DAMS

DAMS

- **Dam, structure built across a stream or a river to retain water.**

➨ **A dam is a hydraulic structure of fairly impervious material built across a river to create a reservoir on its upstream side for impounding water for various purposes.**

➨ **A dam is a barrier constructed across a river or a natural stream to create a reservoir for impounding water or to facilitate diversion of water from the river or to retain debris flowing in the river along with water.**

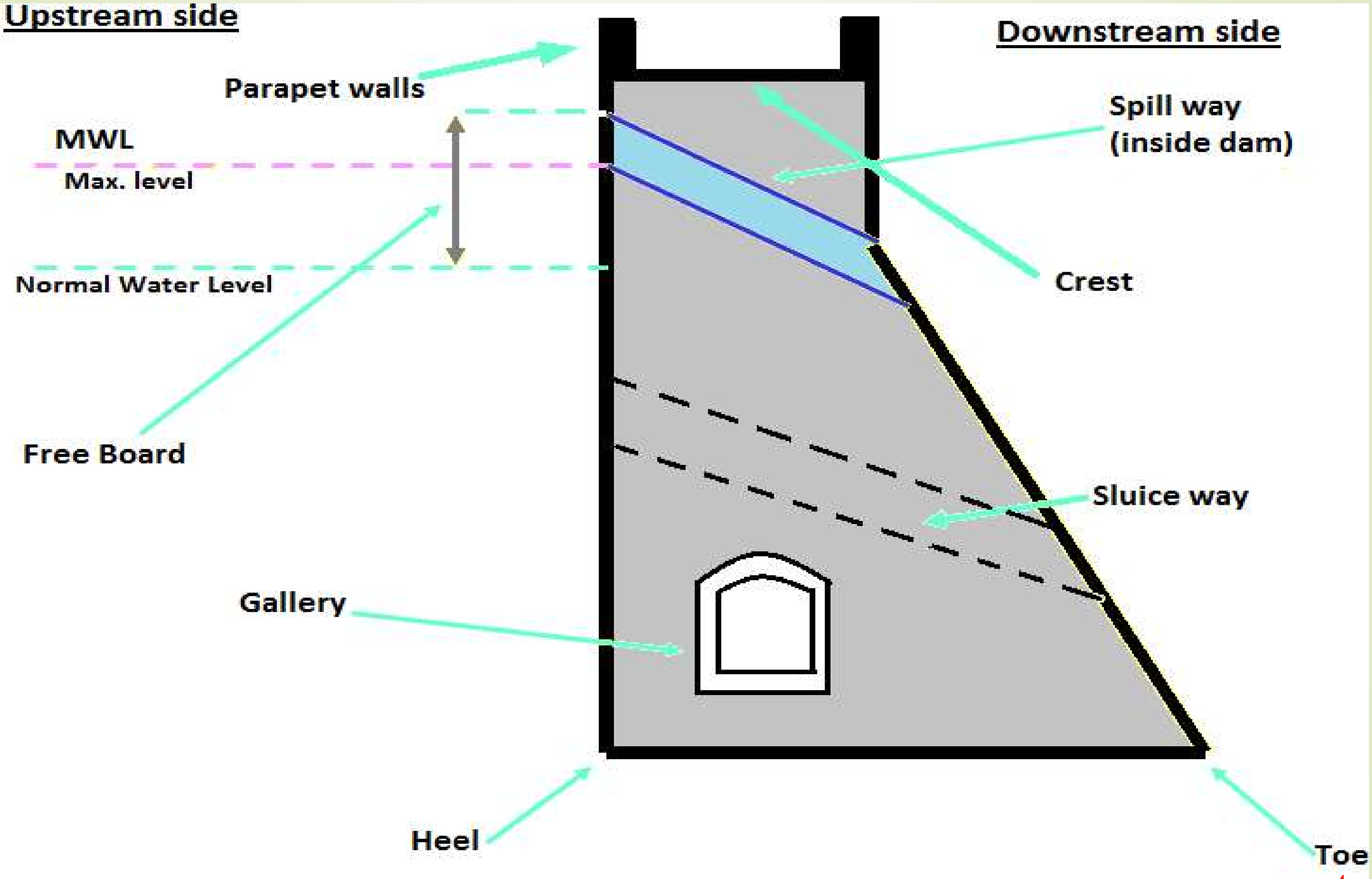
Purposes to construct a dam are

- **Irrigation,**
- **Hydropower,**
- **Water-supply,**
- **Flood Control,**
- **Navigation,**
- **Fishing and Recreation.**

Dams may be built to meet one of the above purposes or they may be constructed fulfilling more than one.

As such, Dam can be classified as: Single-purpose and Multi-purpose Dam.

Different parts & terminologies of Dams:



- **Crest**: The top of the Dam. In some cases these may be used for providing a roadway or walkway over the dam.

- **Parapet walls**: Low Protective walls on either side of the roadway or walkway on the crest.

- **Heel**: Portion of Dam in contact with ground or river-bed at upstream side.

- **Toe**: Portion of dam in contact with ground or river-bed at downstream side.

- **Spillway**: It is the arrangement made (kind of passage) near the top of dam for the passage of surplus/ excessive water from the reservoir.

- **Abutments**: The valley slopes on either side of the dam wall to which the left & right end of dam are fixed to.

- **Gallery**: Level or gently sloping tunnel like passage (small room like space) at transverse or longitudinal within the dam with drain on floor for seepage water.
- These are generally provided for having space for drilling grout holes and drainage holes.
- These may also be used to accommodate the instrumentation for studying the performance of dam.

- **Sluice way**: Opening in the dam near the base, provided to clear the silt accumulation in the reservoir.

- **Free board**: The space between the highest level of water in the reservoir and the top of the dam.

- **Dead Storage level**: Level of permanent storage below which the water will not be withdrawn.

- **Diversion Tunnel**: Tunnel constructed to divert or change the direction of water to bypass the dam construction site. The dam is built while the river flows through the diversion tunnel.

Types OF DAMS

Dams may be classified in different ways on the basis of their

- **Function**
- **Hydraulic design**
- **Structural design**
- **Material of construction**

Based on the functions of dam, it can be classified as follows:

1. Storage dams
2. Diversion dams
3. Detention dams
4. Debris dams
5. Coffer dams

Storage dams: They are constructed to store water during the rainy season when there is a large flow in the river.

- Many small dams impound the spring runoff for later use in dry summers.
- Storage dams may also provide a water supply, or improved habitat for fish and wildlife.
- They may store water for hydroelectric power generation, irrigation or for a flood control project.
- Storage dams are the most common type of dams and in general the dam means a storage dam unless qualified otherwise

Diversion dams:

A diversion dam is constructed for the purpose of diverting water of the river into an off-taking canal (or a conduit).

They provide sufficient pressure for pushing water into ditches, canals, or other conveyance systems. Such shorter dams are used for irrigation, and for diversion from a stream to a distant storage reservoir.

Detention dams:

Detention dams are constructed for flood control. A detention dam retards the flow in the river on its downstream during floods by storing some flood water.

Thus the effect of sudden floods is reduced to some extent. The water retained in the reservoir is later released gradually at a controlled rate according to the carrying capacity of the Channel downstream of the detention dam.

Thus the area downstream of the dam is protected against flood.

Debris dams: A debris dam is constructed to retain debris such as sand, gravel, and drift wood flowing in the river with water. The water after passing over a debris dam is relatively clear.

Coffer dams: It is an enclosure constructed around the construction site to exclude water so that the construction can be done in dry.

A cofferdam is thus a temporary dam constructed for facilitating construction. A coffer dam is usually constructed on the upstream of the main dam to divert water into a diversion tunnel (or channel) during the construction of the dam.

