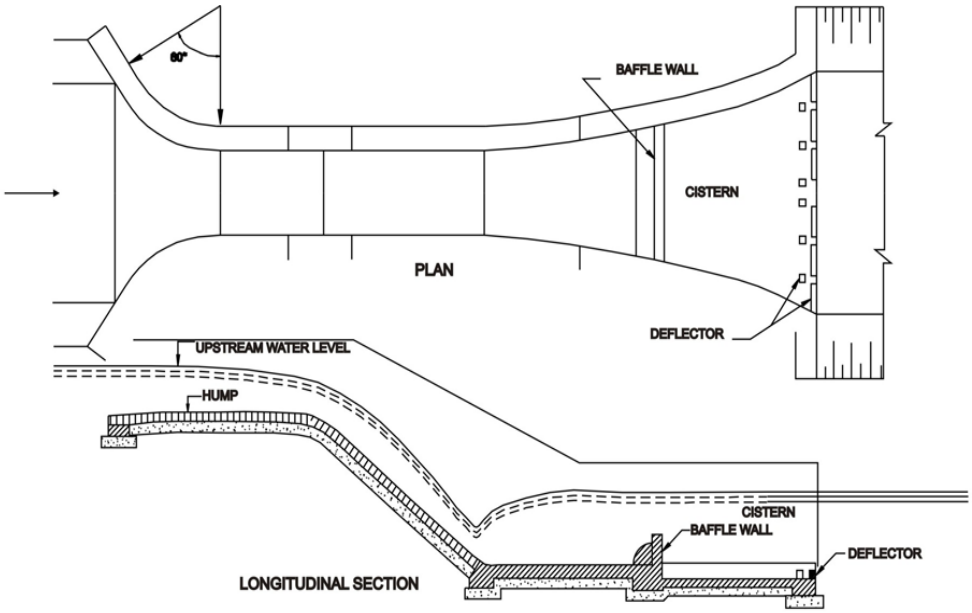


FIGURE 13. PLAN AND SECTION OH STANDING WAVE FLUME- FALL

Measurement or control structures

Efficient management of water resources system is that to measure the "rate of flow", and volume delivered, to prevent unnecessary wasteful water , thereby conservation the natural resources.

The type of water measurement structures or devices is:

- ✓ Parshall flumes.
- ✓ Weirs.
- ✓ Gates and Valves
- ✓ Open flow meters.
- ✓ Constant head orifices.

