UNIT 5

INTRODUCTION TO BUILDINGS

Elements of Building

The basic components of a building structure are the **foundation, floors, walls, beams, columns, roof, stair,** etc. These elements serve the purpose of supporting, enclosing and protecting the building structure.

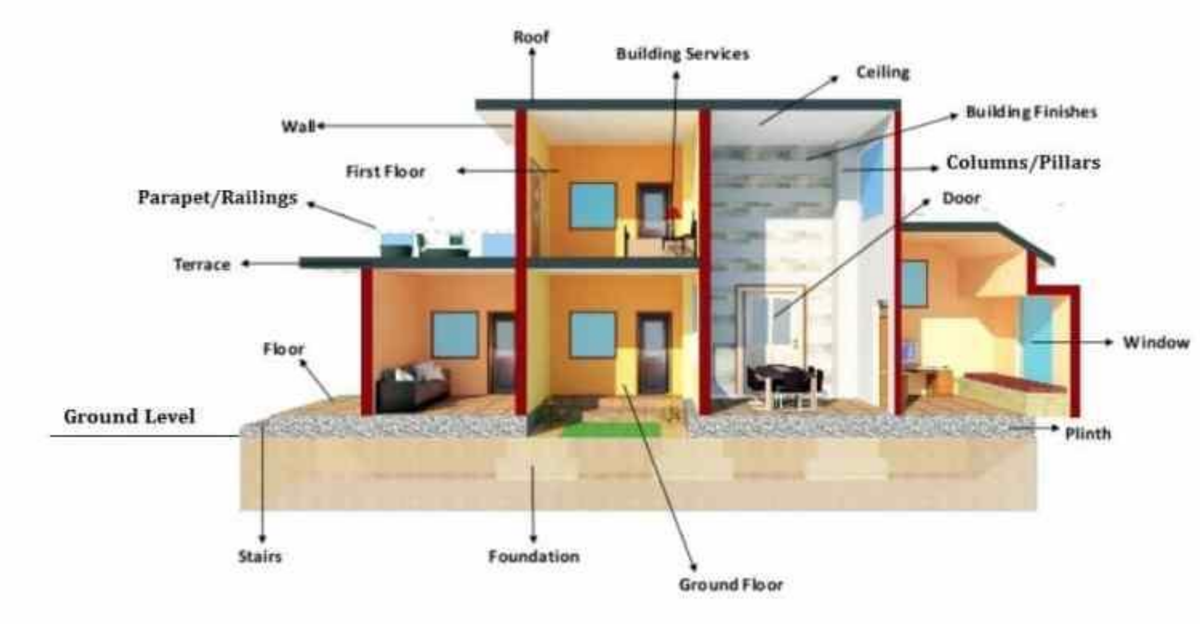


Fig.1. Basic Components of a Building

- Mentioned below are the 12 basic components a building structure.
  1. Roof
  2. Parapet
  3. Lintels
  4. Beams
  5. Columns
  6. Damp proof course (DPC)
  7. Walls
  8. Floor
  9. Stairs
  10. Plinth Beam
  11. Foundation
  12. Plinth

1. Roof

The roof forms the topmost component of a building structure. It covers the top face of the building. Roofs can be either flat or sloped based on the location and weather conditions of the area.

2. Parapet

Parapets are short walls extended above the roof slab. Parapets are installed for flat roofs. It acts as a safety wall for people using the roof.

3. Lintels

Lintels are constructed above the wall openings like doors, windows, etc. These structures support the weight of the wall coming over the opening. Normally, lintels are constructed by reinforced cement concrete. In residential buildings, lintels can be either constructed from concrete or from bricks.

4. Beams and slabs

Beams and slabs form the horizontal members in a building. For a single storey building, the top slab forms the roof. In case of a multi-storey building, the beam transfers the load coming from the floor above the slab which is in turn transferred to the columns. Beams and slabs are constructed by reinforced cement concrete (R.C.C).

