

UNIT - 1

Reservoirs

Dams are constructed across the rivers and streams to create an artificial lake (or) reservoir behind it. Dams and Reservoirs are the most important & expensive elements in multi-purpose river basin development.

→ They required careful planning, design & operation. A number of problems arise in design, construction and operation of dams & reservoirs.

Purposes (or) uses of storage Works [such as Dams & Reservoirs]

→ Storage Works such as dams and reservoirs are constructed to serve many purposes, which include:

- a. Storage & control of water for irrigation
- b. Storage & diversion of water for domestic uses.
- c. Water supplies for industrial uses
- d. Development of hydroelectric power.
- e. Storage space for flood control.
- f. Debris control
- g. Preservation and cultivation of useful aquatic life.

Types (or) classification of Reservoirs

→ Depending upon the purposes served, reservoirs may be classified as under:-

- a. Storage (or) conservation Reservoirs.
- b. Flood protection reservoirs (or) Flood control.

C. Distribution Reservoirs

d. Multipurpose Reservoirs

a. Storage (or) conservation Reservoir

- These are primarily used for water supplies for irrigation, hydroelectric development, domestic and industrial supplies.
- A river does not carry the same quantity of water throughout the years.
- But, a river carries large quantity in the other part of the year.
- It is constructed to store the water & supplies whenever it is needed.

b. Flood control Reservoir

- Flood control Reservoir is also called as "Flood protection Reservoir".
- It stores water during floods & release water after flood reduces.
- There are two pillars in flood control (or) protection reservoirs:
 1. River bed stabilizing planning.
 2. Flood disposition planning.

→ The downstream [discharge] is reduced during floods.

→ This reservoir is used to control floods.

c. Distribution Reservoirs

- It is a small storage reservoir.
- It is used for water supply in a city.
- It is suitable for pumping plants & water-treatment works etc to operate at a constant rate.
- The varying rate of water takes place during the day.

d. Multi purpose Reservoirs

→ It serves more than one purpose.

Selection of site for a Reservoir

The final selection of site for a reservoir depends upon the following factors:

- The geological condition of the catchment area should be such that percolation losses are minimum and maximum run-off is obtained.
- Suitable dam site must exist.
- The reservoir basin should have narrow opening in the valley, so that the length of the dam is less.
- The cost of real estate for the reservoir, including roads, railroad, etc. must be less.
- The topography of the reservoir site should have adequate capacity.
- The reservoir site should store the water for various purposes.
- The soils and rock mass at the reservoir site must not contain any minerals and salts.
- The site should be free from faults.

Zones of storage in a Reservoir

The following are the various zones of storage in reservoir.

- a. useful storage.
- b. Surcharge storage.
- c. Dead storage.
- d. Bank storage.
- e. valley storage.

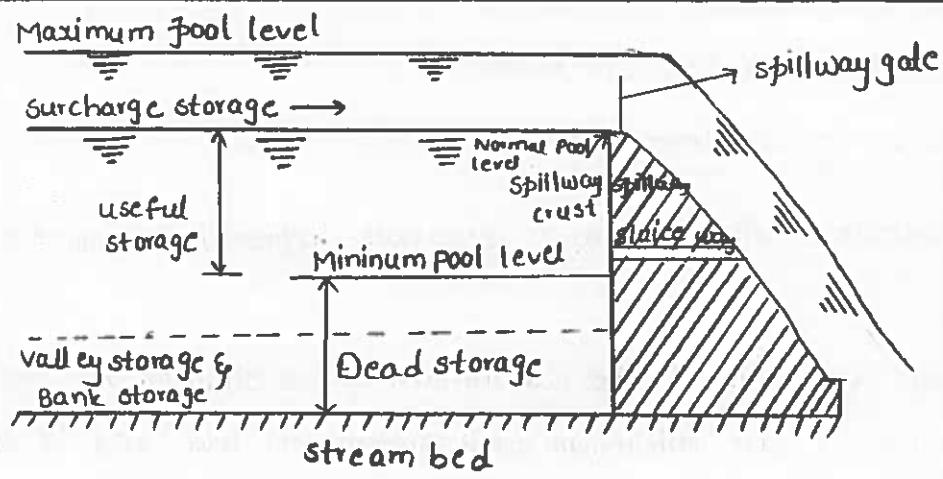


Fig: Zones of storage in a Reservoir

Catchment Area

The area from which the rainfall flows into the reservoir is known as "Catchment Area".

