**DAMS CONSTRUCTION**

**Introduction:**

A dam is a barrier or a large waterproofing device built and installed on a watercourse.

Contain a huge amount of water and then regulate the flow of water.

It would hold water on the upstream side of the system.

The reservoir is the water held by such a large system.

A dam is an artificial barrier that impounds surface water derived from a small or wide field.

Attraction.It may be also a subsurface dam to store underground water.

The mass of water stored at upstream side of the dam is called as reservoir.

Reservoirs created by dams not only controls floods but also provide water for several human

activities .

They are irrigation, human consumption, industrial use, aquaculture, recreation, power generation,

and navigability. Hydropower is often used in conjunction with dams to generate electricity.

A dam can also be used to collect and store water which can be evenly distributed between

locations, through canals or pipelines.

Dams generally serve the primary purpose of retaining water, while other structures such as

floodgates or levees (also known as dikes) are used to manage or prevent water flow into specific land

regions.

**2. Benefits provided by dams**

Benefits provided by dams include water supplies for drinking, irrigation and industrial uses; flood

control; recreation; and navigation. At the same time, dams also represent a risk to public safety.

Man-made dams are typically classified according to their size (height), intended purpose or

structures.

1Dams provide a wide range of economic, environmental, and social benefits. The following are the

major benefits:

• **Water Storage (Fire & Farm Ponds)**

Dams create reservoirs that supply water for many uses, including industrial, municipal, and

agricultural.

• **Irrigation**

A major part of dam water is used for irrigation. Most of the cropland is irrigated using water

stored behind dams.

• **Electrical Generation**

Hydropower is considered to be clean source form dams because it does not contribute to

global warming, air pollution, acid rain, or ozone depletion.

• **Recreation is one of the benefits**

Dams provide prime recreational facilities like Boating, skiing, camping, picnic areas, and

boat launch facilities.

• **Flood Control**

In addition to helping farmers, dams help prevent the loss of life and property caused by

flooding. Flood control dams impound floodwaters and then either release them under control

to the river below the dam or store or divert the water for other uses.

• **Debris Control**

In some instances, dams provide enhanced environmental protection, such as the retention of

hazardous materials and detrimental sedimentation.

• **Inland Navigation**

Dams and locks provide for a stable system of inland river transportation.

**3 . Parts of a Dam:**

• Heel is the contact with the ground on the upstream side

• Toe is the contact on the downstream side.

• Abutments are the s Sides of the valley on which the structure of the dam rests.

• Galleries are small rooms like structure left within the dam for checking operations.

• Diversion tunnels are tunnels constructed for diverting water before the construction of dam.

This helps in keeping the river bed dry.

• Spillways are the arrangement near the top of the dam to release the excess water of the reservoir

to downstream side.

2• Sluice way is an opening in the dam near the ground level, which is used to clear the silt

accumulation in the reservoir side.

**4 . Dams classified based on Purpose:**

1. Storage Dam Or Impounding Dam

2. Detention Dam

3. Diversion Dam

4. Coffer Dam and

5. Debris Dam.

**Storage Dam or Impounding Dam**

It is constructed to create a reservoir to store water during periods when there is huge flow in the river

(in excess of demand) for utilisation later during periods of low flow (demand exceeds flow in the

river). Water stored in the reservoir is used for irrigation, power generation, water supply etc.

By suitable operation, it can also serve as a detention dam.

**Detention Dam:**

It is primarily constructed to temporarily detain all or part of the flood water in a river and to

gradually release the stored water later at controlled rates so that the entire region on the downstream

side of the dam is protected from possible damage due to floods. It may also be used as a storage dam.

**Diversion Dam:**

It is constructed to divert part of or all the water from a river into a conduit or a channel.

For diverting water from a river into an irrigation canal, mostly a diversion weir is constructed across

the river.

**Coffer Dam:**

It is a temporary dam constructed to exclude water from a specific area.

It is constructed on the u/s side of the site where a dam is to be constructed so that the site is dry.

In this case, it behaves like a diversion dam.

**Debris Dam:**

It is constructed to catch and retain debris flowing in a river.

**5 . Dams Classified Based on Hydraulic Designs:**

**Overflow Dam or Overfall Dam**

It is constructed with a crest to permit overflow of surplus water that cannot be retained in the

reservoir.

Generally dams are not designed as overflow dams for its entire length.

Diversion weirs of small height may be designed to permit overflow over its entire length.

**Non-Overflow Dam :**

It is constructed such that water is not allowed to overflow over its crest.

In most cases, dams are so designed that part of its length is designed as an overflow dam (this part is

called the spillway) while the rest of its length is designed as a non-overflow dam. In some cases,

these two sections are not combined.