See figures below

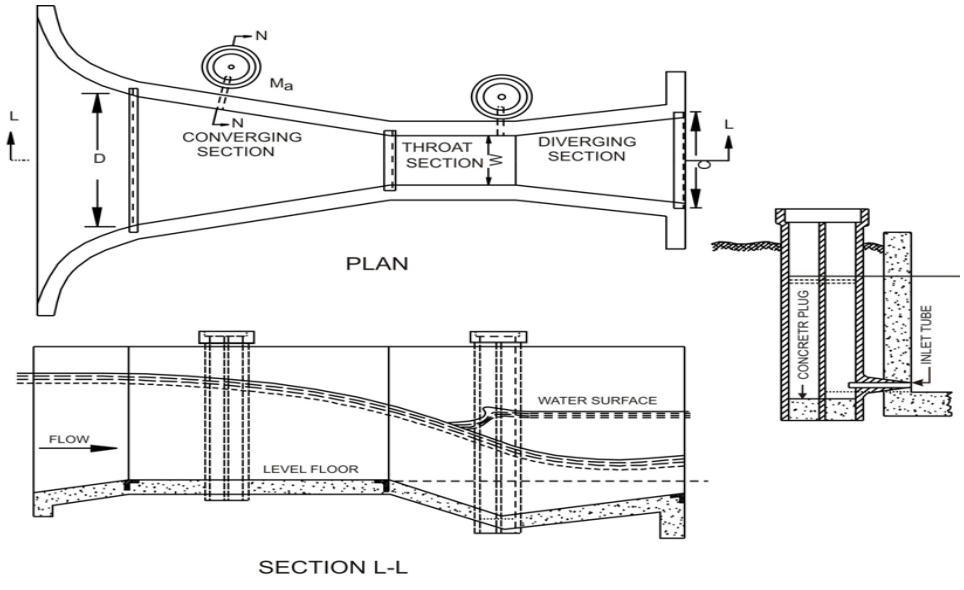


FIGURE 17. PLAN AND SECTION OF PARSHALL MEASURING FLUME

WEIR SHAPE

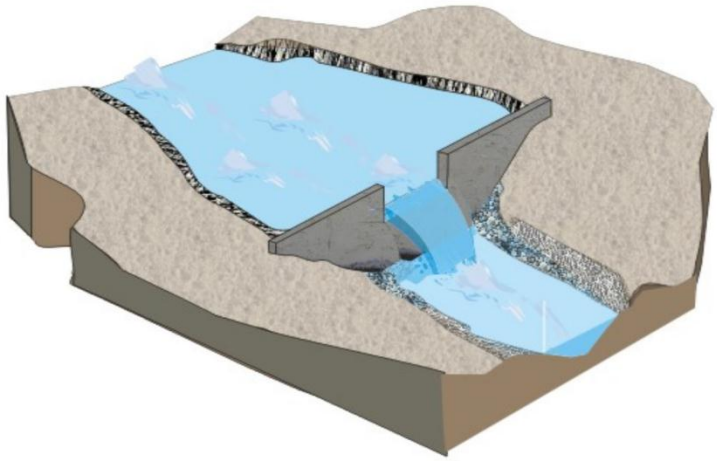


FIGURE 10. General view of a sharp created rectangular weir