Normal pool Level

The maximum level of water will rise in the reservoir during Ordinary operation condition is called "Normal pool Level"

Maximum pool Level

The level to which water rises during the design flood is called as "Maximum pool Level"

Minimum pool Level

The lowest elevation to which the water in the reservoir is to be drawn under ordinary operating conditions is known as "Minimum pool Level".

Surcharge storage

The volume of water stored between the normal pool level and the maximum pool level.

Dead Storage

The volume of water below the minimum pool level.

Bank & Valley storages

The volume of water stored in the formation of reservoir banks.

Storage Capacity & yield (or) Reservoir yield

Capacity of a reservoir in order to meet a particular rate of demand.

yield:

It is the amount of water that can be supplied from the reservoir in a specified interval of time.

Safe (or) Firm yield

The maximum quantity of water that can be guaranteed during a critical dry period.

Secondary yield

It is the quantity of water available in excess of safe yield during high flood.

Average yield

The arithmetic average of the firm & secondary yield over a long period of time.

Specific yield

The quantity of water that can be pumped from the reservoir in a specific interval of time.

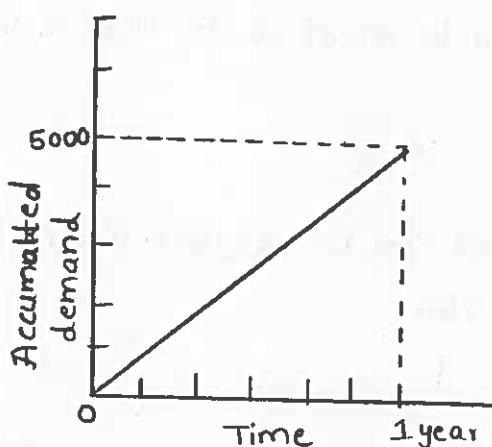
Mass curve

A plotting of the cumulative values of a variable as a

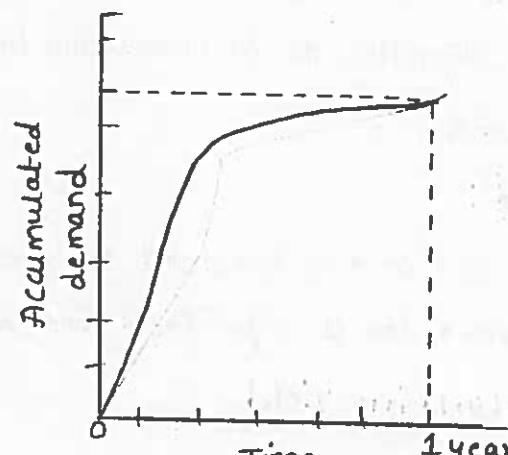
function of time.

Demand Curve

It is a plot between accumulated demand with time. The demand curve representing a uniform rate of demand is a straight line. A demand curve may be curved also, indicating variable rate of demand.