Classification according to Hydraulic design

- Overflow Dams
- Non-Overflow Dams
- Rigid Dams
- Non-Rigid Dams

Overflow dam

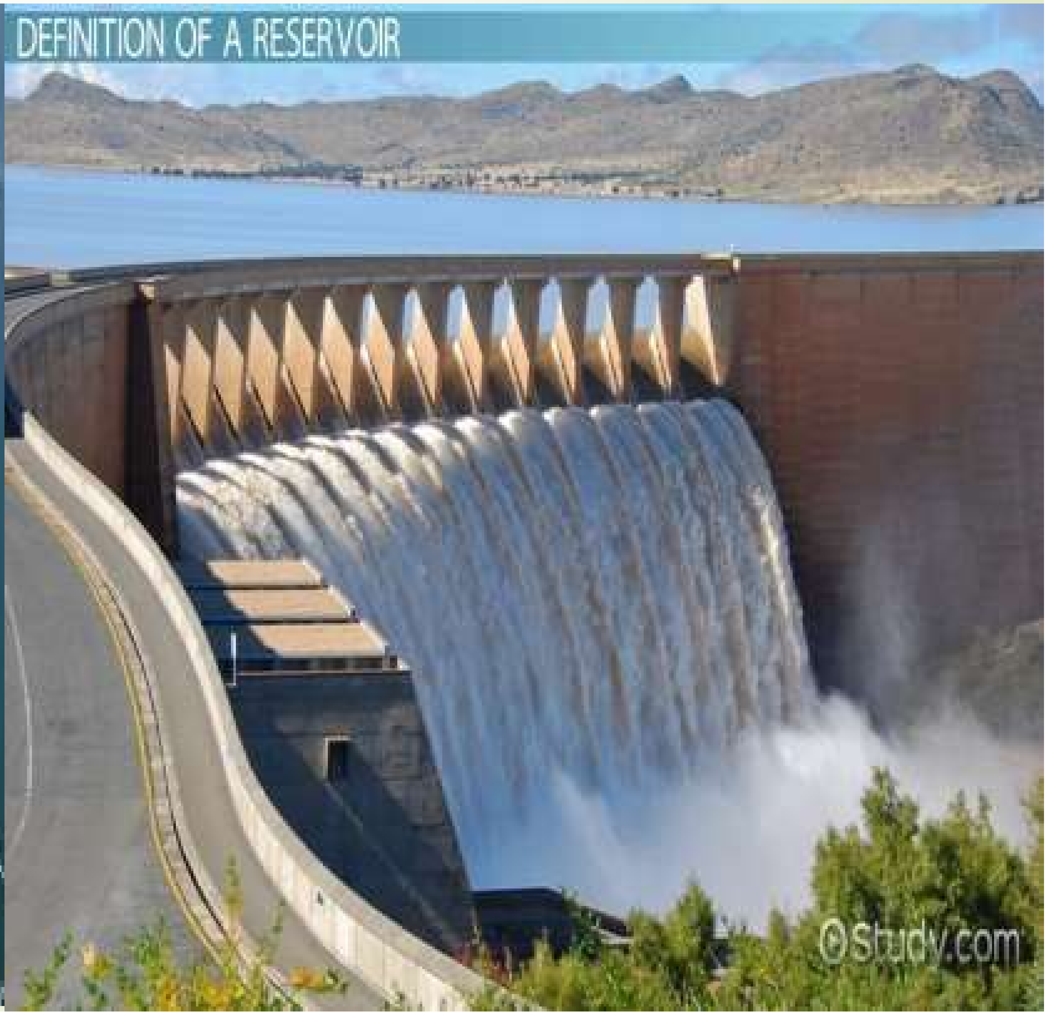
The dam body is made of strong material as concrete and flow is allowed over the dam crest (Concrete dams)

Non-Overflow dam:

Flow is not allowed over the embankment crest for reasons of dam safety. (earth, rock) dams.

RIGID DAM.

It is constructed with **rigid** material such as masonry, concrete, steel, or timber.



NON-RIGID DAM (EMBANKMENT DAMS)

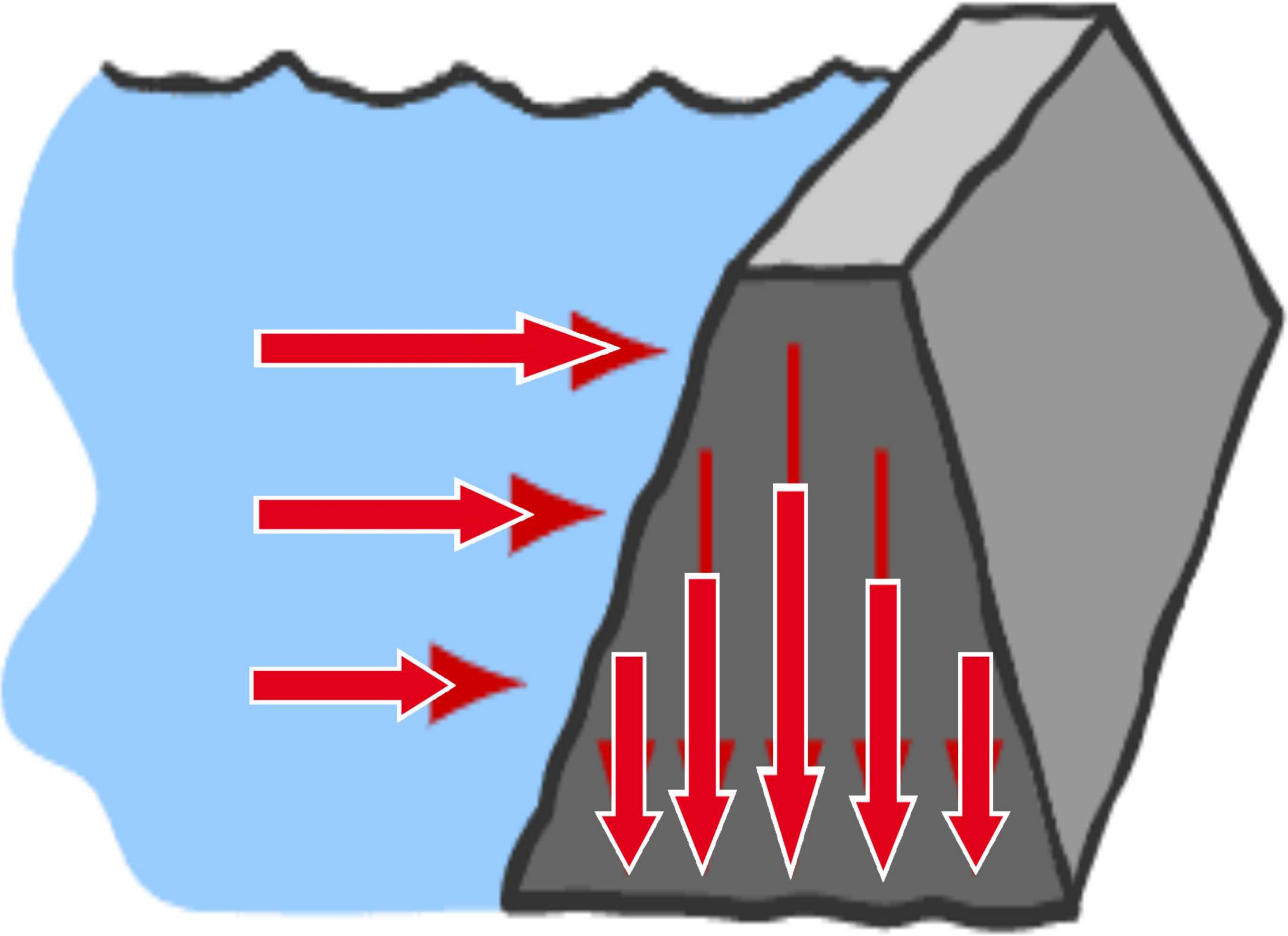
- It is constructed with non-rigid material such as earth, tailings, rockfill etc.

- Earthen dam – gravel, sand, silt, clay etc
- Tailings dam – waste or refuse obtained from mines
- Rockfill dam – rock material supporting a water tight material on the u/s face
- Rockfill composite dam – Rockfill on the d/s side and earth fill on the u/s side
- Earthen dams are provided with a stone masonry or concrete overflow (spillway) section. Such dams are called composite dams.
- In some cases, part of the length of the dam is constructed as earth dam and the rest (excluding the spillway) as a masonry dam. Such dams are called masonry cum earthen dams.

- **BASED ON STRUCTURAL BEHAVIOUR:**

Gravity Dams:

- A gravity dam is a massive sized dam fabricated from concrete or stone masonry. They are designed to hold back large volumes of water.
- By using concrete, the weight of the dam is actually able to resist the horizontal thrust of water pushing against it. This is why it is called a gravity dam.
- Gravity dams are well suited for blocking rivers in wide valleys or narrow gorge ways. Since gravity dams must rely on their own weight to hold back water, it is necessary that they are built on a solid foundation of bedrock.
- Examples of Gravity dam: Grand Coulee Dam (USA), (Nagarjuna Sagar Dam (India) and Itaipu Dam (Between Brazil and Paraguay).