**6. Dams Classified Based on Material of Construction**

**Rigid Dam:**

It is constructed with rigid material such as stone, masonry, concrete, steel, or timber. Steel dams

(steel plates supported on inclined struts) and timber dams (wooden planks supported on a wooden

framework) are constructed only for small heights (rarely).

3**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 downstream 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.

**7. Dams Classified Based on Structure**

Based on structure and material used, dams are classified as easily created without materials, arch

gravity dams, embankment dams or masonry dams, with several subtypes.

**Arch Dams:**

It is a curved masonry or concrete dam, convex upstream, which resists the forces acting on it by arch

action.

The only arch dam in India is the Idukki dam (double curvature in plan). It is a concrete arch dam.

•The Arch shape gives good strength to these types of dams.

•They consume less material (cheaper)

•They use very narrow sites.

•They need strong abutments.

•These type of dams are concrete or masonry dams which are curved or convex upstream in plan

•This shape helps to transmit the major part of the water load to the abutments.

•Arch dams are built across narrow, deep river gorges, but now in recent years they have been

considered even for little wider valleys.

•Good for narrow, rocky locations.

•They are curved and the natural shape of the arch holds back the water in the reservoir.

•Arch dams, like the El Atazar Dam in Spain, are thin and require less material than any other type of

dam.

**Gravity Dams:**

It is a masonry or concrete dam which resists the forces acting on it by its own weight. Its cross

section is approximately triangular in shape.

Straight gravity dam – A gravity dam that is straight in plan.

Curved gravity plan – A gravity dam that is curved in plan. in this type of dam it resists the forces

acting on it by combined gravity action (its own weight) and arch action.

Solid gravity dam – Its body consists of a solid mass of masonry or concrete.

Hollow gravity dam – It has hollow spaces within its body.

Most gravity dams are straight solid gravity dams.

**Concrete Gravity Dams**

•Weight holds dam in place.

•Lots of concrete (expensive). These dams are heavy and massive wall-like structures of concrete in

which the whole weight acts vertically downwards.

As the entire load is transmitted on the small area of foundation, such dams are constructed where

rocks are competent and stable.

4•Bhakra Dam is the highest Concrete Gravity dam in Asia and the second highest in the world.

•Bhakra Dam is across river Sutlej in Himachal Pradesh.

•The construction of this project was started in the year 1948 and was completed in 1963 .

•It is 740 ft. high above the deepest foundation as straight concrete dam being more than three times

the height of Qutab Minar.

•Length at top 518.16m (1700 feet); width at base 190.5m (625 feet), and at the top is 9.14m (30 feet)

•Bhakra Dam is the highest Concrete Gravity dam in Asia and Second Highest in the world.

**Arch-gravity dams:**

These are of mixed composition of both gravity and arch dams.

**Buttress Dam:**

It consists of water retaining sloping membrane or deck on the u/s which is supported by a series of

buttresses.

These buttresses are in the form of equally spaced triangular masonry or reinforced concrete walls or

counterforts.

The sloping membrane is usually a reinforced concrete slab.

In some cases, the u/s slab is replaced by multiple arches supported on buttresses (multiple arch

buttress dam) or by flaring the u/s edge of the buttresses to span the distance between the buttresses

(bulkhead buttress dam or massive head buttress dam). In general, the structural behaviour of a

buttress dam is similar to that of a gravity dam.

1. Face is held up by a series of supports.

2. Flat or curved face.

3. Buttress Dam – Is a gravity dam reinforced by structural supports.

4. Buttress – a support that transmits a force from a roof or wall to another supporting structure.

5. This type of structure can be considered even if the foundation rocks are little weaker.

**Barrages:**

A barrage dam is a special kind of dam which consists of a line of large gates that can be opened or

closed to control the amount of water passing the dam.

The gates are set between flanking piers which are responsible for supporting the water load, and are

often used to control and stabilize water flow for irrigation systems.

Barrages that are built at the mouths of rivers or lagoons to prevent tidal incursions or utilize the tidal

flow for tidal power are known as tidal barrages.

**Embankment dams :**

These are Earth Dams. They are trapezoidal in shape.

Earth dams are constructed where the foundation or the underlying material or rocks are weak to

support the masonry dam or where the suitable competent rocks are at greater depth.

•Earthen dams are relatively smaller in height and broad at the base.

They are mainly built with clay, sand and gravel, hence they are also known as Earth fill dam or Rock

fill dam.

Embankment dams are also armed with a dense, waterproof core that prevents water from seeping

through the structure.

It is a non-rigid dam which resists the forces acting on it by its shear strength and to some extent also

by its own weight (gravity). Its structural behaviour is in many ways different from that of a gravity

dam.