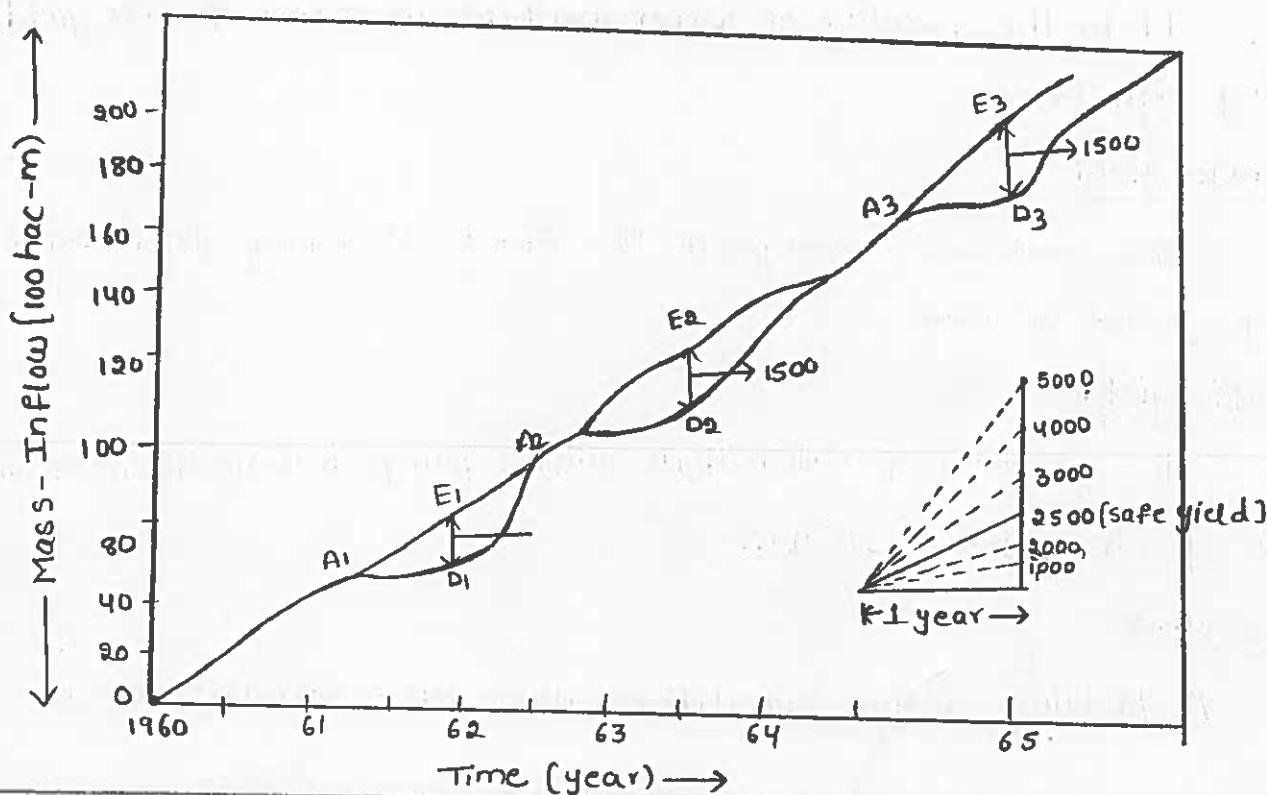


straight Line



curved Line

Determination of safe yield from a reservoir of a given capacity

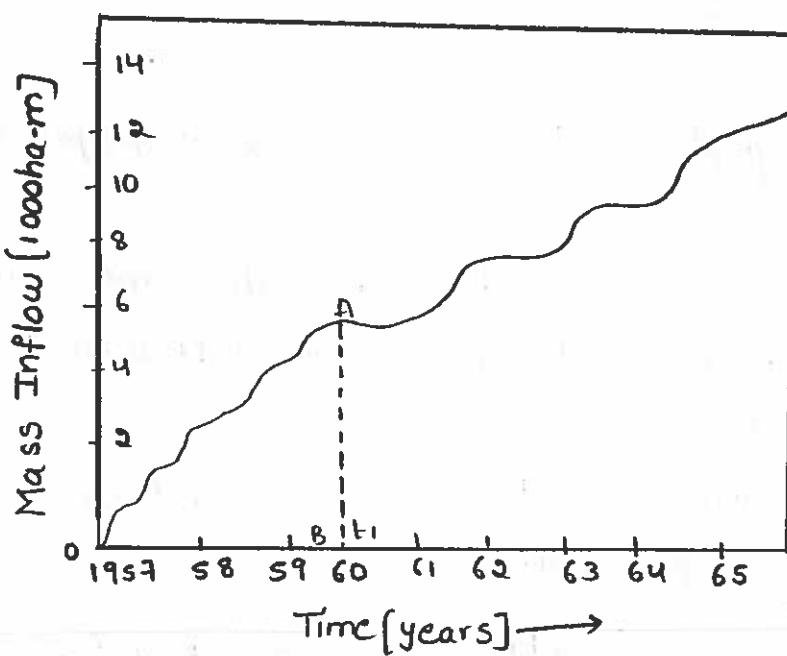


Procedure

- Prepare the mass inflow curve.
- On the same diagram, draw the straight line from a common origin.
- From the apices A_1, A_2, A_3 of the mass inflow curve, draw tangents.
- The ordinates $E_1 D_1, E_2 D_2$ & $E_3 D_3$ are equal to reservoir capacity.
- Measure the slopes of each of these tangents.
- The slopes indicate the yield which can be attained in each year from the reservoir of given capacity.
- The slope of and latest demand line is the firm (or) safe yield.

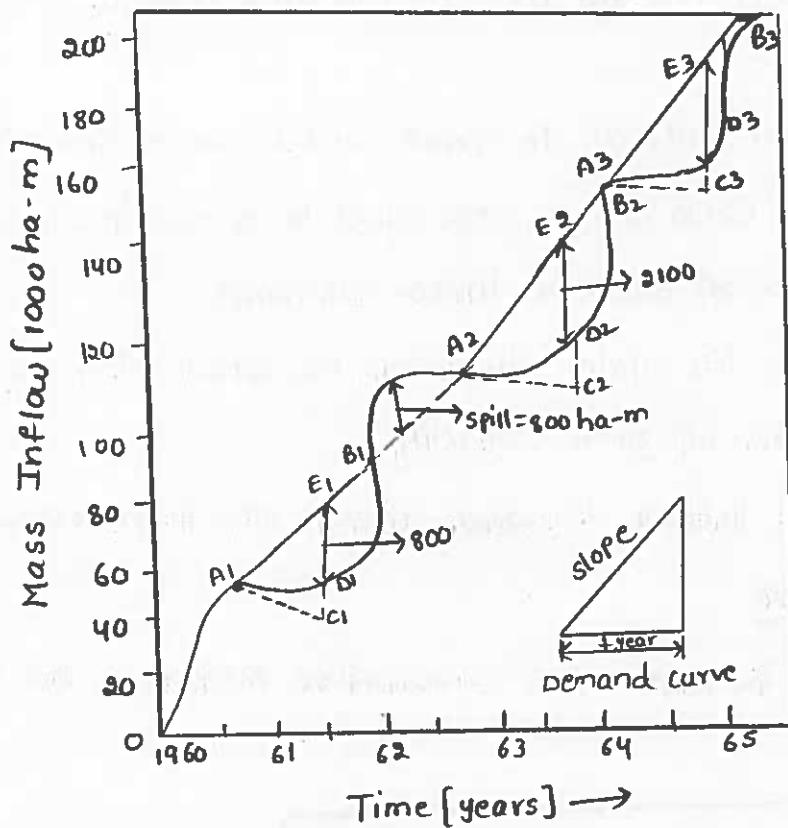
Mass Inflow curve

It is a plot between the cumulative inflow in the reservoir with time.



* Mass Inflow curve *

Calculation of Reservoir Capacity for a specified yield, from the Mass Inflow curve



Procedure

- From the flood hydrograph, the mass inflow curve is prepared for several years.
- Also, prepare the mass curve of demand on the same scale.
- From the apices A_1, A_2, A_3 etc of the mass inflow curve, draw tangents parallel to demand curve.
- Measure the maximum vertical intercepts E_1D_1, E_2D_2, E_3D_3 b/w the tangent & Mass Inflow curve.
- The biggest of the vertical ordinates amongst E_1D_1, E_2D_2 & E_3D_3 represent the required reservoir capacity.