Earth Dams:

- An earth dam is made of earth (or soil) built up by compacting successive layers of earth, using the most impervious materials to form a core and placing more permeable substances on the upstream and downstream sides.
- A facing of crushed stone prevents erosion by wind or rain, and an ample spillway, usually of concrete, protects against catastrophic washout should the water overtop the dam
- Earth dam resists the forces exerted upon it mainly due to shear strength of the soil. Although the weight of the earth dam also helps in resisting the forces, the structural behavior of an earth dam is entirely different from that of a gravity dam.
- They can be built on all types of foundations. However, the height of the dam will depend upon the strength of the foundation material.
- Examples of earthfill dam: Rongunsky dam (Russia) and New Cornelia Dam(USA).

Arch Dams:

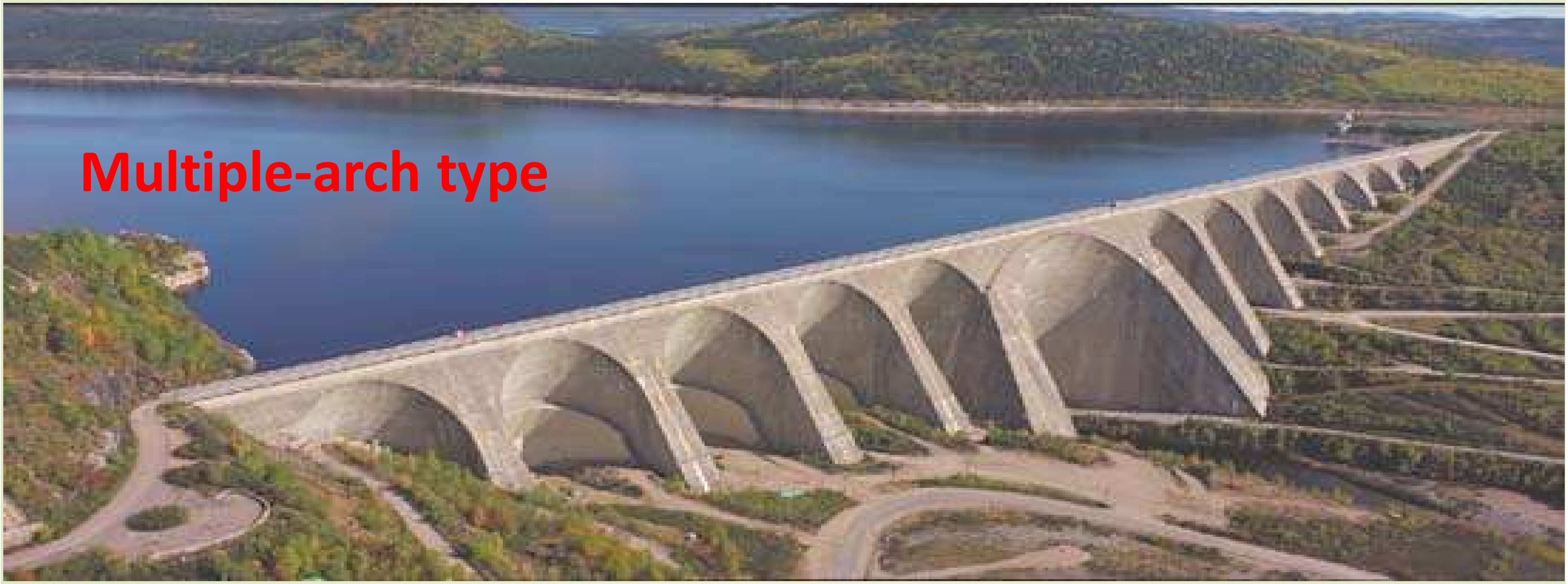
- An arch dam is curved in plan, with its convexity towards the upstream side. An arch dam transfers the water pressure and other forces mainly to the abutments by arch action.
- An arch dam is quite suitable for narrow canyons with strong flanks which are capable of resisting the thrust produced by the arch action.
- Hoover Dam, USA . The section of an arch dam is approximately triangular like a gravity dam but the section is comparatively thinner. The arch dam may have a single curvature or double curvature in the vertical plane. Generally, the arch dams of double curvature are more economical and are used in practice.
- Examples of Arch dam: Hoover Dam (USA) and Idukki Dam (India)

Buttress Dams: Buttress dams are of three types :

(i) Deck type,
(ii) Multiple-arch type, and
(iii) Massive-head type.

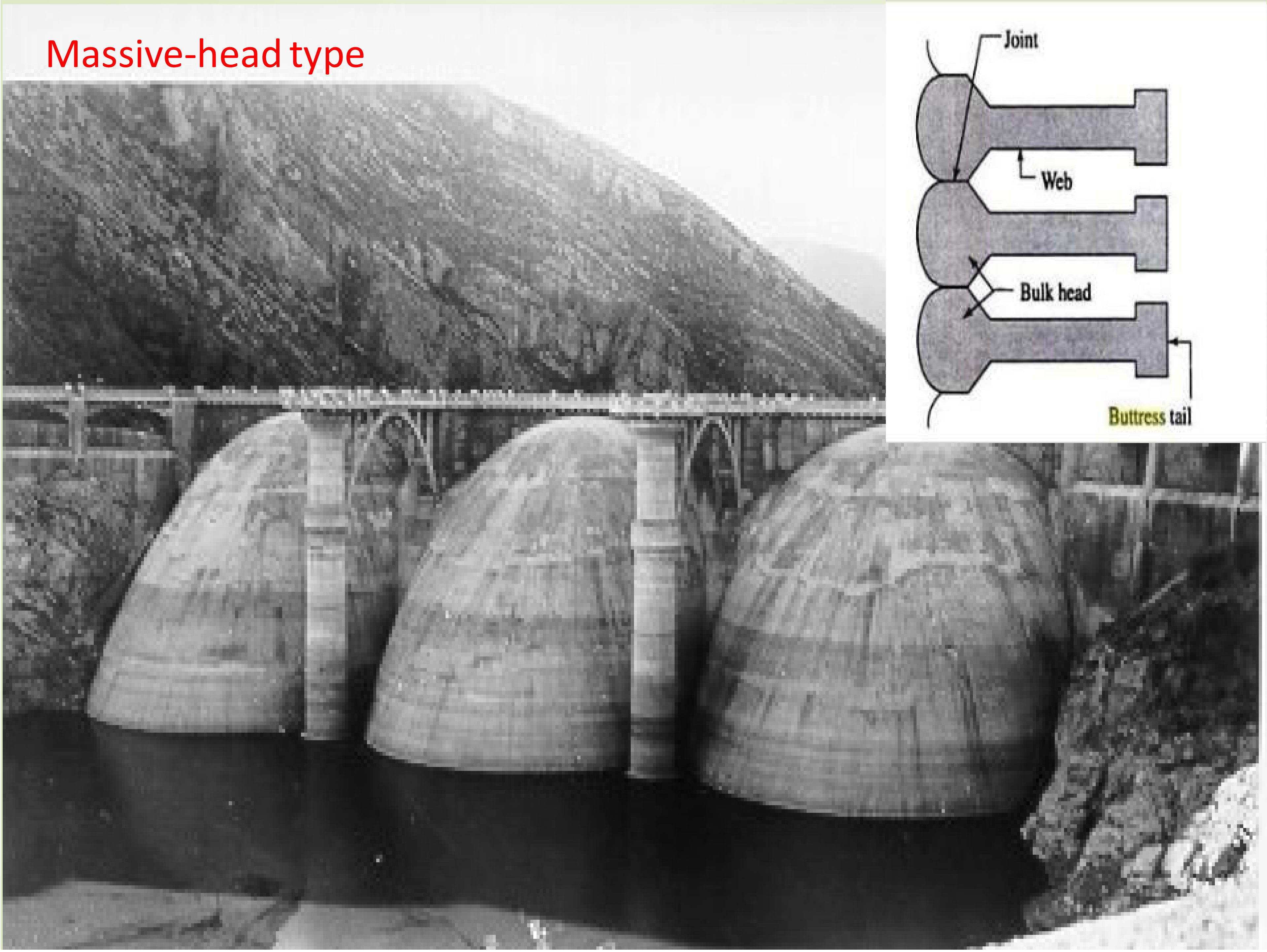
- A deck type buttress dam consists of a sloping deck supported by buttresses. Buttresses are triangular concrete walls which transmit the water pressure from the deck slab to the foundation.
- Buttresses are compression members. Buttresses are typically spaced across the dam site every 6 to 30 metre, depending upon the size and design of the dam. Buttress dams are sometimes called hollow dams because the buttresses do not form a solid wall stretching across a river valley.
- The deck is usually a reinforced concrete slab supported between the buttresses, which are usually equally spaced.
- Buttress Dam In a multiple-arch type buttress dam the deck slab is replaced by horizontal arches supported by buttresses.
- Examples of Buttress Dam: Bartlett dam (USA) and The Daniel-Johnson Dam (Canada)