WEIR SHAPE

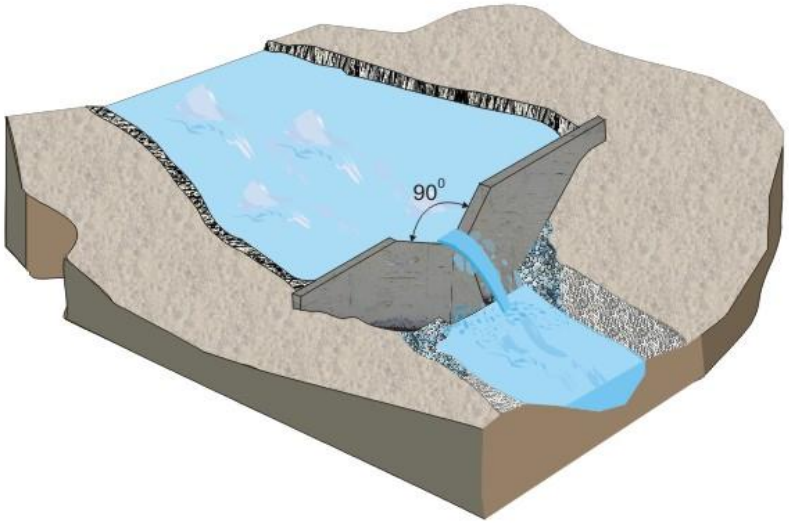


FIGURE 12. General view of 90^0 v-notch weir

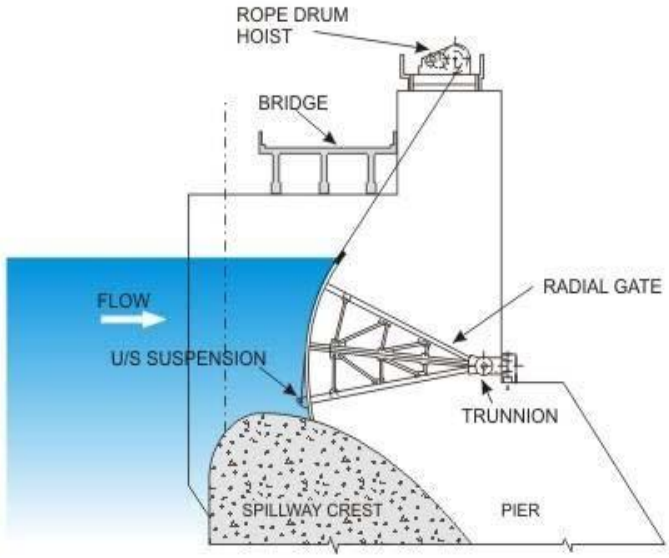


FIGURE 4 : RADIAL GATE SHOWN WITH ROPE DRUM HOISTING MECHANISM