Sediment Flow in streams : Reservoir sedimentation

Explanation:

→ All the rivers carry certain amount of silt eroded from the catchment area during heavy rains.

Factors of sedimentation

a. Nature of soil of the catchment area.

b. Topography of the catchment area.

c. vegetation cover.

d. Intensity of rainfall.

→ The nature of soil of the catchment area is an important factor.

→ If the soil is soft, there is always a possibility of sheet erosion.

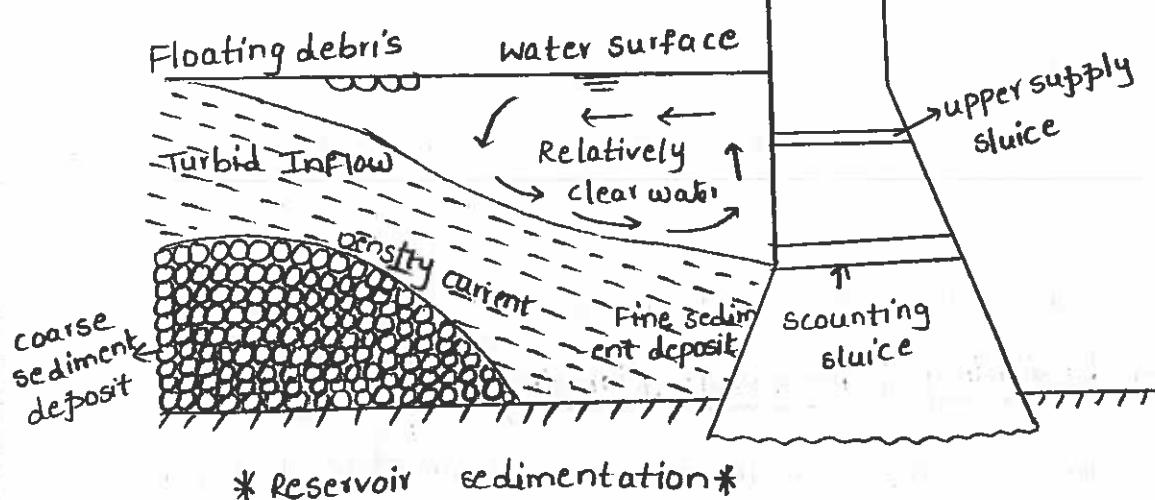
→ High intensity of rainfall causes great run-off & more erosion.

→ If the catchment area has sufficient vegetation, then erosion is much reduced.

→ The sediment transported by the river can be divided into two heads.

a. Bed load

b. suspended load.



Reservoir sediment control

The following are some of the methods used for the control of reservoirs:

- a. proper selection of Reservoir site.
- b. Control of sediment inflow.
- c. proper designing & Reservoir planning.
- d. Control of sediment deposit.
- e. Removal of sediment deposit.
- f. Erosion control in the catchment area.

a. proper selection of Reservoir site

- The silt transported in the system depends upon the nature of the catchment area.
- A stream collecting water from catchment area having soft (or) loose soil, may carry more sediment load.
- Hence, the reservoir site should exclude runoff from easily erodible catchment area.

b. Control of sediment Inflow

- This is a preventive measure.
- small check dams may be constructed across those tributaries which carry more silt.
- Increase of vegetal cover over the catchment area also decreases the soil erosion.
- Hence, sediment inflow is reduced.

c. proper designing & Reservoir planning

- The sediment trapped in the reservoir also depends upon

the reservoir planning.

→ To control reservoir sediment, the proper designing & Reservoir planning are required.

d. Control of sediment deposit

→ The sediment deposit in the reservoir can be controlled by proper operation of the gates of head regulators of the canals etc.

→ These should be so designed & operated that selective removal of silt is affected.

e. Removal of sediment deposit

→ This is a curative measure.

→ sediment deposit should be removed for the reservoir sedimentation control.

f. Erosion control in the catchment area

provision of vegetation screen helps in reducing the sheet erosion.