**8. Dams are classified based on material:**

The dams are classified based on material include:

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1. Steel dams and

2. Timber dams.

The miscellaneous types of Dams include

a) Natural dams

b) Beaver dams.

There are many ways in which natural lakes and their dams can form in nature. Natural dams have

many economic benefits, including hydropower generation and recreation, but also can constitute

serious hazards.

In the last one hundred years, a number of catastrophic events associated with rockslide dam

formation and failure have occurred in the mountain regions of the world. Most of them happened in

the natural dams only. Natural dams may cause upstream flooding as the lake rises and downstream

flooding as a result of failure of the dam.

**Beaver dams** are **dams** built by **beavers** to provide ponds as protection against predators such as

coyotes, wolves, and bears, and to provide easy access to food during winter. Beavers and their dams

play an important role in nature. Because of the dramatic effects their dams have on surrounding

ecosystems, these mammals are considered a **keystone species**.

By constructing dams they create **wetlands** -- lush environments which attract fish, ducks, frogs and

other creatures. Beaver dams are common in forested areas of western Canada. Beavers construct

dams of sticks and mud. Breaches in the dams are continuously repaired by the beaver while local

food supplies (the inner bark of deciduous trees) last - usually six to ten years.

**There is also a technical classification of dams. It is based on three factors.**

**Class of Dam**

**Maximum Depth**

**of Water at NWL (m)**

**Impoundment**

**at NWL (*m*3)**

**Catchment Area (*km*2)**

A (Low Hazard)

0 - 4.99

<100,000

<100

B (Medium Hazard) 5.00 - 14.99

100,000 to 1,000,000

100 to 1,000

C (High Hazard)

>15.00

>1,000,000

>1,000

NWL = Normal Water Level

When using the table above, it is important to note that only one factor is necessary to place a dam

into a higher hazard class.

For example, a 3m deep reservoir with 20,000 cubic meters of storage and a 1,500 square kilometre

catchment area would classify as a high hazard dam due to its large catchment area.

Similarly, a 15.5m tall mass gravity wall with 25,000 cubic meters of storage and a 3 square kilometre

catchment area would be a high hazard dam due to the maximum water depth.

**9 . Causes of Dam Failure:**

This itself is a different topic. Dam failures are of particular concern because the failure of a large

dam has the potential to cause more death and destruction than the failure of any other man-made

structure.

This is because of the destructive power of the flood wave that would be released by the sudden

collapse of a large dam. In general, a failure results in the release of large quantities of water, posing

serious risks for the people or property downstream.

Failure of earth dams may be:

1.Hydraulic Failure

2.Seepage Failure

3.Structural Failure7

The following are some of the reasons for dam failure:

1. Overtopping of embankment dams due to inadequate spillway discharge capacity to pass

flood waters.

2. Faults in construction methods (eg inadequate compaction of fill) or use of the wrong type of

construction materials.

3. Geological problems with the dam foundation.

4. Landslides which fall into the storage reservoir

5. Earthquakes can certainly cause damage to dams.

1. The causes of Hydraulic Failure includes these factors:

• 1.Overtopping of dams.

• 2.Erosion of the Upstream Surface

• 3.Erosion of the Downstream Surface

• 4.Erosion of the Downstream toe.

2. Seepage Failure:

3. Structural Failure: Slip failure in Dams - Structural failure . Failure due to sliding of foundation.

4. Damage due to burrowing animals

5. Failure of dam due to earthquake or neotectonic movements.

**10. Causes of failure in percentage**:

A survey has shown the following percentages due to various factors of failures.

Foundation problems 40 %

Inadequate spillway

23 %

Poor construction

12 %

Uneven settlement

10 %

High pore pressure

5 %

Acts of war

3 %

Embankment slips

2 %

Defective materials

2 %

Incorrect operations

2 %

Earthquakes

1 %

The major part lies in the foundation, where in the role of geology plays a dominant factor.

The geological investigations of dam site selection is a major part in engineering geology and

construction of dams.

**11. Conclusion:**

In ancient times, dams were built for the single purpose of water supply or irrigation. As civilizations

developed, there was a greater need for water supply, irrigation, flood control, navigation, water

quality, sediment control and energy. Therefore, dams are constructed for a specific purpose such as

water supply, flood control, irrigation, navigation, sedimentation control, and hydropower. The

demand for water is steadily increasing throughout the world. There is no life on earth without water,

our most important resource apart from air and land.

For almost 5 000 years dams have served to ensure an adequate supply of water by storing water in

times of surplus and releasing it in times of scarcity, thus also preventing or mitigating floods.

Most of the dams are single-purpose dams, but there is now a growing number of multipurpose dams.

If the dams are not properly constructed, there will be a severe disaster in the downstream regions of

dams.

This lesson highlighted the different general aspects of dams, their types and the causes of their

failures.