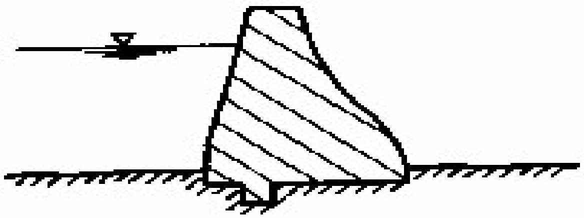
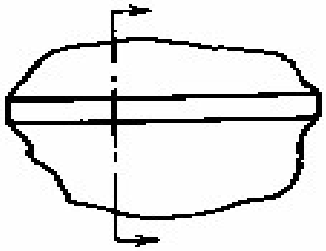
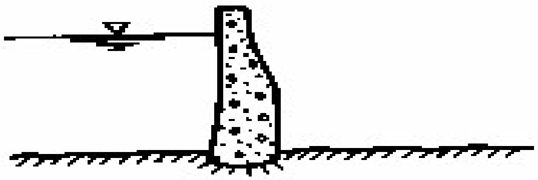
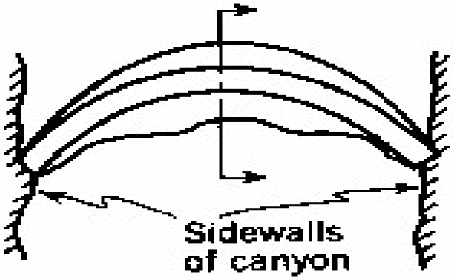
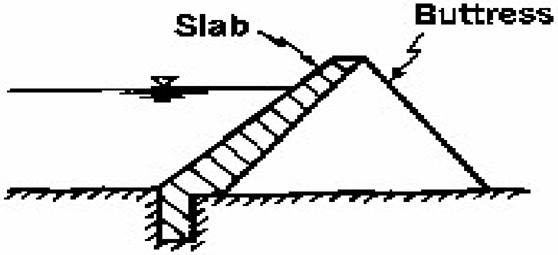
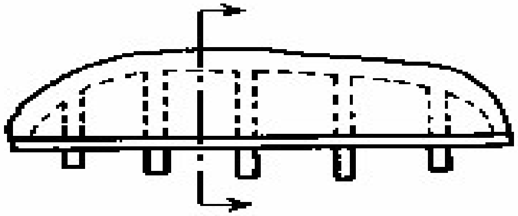
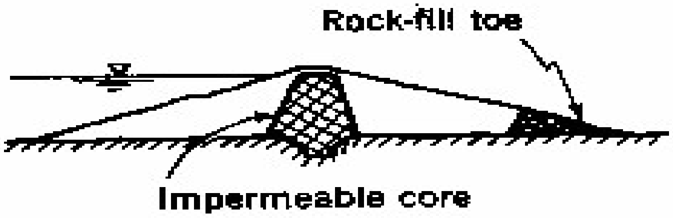
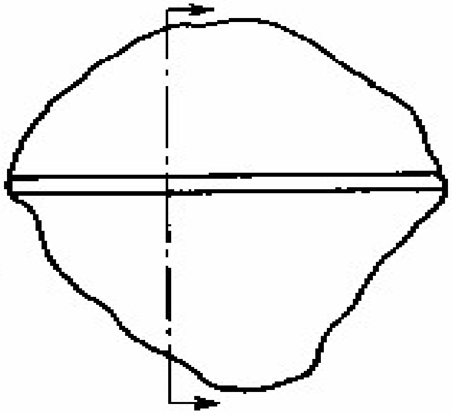
Deck type



Multiple-arch type

Massive-head type



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

BASED ON TYPE OF MATERIALS:

Masonry dams are built using either stone masonry or brick masonry.
Cement mortar is used to join the masonry blocks.
Gravity dam, arch dam etc. are examples of masonry dams.

Concrete is most commonly used material to construct a dam. Most of the major dams in the world are built using concrete. Gravity dams, arch dam, Buttress dam etc. can be constructed using concrete.

Timber dams generally used for temporary purposes such as to divert the water for the construction of main dam, to control flood water flow etc. Timber dams are suitable up to 9 meters height.

Steel dams are also used for temporary requirements like timber dams.

Steel plates and inclined struts are used for the construction of steel dam. This type of dams are suitable up to 15 to 18 meters of height.

Rockfill Dams: A rockfill dam is built of rock fragments and boulders of large size.

An impervious membrane is placed on the rockfill on the upstream side to reduce the seepage through the dam.

The membrane is usually made of cement concrete or asphaltic concrete.

In early rockfill dams, steel and timber membrane were also used, but now they are obsolete.

Factors Governing Selection Of Type Of Dam

Whenever it is decided to construct a dam, the first question that one face is which type of dam will be most suitable and most economical? Following are the factors affecting selection of dam site by dam type.

- **Topography**
- **Geology and Foundation Conditions**
- **Availability of materials**
- **Spillway size and location**
- **Earthquake zone**
- **Height of the Dam**
- **Other factors such as cost of construction and maintenance, life of dam, aesthetics etc.**

Topography

- A narrow U-shaped valley, i.e. a narrow stream flowing between high rocky walls, would suggest a concrete overflow dam.
- A low plain country, would suggest an earth fill dam with separate spillways.
- A narrow V-shaped valley indicates the choice of an Arch dam

- **Geology and Foundation Conditions** : The foundation strata should be strong enough to carry weight of dam. Hence the dam site must be surveyed by geologists so as to detect the thickness of foundation strata, presence of faults, fissured material etc.

  The various types of foundations generally encountered are :-

- Solid-rock foundation :Similar like granite, gnesis etc. Almost every type of dam can be built as it is strong enough to withstand the self weight of the dam and external forces acting on the dam.

- Gravel foundation :This type of foundation is suitable for earth and rock fill dams. For this foundation, low concrete gravity dams upto height of 15 meter may also be suggested.

- Silt and fine sand foundation: This type of foundation suggests the adoption of earth or very low gravity dam, upto height of 8 meter.

- Clay foundation : This foundation may be accepted for earthen dam after special treatment.

- **Availability of Materials**

  Availability of materials is another important factor in selecting the type of dam. In order to achieve economy in dam construction, the materials required must be available locally or at short distances from the construction site.

- **Spillway Size and Location**

  spillway disposes the surplus river discharge. The capacity of the spillway will depend on the magnitude of the floods to be by-passed. The spillway is therefore much more important on rivers and streams with large flood potential.

- **Earthquake Zone**

  If dam is situated in an earthquake zone, its design must include earthquake forces. The type of structure best suited to resist earthquake shocks without danger are earthen dams and concrete gravity dams.

- **Height of Dam**

  Earthen dams are usually not provided for heights more than 30 m or so. For greater heights, gravity dams are generally preferred.

Selection of Dam Site

The selection of Dam site for constructing a dam should be governed by the following factors.

- Small river channel width with steep side gorge: short dam crest length, leads to large storage for small dam length.
- A wide and gently sloping valley upstream of the dam site (for storage dams) and narrow and steeply sloping valley for hydropower dams.
- River channel and valley has very flat slopes upstream of dam site (leads to large storage for small dam heights).
- Where a deep reservoir possible, it resultantly requires less area and lesser land costs, less surface evaporation.
- Enough water flow/yield should be available to meet the demand of the area

Selection of Dam Site cont…

- **High sediment load tributaries are excluded**

- **Geology should be favorable for foundation (foundation can be designed at any site, but it increases costs), competent hard rock is most suitable.**

- **Abutments are water tight, and reservoir rim allows minimum percolation and seepage losses.**

- **Small river sediment rate (longer dam life) Depend on river morphology and catchment characteristics.**

Selection of Dam Site cont…

- Land use of reservoir area should be minimal – Less land area means lesser compensations to be given to the land owners and lower land cost.
- Reservoir area not very sensitive to environment (wild life parks, endangered species, historical places, monuments etc).
- No seismic and tectonic activities or active faults in and near the site.
- Socio-political stability (no unstable gestures)
- Reservoir and dam area should be thinly populated
- Site must have adequate stream flow record
- Site is easily accessible; approach road is present or can be developed easily.
- Construction material available nearby easily
- Site near load center (demand area) for water + power.
- No mineral resources in reservoir area (present or future)
- Site allows a deep reservoir & small surface area (less land costs and small evaporation losses).
- Existing infrastructure, e.g. highway, least affected.