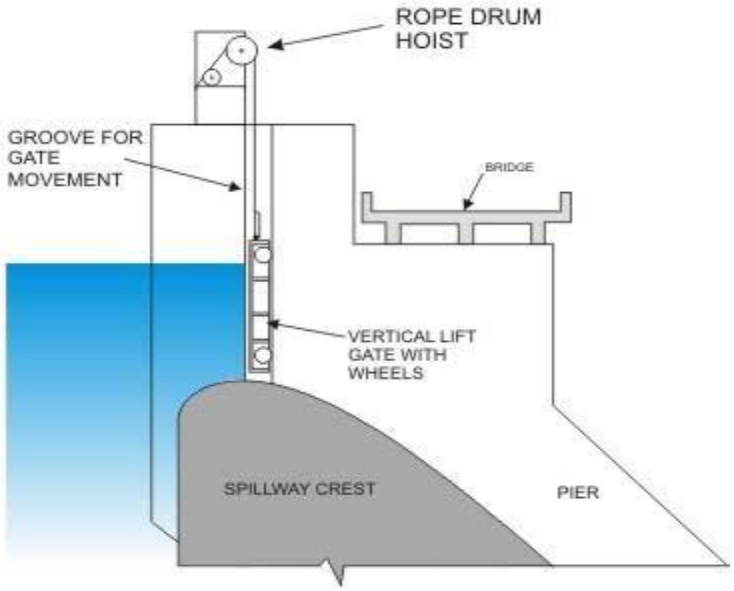


FIGURE 3 : VERTICAL LIFT GATE ARRANGEMENT FOR DAM SPILLWAY

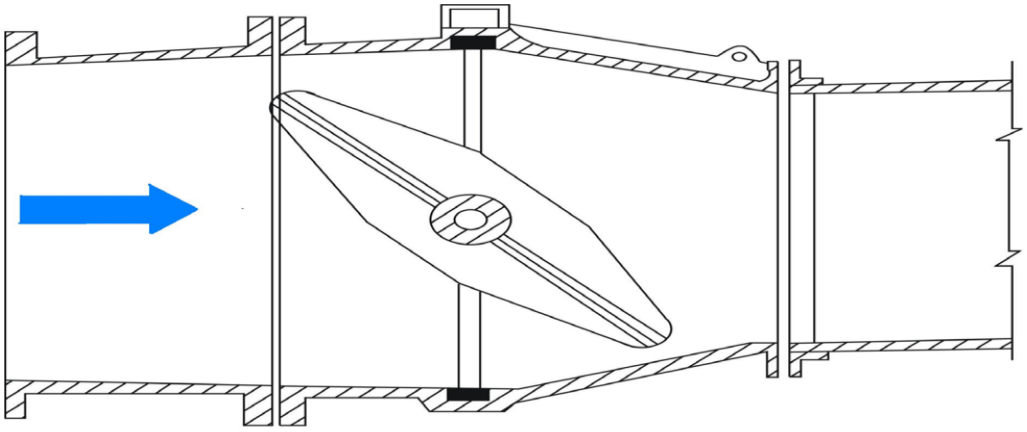
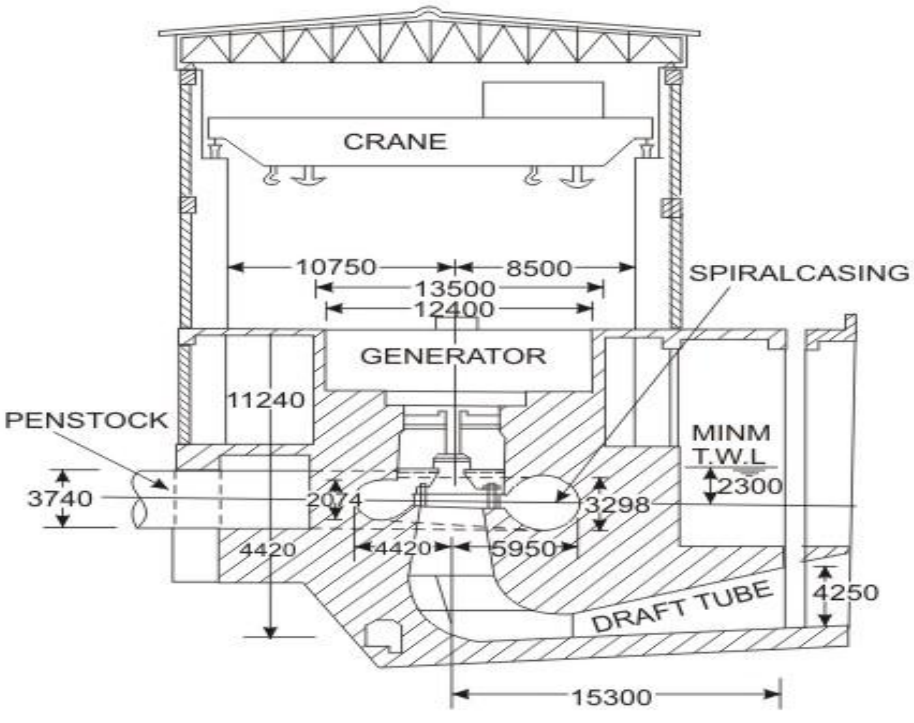