Factors on which the sediment load of river depends

The following are the factors on which the sediment load of river depends:

- Nature of soil of the catchment area.
- Topography of the catchment area.
- vegetation cover.
- Intensity of rainfall.

Principal adverse effects of sedimentation of reservoir

- The passage of sediments in the irrigation canals and power houses may be increased.
- The availability of firm water and supply of power may be reduced.
- The river regime at the inlet to the reservoir may get affected.

Life of Reservoir

Def:

It is defined as the period upto which the reservoir serves its purpose as expected.

Explanation

- The estimation of life of reservoir in advance is compulsory for making the reservoir a feasible project.
- The capacity of the reservoir is divided by the estimated load for obtaining the life of reservoir.
- When the rate of silting is low then the life of reservoir will be long.
- The life of reservoir can be made longer by the prevention of erosion, due to which the formation of sediment is prevented.
- Therefore, for the useful life of reservoir to be determined.
- The different factors which influence the life of reservoir are as follows:
 - a. silting of reservoir.
 - b. Leakage of reservoir.

→ The life of reservoir is terminated when its capacity is reduced to 20% of designed capacity.

Procedure for calculation (or) determination of life of a reservoir

→ The life of reservoir is determined by using following steps:-

- i. The required reservoir capacity is determined by knowing the inflow rate.
- ii. calculate the capacity inflow ratio & obtain the trap efficiency for the full capacity of the reservoir.
- iii. Divide the total capacity into any suitable interval, say 10%. Assuming that 10% capacity has been reduced due to sediment deposit, find the trap efficiency for the reduced capacity & the inflow ratio.
- iv. For this interval of 10% capacity. find the avg. trap efficiency by taking the avg of " η "
- v. Determine the sediment inflow rate by taking water samples & drying the sediment.
- vi. Divide the vol. interval by the sediment deposited to get the no.of years to fill this vol. interval of 10% capacity.
- vii. Repeat the same procedure for further intervals.

Dams

Def:

A dam is a hydraulic structure constructed across a river to store water on its up-stream side. This water is then utilised when it is needed.

Classification (or) Types of Dams

Dams may be classified into different categories depending upon the purpose (or) basis of the classification.

Basis of classification	Types	common examples (or) Types
a. classification according to use	i. storage dam ii. Diversion dam iii. Detention dam	Gravity dam, earth dam, Arch dam & Rockfill dam etc. Weir & barrage Dike, water spreading dam & debris dam
b. classification by hydraulic design.	i. Overflow dam ii. Non-overflow dam	Spillway Gravity dam, Earth dam & Rock fill dam.
c. classification by Materials.	i. Rigid dam ii. Non-Rigid dam	Gravity, arch, buttress, steel & timber dams etc. Earth dam & Rock fill dam.

a. classification according to use

→ Based on use, dams are classified as.

- i. storage dam
- ii. diversion dam
- iii. detention dam.

i. storage dam

- This is the most common type of dam.
- The storage dams may be constructed for various purposes such as irrigation, power generation etc.
- It can be used for multi-purposes.

- It is constructed by stone, concrete, earth & rockfill etc.
- The most common types (or) common examples of storage dams are.

- i. Gravity dam
- ii. Earth dam
- iii. Arch dam
- iv. Rockfill dam .

i. Gravity dam:

Def:-

A gravity dam is a structure so proportioned that its own weight resists the forces exerted upon it. This type of dam is the most permanent one, but requires little maintenance. This type of dam is most commonly used. A gravity dam may be constructed either of masonry (or) concrete [refer unit-II]