5. Columns

Columns are vertical members constructed above the ground level. Columns can be of two types: Architectural columns and structural columns. Architectural columns are constructed to improve the building's aesthetics while a structural column takes the load coming from the slab above and transfers safely to the foundation.

6. Damp Proof Course (DPC)

DPC is a layer of waterproofing material applied on the basement level to prevent the rise of surface water into the walls. The walls are constructed over the DPC.

7. Walls

Walls are vertical elements which support the roof. It can be made from stones, bricks, concrete blocks, etc. Walls provide an enclosure and protect against wind, sunshine, rain etc. Openings are provided in the walls for ventilation and access to the building.

8. Floors

The floor is the surface laid on the plinth level. Flooring can be done by a variety of materials like tiles, granites, marbles, concrete, etc. Before flooring, the ground has to be properly compacted and leveled.

9. Stairs

A stair is a sequence of steps that connects different floors in a building structure. The space occupied by a stair is called as the stairway. There are different types of stairs like a wooden stair, R.C.C stair etc.

10. Plinth Beam

Plinth beam is a beam structure constructed either at or above the ground level to take up the load of the wall coming over it.

11. Plinth

The plinth is constructed above the ground level. It is a cement-mortar layer lying between the substructure and the superstructure.

12. Foundation

The Foundation is a structural unit that uniformly distributes the load from the superstructure to the underlying soil. This is the first structural unit to be constructed for any building construction. A good foundation prevents settlement of the building.

INTRODUCTION TO VARIOUS CIVIL ENGINEERING STRUCTURES

The bridge, a connecting structure, creates bonding between different disconnected parts of a country, two banks of the ocean or parts of two countries. A Bridge is a structural marvel which is generally used to pass any type of obstruction that can slow the life of people. From the very beginning, engineers were trying to win over nature and consequently, they have invented bridge structure which can use to overcome the mentioned natural obstacles.

Main Parts of a Bridge

There are different types of bridge. Different bridge type contains different parts. Followings are the main parts of a bridge:

- Deck
- Abutment
- Pile
- Pier
- Girder
- Rail Track

To give a preliminary idea of these bridge parts a brief description of each part is given below.

Deck

A deck is a fundamental part of any bridge to pass vehicle, goods, people etc. from one side to another.

Abutment

The support provided at the two ends of a bridge is known as an abutment.

Pile

For the bridge with pier, the pile is a fundamental component. Pile type foundation is generally needed when the upper soil layer is loose. Pile depth depends on the soil layer. To find the hard soil layer which will make the structure stable, the pile is usually extended to some depth into the hard soil layer.

Pier

Pier is the compression member which stay above the pile and make the structure stable. Pier generally provides for span at intermediate points.

Piers perform two main functions:

- Transferring superstructure vertical loads to the foundation.
- Resisting to the horizontal forces acting on the bridges.

For bridge pier to pier, distance is the span. Water pressure is the extra pressure which acts onto the pier laterally.

Girder (Box or I-joist)

Just like the beam, girder is used in the bridge. It can be two types I-joist and Box. This name has been given because of their shape. I-joist girder type is commonly used in bridges. Box girder can be precast or cast in place and it is generally existing in prestressed condition.

Rail Track

Normally Road traffic is the main vehicle onto the bridge but if the train needs to be passed through that bridge rail track is the extra component.

Types of Bridges

Followings are the main types of bridges.

- Truss Bridge
- Arch Bridges
- Suspension Bridges
- Cable-Stayed Bridges
- Slab Bridges
- Box Girder Bridges

A brief description of these bridge types is given below.

Truss Bridges

Bridges with truss are made by steel two force member with only tension and compression. No bending moment is allowed in this structure. Most stable structural shape for truss is triangular.

Arch Bridges

Arch bridge mainly exists in compression. Utilizes an aerodynamic system with torsional rigidity.