FIGURE 31. BUTTERFLY VALVE

Energy conversion structures

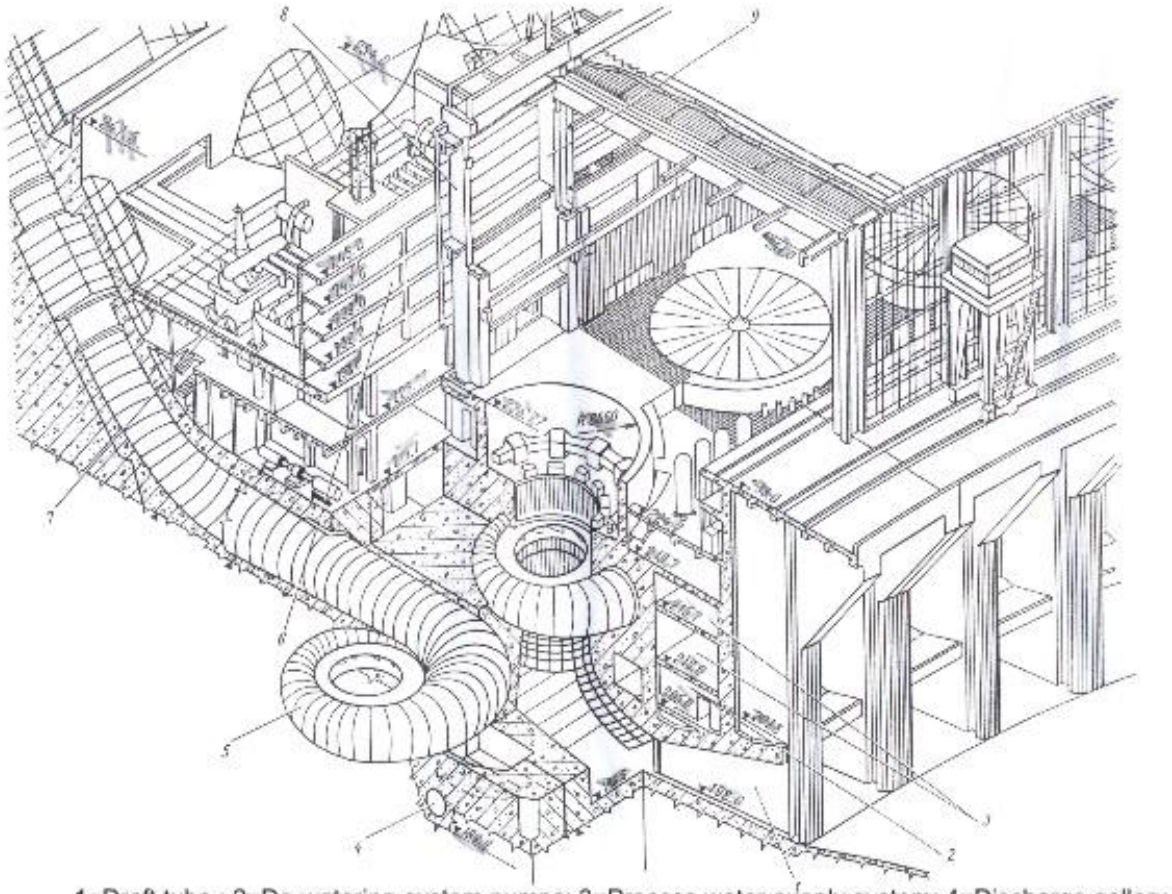
The power generations with turbines are designed to convert the kinetic hydraulic energy to electrical energy . see Figures below