Advantages of Dams

- Dams provide us with a source of clean energy.
- Dams help us to retain our water supply
- This technology provides us with critical recreational opportunities
- A well-constructed dam provides several flood-control benefits.
- Dams give us a way to irrigate croplands that may not receive enough moisture.
- A dam can provide a stable system of navigation.
- Reservoirs can serve as a source of drinking water.

Disadvantages of Dams

- Dams can displace a significant number of people.
- Reservoirs behind a dam can lead to higher greenhouse gas emissions.
- This technology disrupts local ecosystems.
- Dams create a flooding risk if they experience a failure.
- Dams can have an adverse impact on the groundwater table.
- The construction of a dam is a costly investment.
- Dams can block water progression to different states, provinces, and countries.
- Reservoirs can be challenging to maintain.

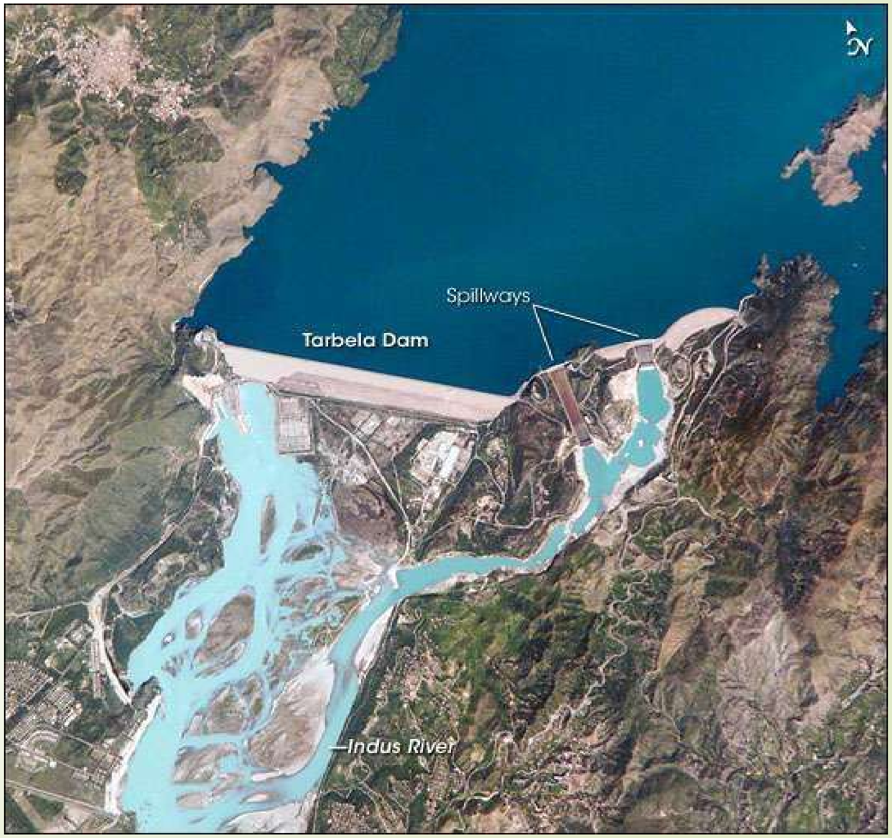
RESERVOIRS

Contents:

- Types
- Investigations
- Site selection
- Zones of storage
- Safe yield
- Reservoir capacity

What is a Reservoir?

- It is an area developed by water body due to construction of dam.



Storage reservoir serve the following purpose :

- Irrigation
- Water supply
- Hydroelectric power generation
- Flood control
- Navigation
- Recreation
- Development of fish & wild life
- Soil conservation

Classification of Reservoirs

- **Storage Reservoirs:** Storage reservoirs are also called conservation reservoirs because they are used to conserve water. Storage reservoirs are constructed to store the water in the rainy season and to release it later when the river flow is low.

- **Flood Control Reservoirs:** A flood control reservoir is constructed for the purpose of flood control. It protects the areas lying on its downstream side from the damages due to flood.

- **Retarding Reservoirs:** A retarding reservoir is provided with spillways and sluice ways which are ungated. The retarding reservoir stores a portion of the flood when the flood is rising.

- **Detention Reservoirs :** A detention reservoir stores excess water during floods and releases it after the flood. It is similar to a storage reservoir but is provided with large gated spillways and sluiceways to permit flexibility of operation.

- **Distribution Reservoirs:** A distribution reservoir is a small storage reservoir to tide over the peak demand of water for municipal water supply or irrigation. The distribution reservoir is helpful in permitting the pumps to work at a uniform rate. It stores water during the period of lean demand and supplies the same during the period of high demand.

- **Multipurpose Reservoirs:** The are constructed for more than single purpose.

- **Balancing Reservoirs:** A balancing reservoir is a small reservoir constructed d/s of the main reservoir for holding water released from the main reservoir.

Investigations

- Engineering surveys
- Geological investigations
- Hydrological investigations

Engineering surveys

- Conducted for dam, reservoir and other associated work.
- Topographic survey of the area is carried out and the contour plan is prepared
- The horizontal control is usually provided by triangulation survey, and the vertical control by precise levelling.

Geological investigation

- Geological investigations of the dam and reservoir site are done for the following purposes.

  - ✓ Suitability of foundation for the dam.
  - ✓ Watertightness of the reservoir basin
  - ✓ Location of the quarry sites for the construction materials.

Hydrological investigations

- The hydrological investigations are conducted for the following purposes :

  - ✓ To study the runoff pattern and storage capacity.
  - ✓ To determine the maximum discharge at the site.