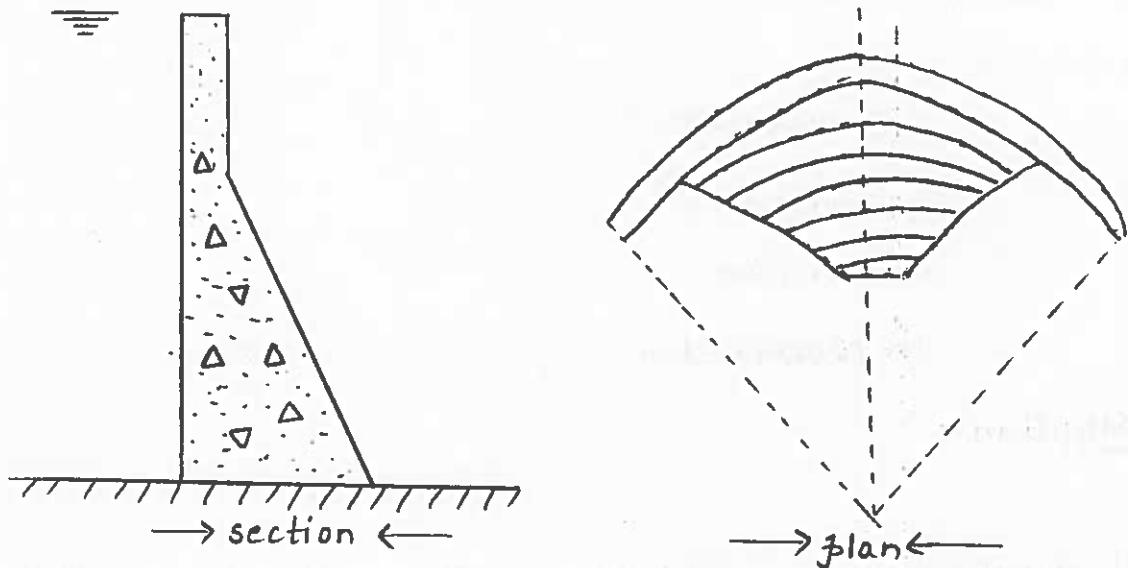
ii. Earth (or) Earthen Dam

Def:

It is the most common type of dams, which is generally built with locally available materials such as soils & gravels. They are of trapezoidal shape with lighter structure [refer unit-III]

iii. Arch dam

- It consists of an arch shaped structure .
- The convex side of this dam is always faces upstream.
- In this dam, water pressure is transmitted .
- The modulus of elasticity is high .
- It is suitable to narrow, deep, wider valleys .



Advantages

- The length is small in proportion to the height.
- It is cheaper
- Material required are less (or) less materials required.
- The problems of uplift pressure are minor.
- It is constructed in moderate foundation.

Disadvantages

- It requires skilled labours.
- The design of an arch dam is also quite specialized.
- The speed of construction is normally slow.
- Only few sites are suitable for this type of dam.

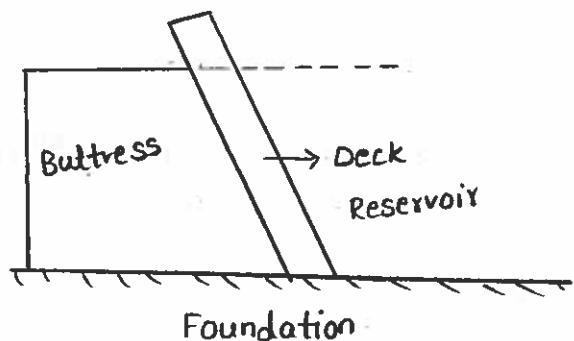
iv. Rockfill dams

It is similar to earthdams.

Buttress dams

- It consists of a no. of buttresses (or) piers.

- To hold up water & retain the water b/w these buttresses are constructed .
- The other types of buttress dam are rigid, semi-rigid etc .



Advantages

- It is less massive than a gravity dam .
- It is constructed even on weak foundations .
- The water loads acts normally .
- The reduction in concrete volume .
- Increase in the surface area .

Disadvantages

- Skilled labours are required .
- It is more susceptible to willful damage .
- Serious effects takes place in this dam .