(c)

All dimensions in milimetres.

FIGURE 15. Vertical section through a powerhouse built isolated from head works (intake) showing typical dimension in mm.The turbine unit may be either Kaplan or Francis



1=Draft tube ; 2=De-watering-system pumps; 3=Process water-supply system; 4=Discharge gallery
5=Spcial case; 6=Cable gallery ; 7= Tran sformer; 8,9= Columns

FIGURE 10. Cut-out view through the water passage and powerhouse of a reaction turbine

Sedimentation or fish control structures

This structures used as appurtenant parts with the barrages and regulators to control the passage of sediments and debris and prevent or reduce its effects towards downstream . However , the fish leader structure is essential part used for passing

fish from upstream towards downstream of hydraulic structure or vise versa . See figures below .

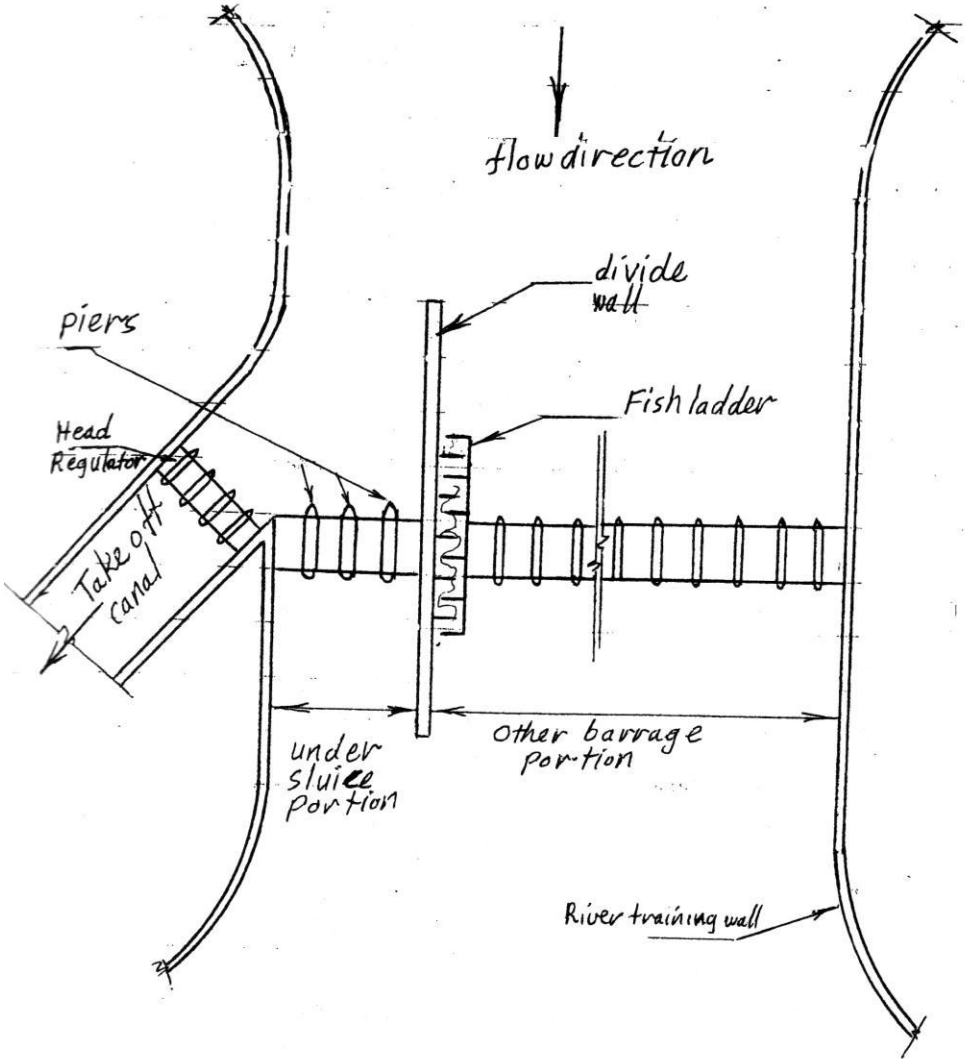


Fig 4 Headwork components

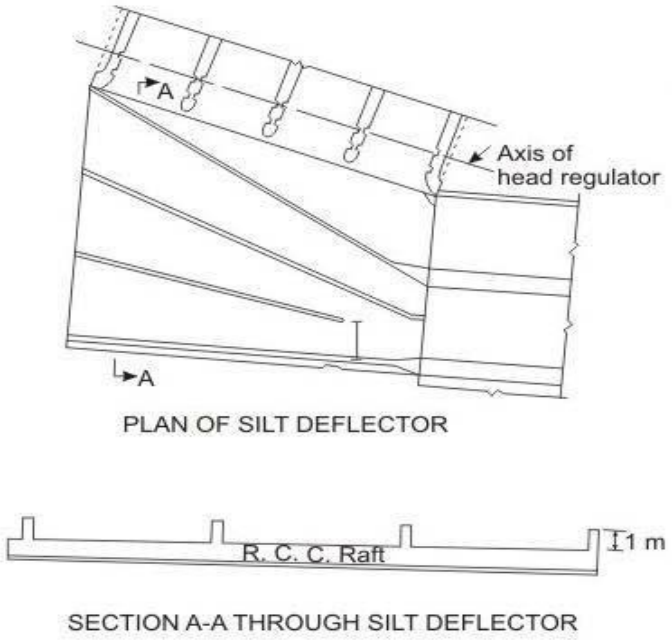


FIGURE 16. Silt / sediment deflector

Energy dissipation structures

These structures is usually constructed downstream of barrages bays , at ends of spillways and chutes , at end of outlet works , at culvert exit , etc. The performance of these structures are to reduce the action of highly outlet velocity for scouring and damage the channels or waterways at D/S of these structures . See figures below .