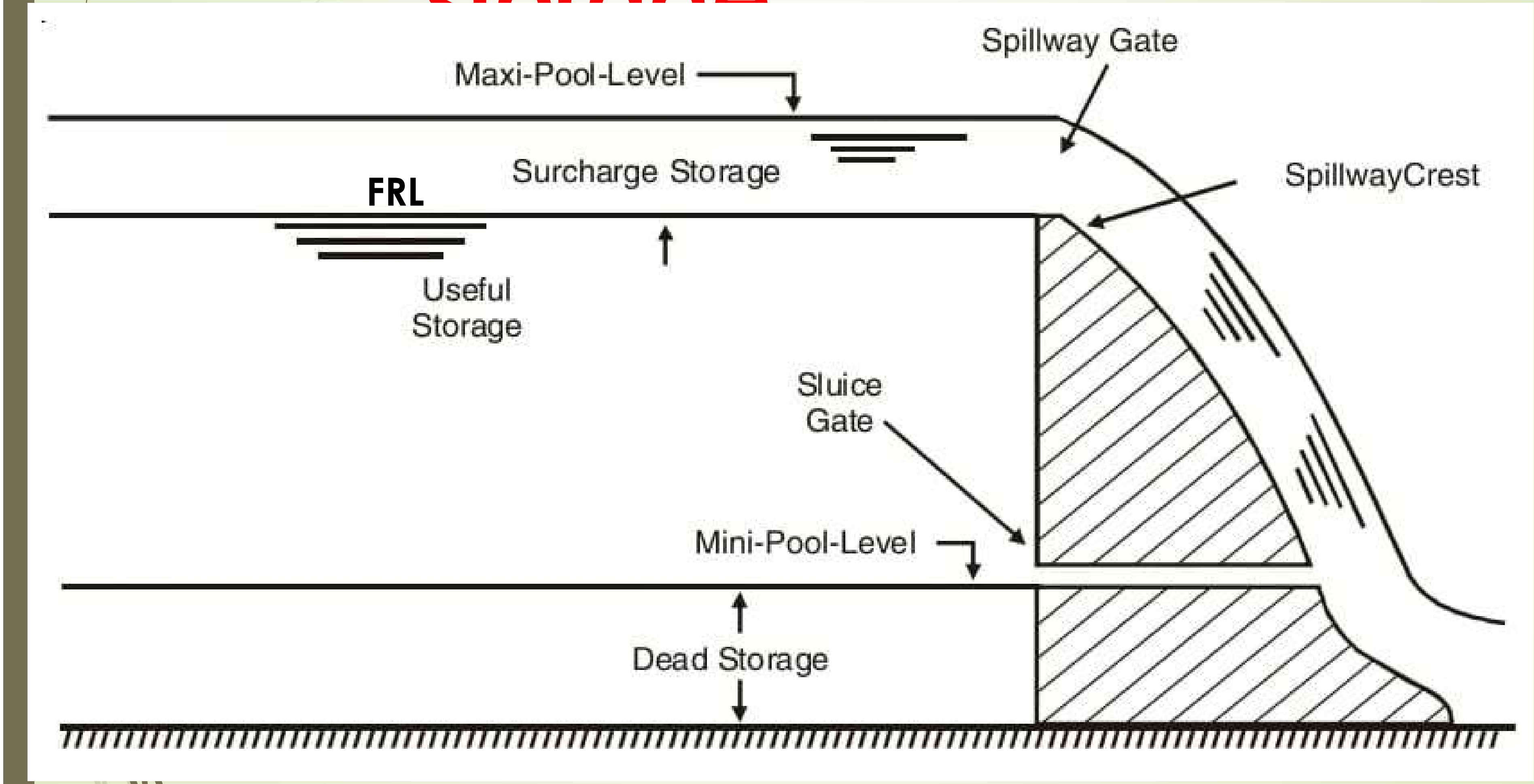
Site selection

- Large storage capacity
- River valley should be narrow, length of dam to constructed is less.
- Watertightness of reservoir.
- Good hydrological conditions
- Deep reservoir

Site selection cont….

- Small submerged area
- Low silt inflow
- No objectionable minerals
- Low cost of real estate
- Site easily accessible

Zones of storage



- **Full reservoir level (FRL):** The full reservoir level (FRL) is the highest water level to which the water surface will rise during normal operating conditions.
- **Maximum water level (MWL):** The maximum water level is the maximum level to which the water surface will rise when the design flood passes over the spillway.
- **Minimum pool level:** The minimum pool level is the lowest level up to which the water is withdrawn from the reservoir under ordinary conditions.

- **Dead storage:** The volume of water held below the minimum pool level is called the dead storage. It is provided to cater for the sediment deposition by the impounding sediment laid in water. Normally it is equivalent to volume of sediment expected to be deposited in the reservoir during the design life reservoir.

- **Live/useful storage:** The volume of water stored between the full reservoir level (FRL) and the minimum pool level is called the useful storage. It assures the supply of water for specific period to meet the demand.

- **Bank storage:** is developed in the voids of soil cover in the reservoir area and becomes available as seepage of water when water levels drops down. It increases the reservoir capacity over and above that given by elevation storage curves.

- **Valley storage:** The volume of water held by the natural river channel in its valley up to the top of its banks before the construction of a reservoir is called the valley storage. The valley storage depends upon the cross section of the river.

- **Flood/Surcharge storage:** is storage contained between maximum reservoir level and full reservoir levels. It varies with spillway capacity of dam for given design flood.

Effective Storage= useful storage+surcharge storage-valley storage

Reservoir capacity

- Depends upon the inflow available and demand.
- Inflow in the river is always greater than the demand, there is no storage required.
- If the inflow in the river is small but the demand is high, a large reservoir capacity is required.

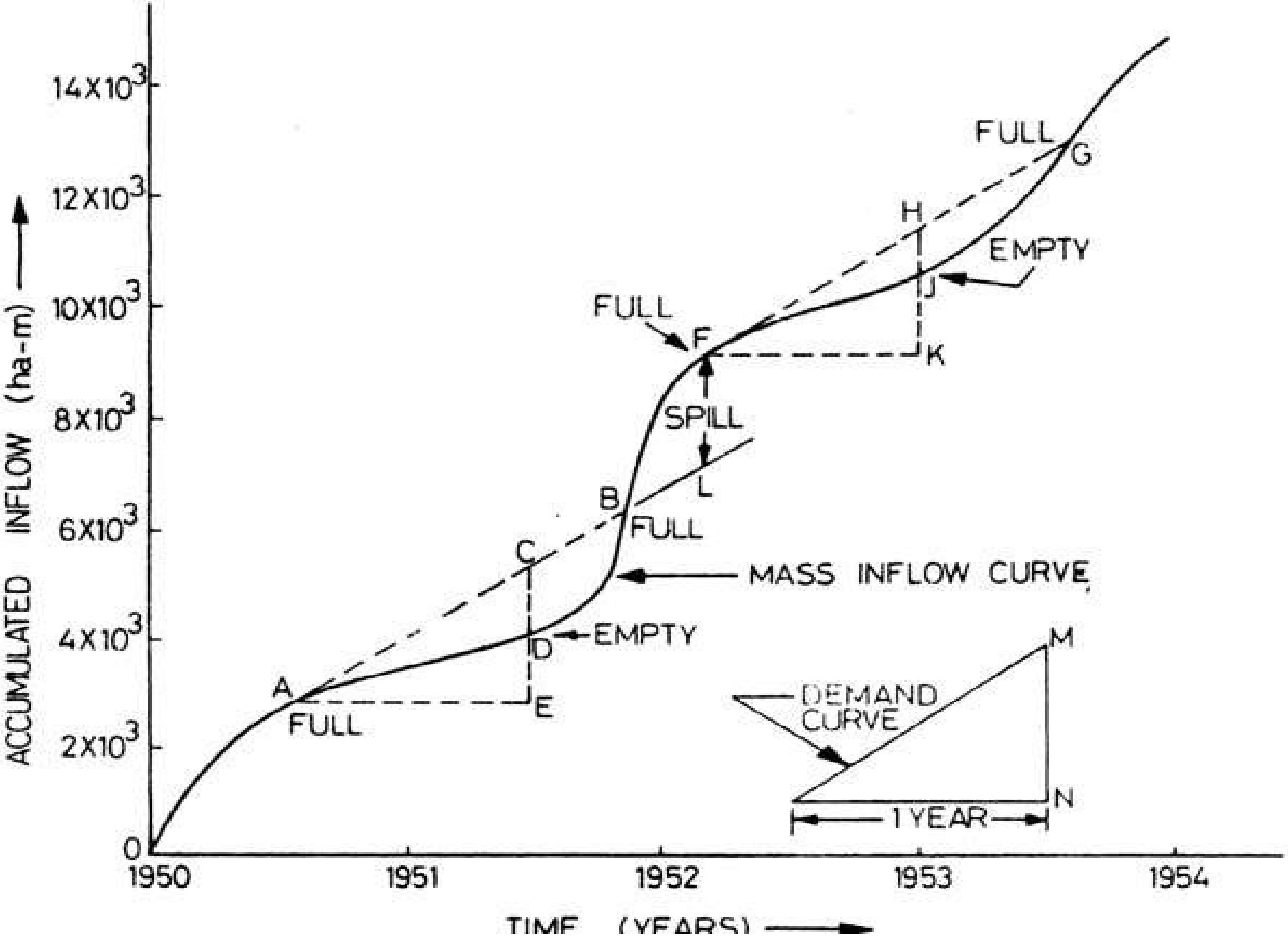
- The required capacity for a reservoir can be determined by the following methods:

1. Graphical method, using mass curves.
2. Analytical method.
3. Flow duration curve method.

Graphical method

1. Prepare a mass inflow curve from the flow hydrograph of the site for a number of consecutive years including the most critical years (or the driest years) when the discharge is low.

2. Prepare the mass demand curve corresponding to the given rate of demand. If the rate of demand is constant, the mass demand curve is a straight line. The scale of the mass demand curve should be the same as that of the mass inflow curve.



14X10^3
12X10^3
10X10^3
8X10^3
6X10^3
4X10^3
2X10^3
0
ACCUMULATED INFLOW (ha-m)
1950
1951
1952
1953
1954
TIME (YEARS)
FULL
G
H
EMPTY
J
FULL
F
K
SPILL
L
B
FULL
C
MASS INFLOW CURVE
EMPTY
D
A
E
FULL
M
DEMAND CURVE
N
1 YEAR

3. Draw the lines *AB, FG, etc. such that*

- ✓ They are parallel to the mass demand curve, and
- ✓ They are tangential to the crests A, F, etc. of the mass curve.

4. Determine the vertical intercepts CD. HJ, etc. between the tangential lines and the mass inflow curve. These intercepts indicate the volumes by which the inflow volumes fall short of demand.

Assuming that the reservoir is full at point A, the inflow volume during the period AE is equal to ordinate DE and the demand is equal to ordinate CE. Thus the storage required is equal to the volume indicated by the intercept CD.