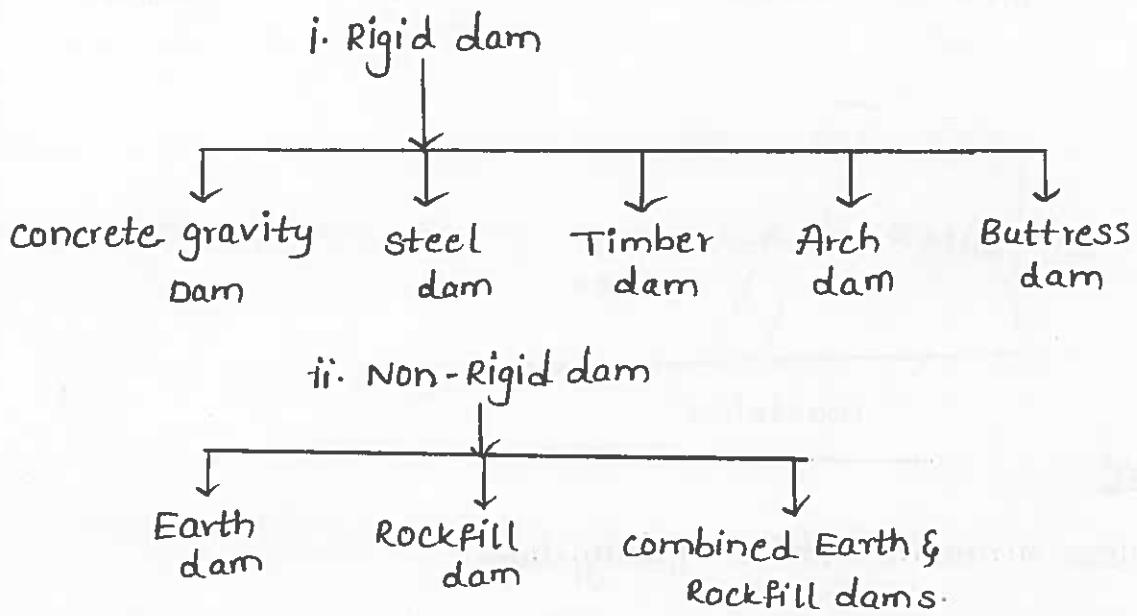
b. classification according to hydraulic design

- According to hydraulic design, dams may be classified as :-

- i. Overflow dam [eg:- spill way]
- ii. Non-Overflow dam [eg:- Gravity, earth & Rock fill dams]

c. classification according to material

→ According to material, dams may be classified as :



Forces Acting on Dams

→ The following are the forces acting on the dams .

- a. Water pressure.
- b. Ice pressure.
- c. Wind pressure
- d. Wave pressure
- e. Uplift pressure
- f. Silt pressure
- g. Weight of dam .
- h. Earthquake pressure.

Purpose/uses of dams

→ Dams are constructed for the serving the following purposes:

- a. Controlling of floods.
- b. Generating hydro-electric power .

- c. Recreation
- d. used for multi purposes
- e. For conservation

Particular type of Dam

Physical Factors Governing Selection of type of a dam

→ The following are the factors which affects (or) effects (or) governing the selection of type of a dam:

- a. Topography
- b. Geology & Foundation conditions.
- c. Materials of construction.
- d. Spillway size & Location.
- e. Roadway.
- f. Length & height of dam.
- g. Life of Dam

Selection of site for a dam

→ The following are the requisites of good sites for various types of dams:

- a. Foundations
- b. Topography
- c. site for spillway
- d. Materials
- e. Reservoir & catchment area.
- f. Communication.
- g. Locality.
- h. Cost of site.

Dam & Reservoir

Dam	Reservoir
1. It controls the flow of a river & store water for various purposes.	1. It is impounding of water of a flowing river.
2. It is built across a stream, river etc.	2. It is integral part of dam
3. It is used for generation of hydropower.	3. It is used for irrigation & domestic water supply.
4. It is artificial wall in the reservoir.	4. It might be natural (or) artificial lake.
5. It is constructed to stop the flowing water.	5. It is designed to accommodate to store the silt.
Eg: Nagarjuna Sagar Dam	Eg: Osman Sagar reservoir on Musi river in Hyderabad.