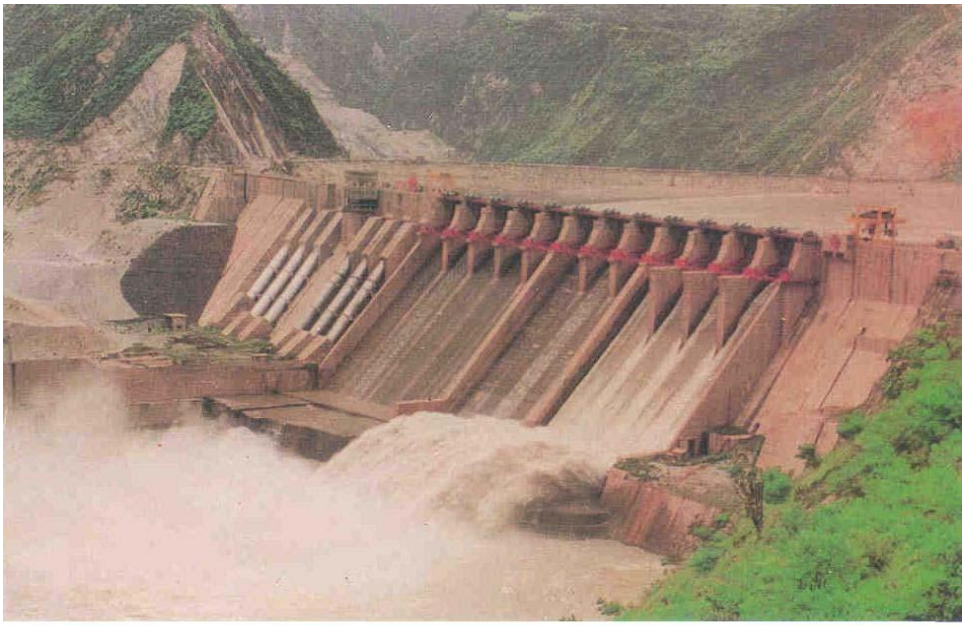
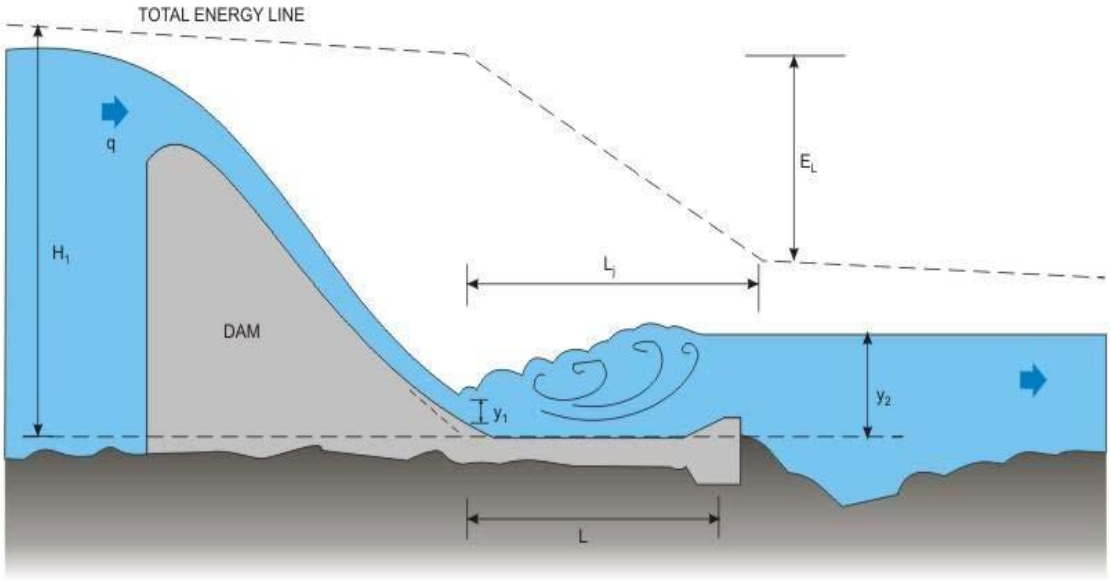


FIGURE 46. Salal project on river Chenab showing energy being dissipated by ski-jump bucket type energy dissipators

(Image courtesy: Web-site of Ministry of Water Resources, Government of India)