5. Determine the largest of the vertical intercepts found in Step (4). The largest vertical intercept represents the storage capacity required.

- The following points should be noted.

  - The capacity obtained in the net storage capacity which must be available to meet the demand. The gross capacity of the reservoir will be more than the net storage capacity. It is obtained by adding the evaporation and seepage losses to the net storage capacity.

- ✓ The tangential lines AB, FG; etc. when extended forward must intersect the curve. This is necessary for the reservoir to become full again, If these lines do not intersect the mass curve, the reservoir will not be filled again. However, very large reservoirs sometimes do not get refilled every year. In that case, they may become full after 2-3 years.

- ✓ The vertical distance such as FL between the successive tangents represents the volume of water spilled over the spillway of the dam.

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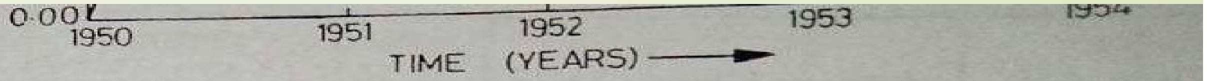


Fig. 7.13

Illustrative Example 7·2 *The age annual discharge of a river l years is as follows:*

Year	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*	*1969*	*19*
arge (cumecs)	*1750*	*2650*	*3010*	*2240*	*2630*	*3200*	*1000*	*950*	*1200*	*4150*	*35*

Determine the storage capacity required to meet a demand of 2000 cumecs throughout the ye

Solution 1 cumec - year = 1 × 365 × 24 × 60 × 60 = 31·536 × $10^6 m^3$ = 3153·6ha-m

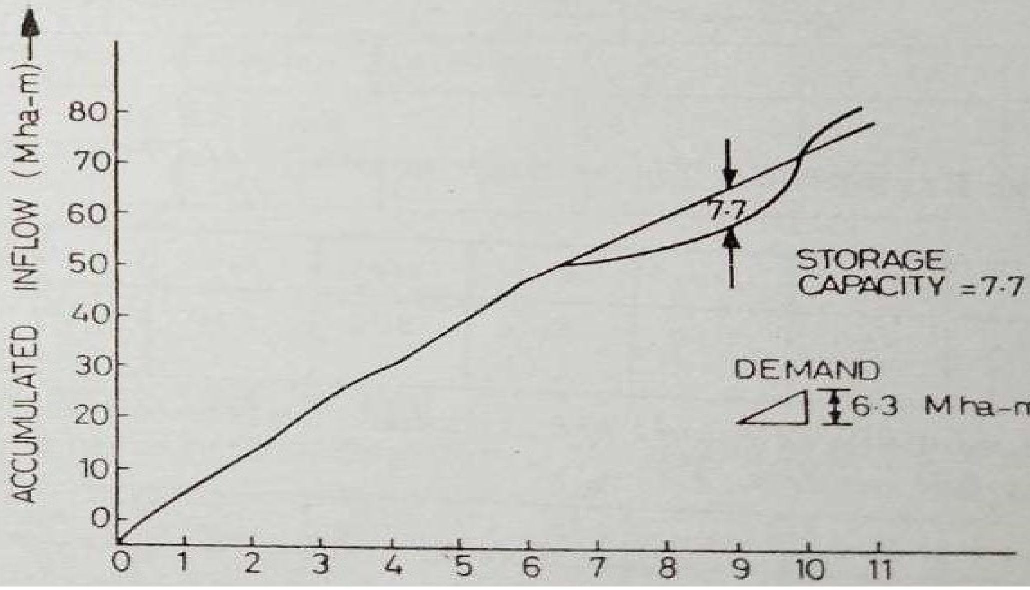
Yearly demand = 3153·6 × 2000 = 6·31 Mha-m

Inflow volume in 1960 = 1750 × 3153·6 = 5·52 × 10^6 ha-m = 5·52 Mha-m

The inflow volume and cumulative inflow are calculated in the table below:

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	19
rge (cumecs)	1750	2650	3010	2240	2630	3200	1000	950	1200	4150	35
volume Iha-m)	5·52	8·35	9·49	7·06	8·29	10·09	3·15	3·00	3·78	13·09	11·
ative inflow Iha-m)	5·52	13·87	23·36	30·42	38·71	48·80	51·95	54·95	58·73	71·82	82·

Fig· 7·14 shows the mass inflow The tangents are drawn at the at the slope of 6·31 Mha-m ar. The maximum intercept is ha-m. Storage capacity = 7·7 ı.



llustrative Example 7·3 *The from a catchment area during sive months in a year is given Determine the maximum y of the reservoir required entire volume of water is to wn off at a uniform rate, any loss of water over the*

th	*Jan*	*Feb*	*Mar*	*April*	*May*	*June*	*July*	*Aug*	*Sept.*	*Oct.*	*Nov.*
ff n^3)	*1·3*	*2·0*	*2·70*	*8·50*	*12·0*	*12·0*	*19·0*	*22·0*	*2·50*	*2·20*	*1·90*

Solution Total inflow = 1.30 + 2.0 + ... + 1.70 = 87.8 Mm^3

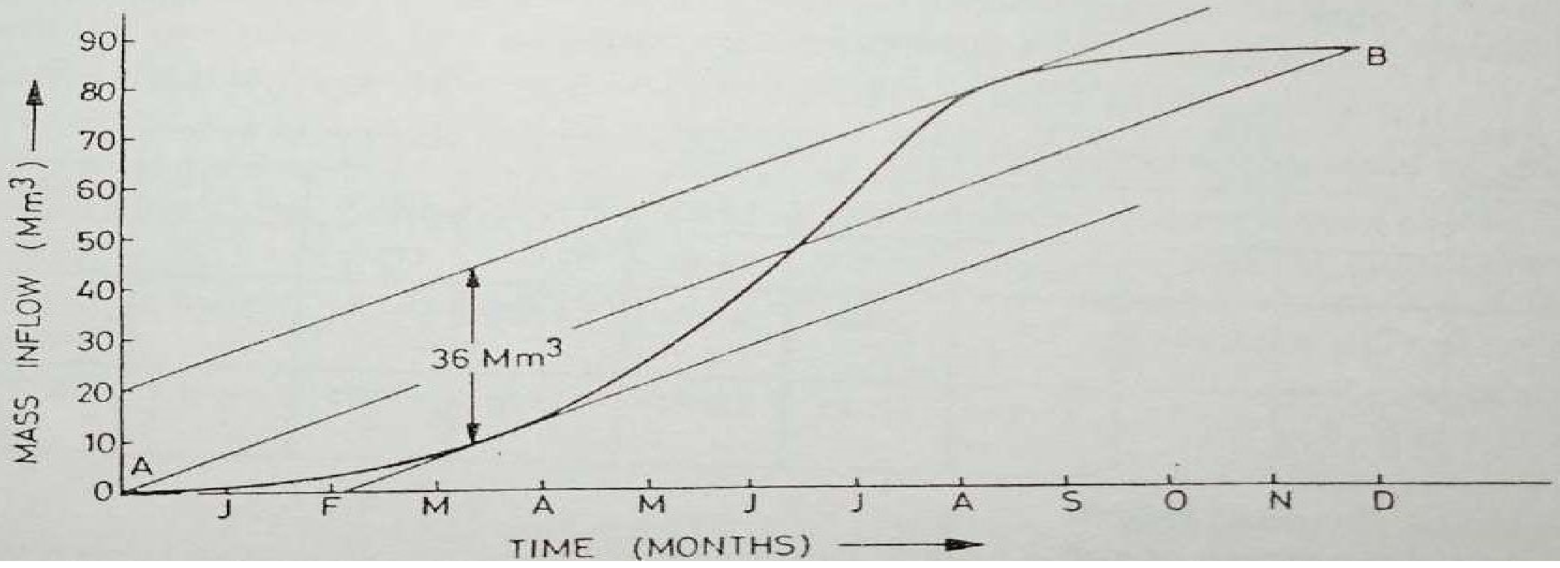
For no wastage, monthly yield = 87·8/12 = 7·32 Mm^3

The cumulative inflow is calculated in the table below.

h	*Jan*	*Feb*	*Mar*	*April*	*May*	*June*	*July*	*Aug*	*Sept.*	*Oct.*	*Nov.*
ılative v)	1·3	3·30	6·00	14·50	26·50	38·50	57·50	79·50	82·00	84·20	86·10

Fig· 7·15 shows the mass inflow curve. The tangents are drawn at the crest and at the dep
lel to the average demand line at a slope of 7·32 Mm^3/month. The vertical intercept between t
ents is 36 Mm^3.