L : LENGTH OF STILLING BASIN APRON

L_j : LENGTH OF HYDRAULIC JUMP

q : DISCHARGE PER UNIT WIDTH

H_1 : TOTAL ENERGY UPSTREAM OF JUMP

y_1 : PRE-JUMP (SUPER CRITICAL FLOW) DEPTH

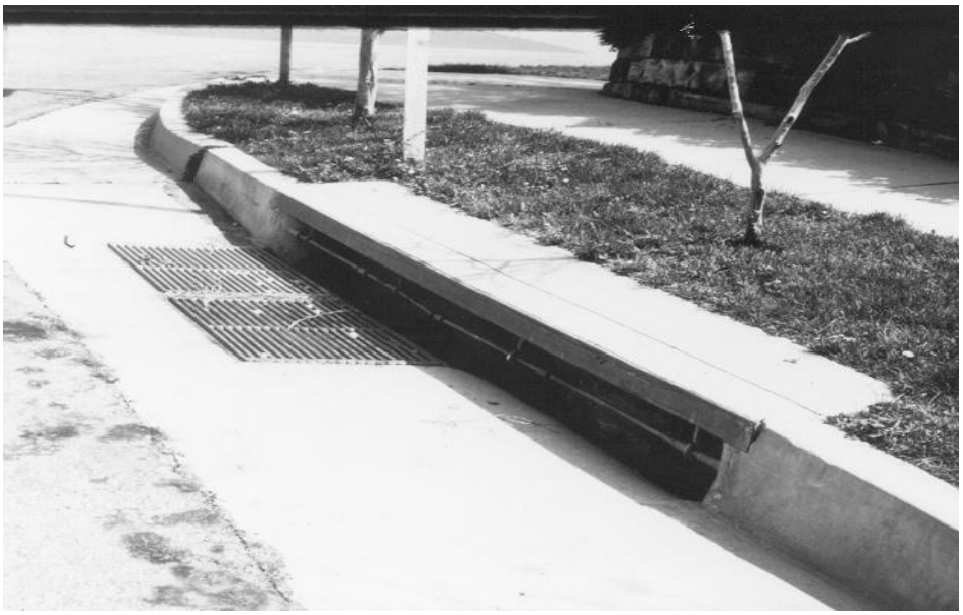
y_2 : POST-JUMP (SUB CRITICAL FLOW) DEPTH

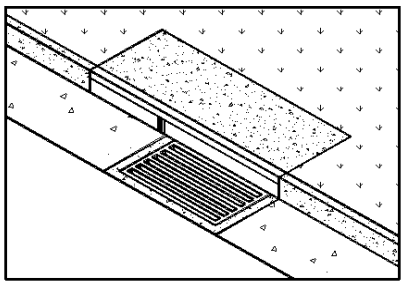
E_L : ENERGY LOST IN JUMP

FIGURE 47. Definition sketch of hydraulic jump & associated parameters

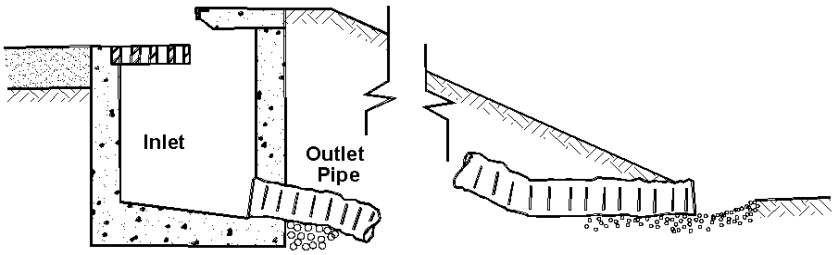
Collection structures

This structures designed to gather water to a conduit or system used to collect surface runoff for a storm from rods and highways . See figures below





a. Perspective



b. Section

General requirements and design considerations

The water delivery to the land must be provided by a reliable and efficient conveyance systems . A canal is frequently used to convey water for farmland irrigation and other uses such as used to transport water for municipal, industrial and outdoor recreational uses . The flow within these canals can be considered as :

- Closed conduit (pressurized)
- Open channel (have a free surface)

The conveyance canal and its related structures should perform their functions efficiently and competently with - **minimum maintenances – ease of operation – minimum water loss.**

STRUCTURAL COMPONENTS AND APPURTENANCES

All structures are made of several structural parts which together make up the complete structure, these parts include:-

1. Pipe or Tunnels : this part make a main piece of hydraulic structure, it's placed underground and may or may not be subjected to hydraulic pressure.
2. Gates : at any type and configuration the aim of usage is to control the flow .
3. Crest and glacis : It is a main feature of any hydraulic structure aims to regulate or measure flow such as regulators or weirs .
4. Transition: its connect a canal or natural channel to a structure inlet or outlet, several different configuration of reinforced concrete are used.

5. Energy dissipaters: it's used at outlet ends of drop or chute … etc. to dissipate excess energy of water to decrease or prevent the ability of this water to damage the reach of canals at this location.
6. Protection works : This works is mainly located at D/S of hydraulic structures aims to protect the channels form damage that often accompanied with flow at toe of structures . These works are usually consist a riprap or stone pitching .