Required capacity = 36·0 Mm^3



Analytical method

- Capacity of the reservoir is determined from the net inflow and demand.
- Storage is required when the demand exceeds the net inflow.
- The total storage required is equal to the sum of the storage required during the various periods.

1. Collect the stream flow data at the reservoir site during the critical dry period. Generally, the monthly inflow rates are required. However, for very large reservoirs, the annual inflow rates may be used.

2. Ascertain the discharge to be released downstream to satisfy water rights or to honour the agreement between the states or the cities.

3.Determine the direct precipitation volume falling on the reservoir during the month.

4.Estimate the evaporation losses which would occur from the reservoir „The panevaporation data are normally used for the estimation of evaporation losses during the month.

5. Ascertain the demand during various months.

6.Determine the adjusted inflow during different months as follows:

Adjusted inflow = Stream inflow + Precipitation - Evaporation – Downstream Discharge

7.Compute the storage capacity for each months.

Storage required = Adjusted inflow – Demand

8.Determine the total storage capacity of the reservoir by adding the storages required found in Step 7.

Safe yield

- Yield is the volume of water which can be withdrawn from a reservoir in a specified period of time.

- Safe yield is the maximum quantity of water which can be supplied from a reservoir in a specified period of time during a critical dry year.

- **Secondary yield:** is the quantity of water which is available during the period of high flow in the rivers when the yield is more than the safe yield.

- **Average yield:** The average yield is the arithmetic average of the firm yield and the secondary yield over a long period of time.

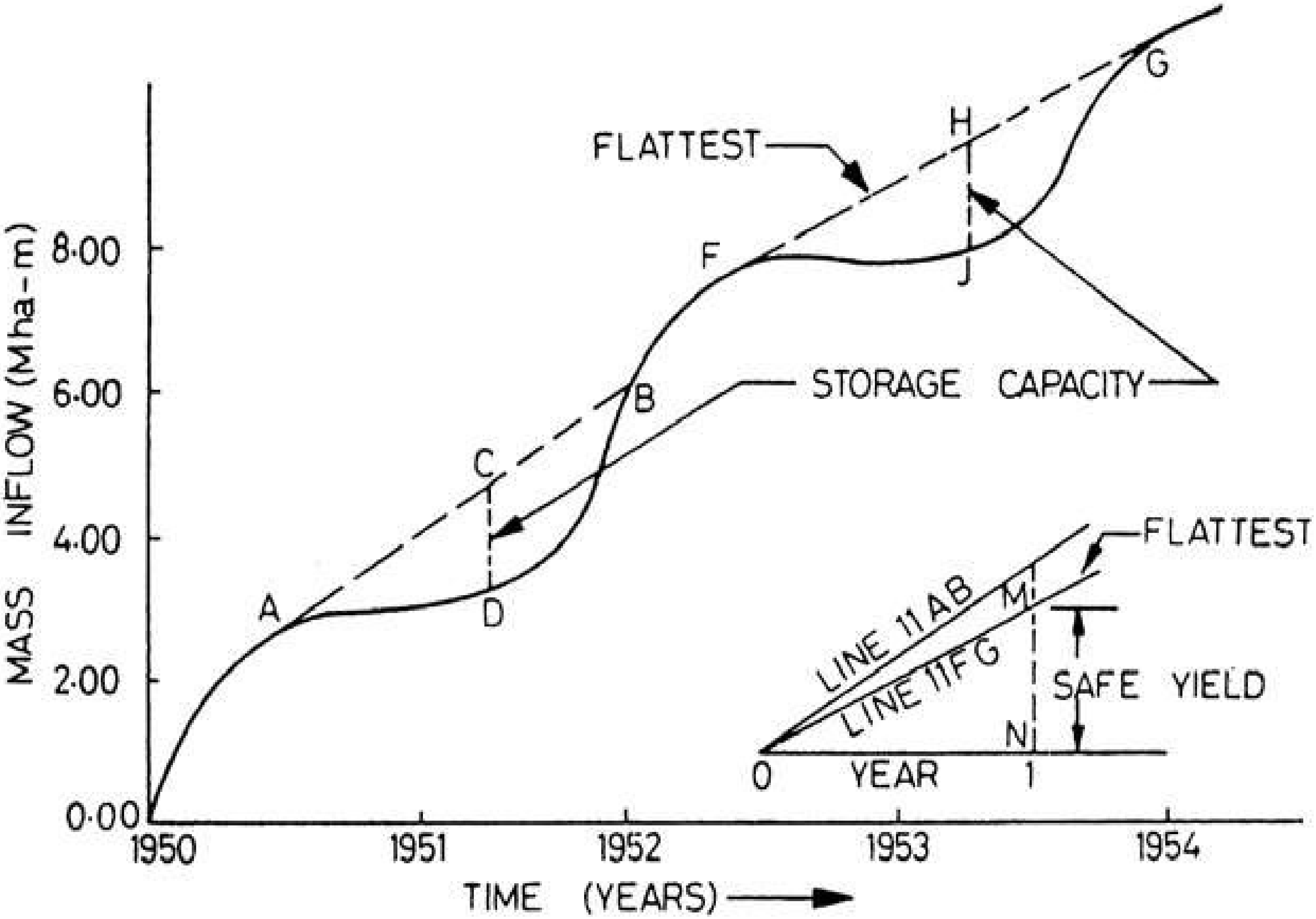
- **Design yield:** The design yield is the yield adopted in the design of a reservoir. The design yield is usually fixed after considering the urgency of the water needs and the amount of risk involved.

Determination of Yield of a Reservoir

- The yield from a reservoir of a given capacity can be determined by the use of the mass inflow curve

1.Prepare the mass inflow curve from the flow hydrograph of the river.

2.Draw tangents AB, FG, etc. at the crests A, F, etc. of the mass inflow curve in such a way that the maximum departure (intercept) of these tangents from the mass inflow curve is equal to the given reservoir capacity.


FLATTEST
H
G
F
J
8·00
6·00
4·00
2·00
0·00
MASS INFLOW (Mha-m)
B
STORAGE CAPACITY
C
D
A
FLATTEST
LINE 11 AB
LINE 11 FG
M
SAFE YIELD
N
0
YEAR
1
1950
1951
1952
1953
1954
TIME (YEARS)

3. Measure the slopes of all the tangents drawn in Step 2.

4. Determine the slope of the flattest tangent.

5. Draw the mass demand curve from the slope of the flattest tangent (see insect). The yield is equal to the slope of this line

1. The major resisting force in a gravity dam is:
Water pressure
Wave pressure
Self weight of the dam
Uplift pressure

2.The water stored in the reservoir below the minimum pool level is called
Useful storage
Dead storage
Valley storage
Surcharge storage

3. The temporary dam constructed for dewatering the area tofacilitates the execution of foundation work is known as
Detention dam
Diversion dam
Coffer dam
Storage dam

4. Steel dam offer more resistance to catastrophic failure due to
Ground settlement
Sliding
Overturning
Tension

5. The main advantage of arch dam is
Minimum depth
Minimum length
Maximum span
Minimum width

6. For wave action in dams, the height of freeboard is generally taken to be equal to
0.5hw
0.75hw
1.25hw
1.50hw

7. The availability of water over certain period is known as
Discharge
Assured flow
Run flow
Yield

8. When the height of the dam exceeds 15m, then it is termed as
Small dam
Saddle dam
Large dam
Tailing dam

9. Storage capacity of small dam is less than m3
106
104
206
305

10. A major dam project has hydraulic head equal to
0.5Mm3
More than 60
10
10-60

11. A medium dam project has hydraulic head equal to
12 to 30m
12m
7.5m
More than 30m

12. The water stored between the zone of minimum pool level and normal pool level is known as
Valley storage
Dead storage
Surcharge storage
Live storage

13. The water stored temporarily in zone between normal pool level and maximum pool level is known as
Dead storage
Live storage
Valley storage
Surcharge storage

14. The hirakud dam is build across which river
Saraswati
Mahanadi
Godavari
Kaveri

15.Which is the highest , longest dam in india
Tehri
Bhakranangal
Hirakud
Koyna

16. When the reservoir is full, the maximum compressive force in a gravity dam is produced
At the heel
At the toe
At the centre of base
At centre of height