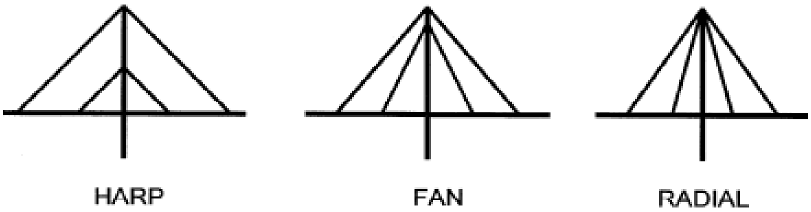
Suspension Bridges

In suspension bridges, long spans can be provided which is essential in many situations. It gives freedom to the engineer to provide a long span with the help of a cable. Followings are the Basic components of a suspension bridge Structural system:

- Stiffening Girder/ Trusses: Longitudinal structures support and distribute moving vehicle loads. Secure aerodynamic stability of the structure.
- Main Cables: Main cables are connected to girders through hanger rope. These hanger ropes transfer the loads from girder to the main cables. The main function of these main cables to carry these loads to the main towers.
- Main Towers: Main cables are supported by these intermediate vertical structures and transfer the total load of the bridge to the foundation.

Cable-Stayed Bridges

It has a lot of similarities to the suspension bridge. But there are few differences between a suspension bridge and cable-stayed bridge. In this case, bridge mainly carries the vertical loads acting on the girder. The purpose of the stay cables is to provide intermediate support for the girder and it helps to span a long distance.



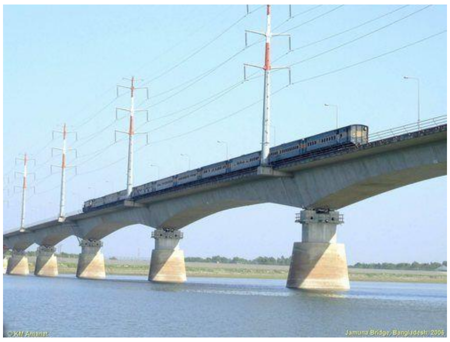
Slab Bridges

It is the most common type of bridge. Use in every place where the span is not so long.

Box Girder Bridges

It's a box type girder different from normal I girder and it can easily resist more amount of torsion. This type of bridge contains top deck, vertical web, bottom slab. Box girder bridge can be subdivided into three basic categories:

1. Single cell box.
2. Multicell box.
3. Box with struts supporting a cantilever deck.



Retaining Walls

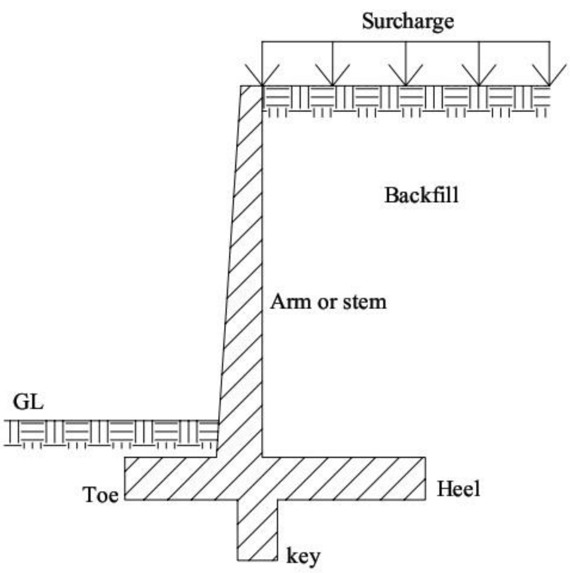
Retaining wall is a structure that retain (holds back) any material (usually earth) and prevents it from sliding or eroding away. It is designed so that to resist the material pressure of the material that it is holding back.

Types of Retaining Wall

An earth retaining structure can be considered to have the following types:

1. Gravity Walls
    - Reinforced Gravity Walls
        1. Concrete Cantilever retaining wall
        2. Counter-fort / Buttressed retaining wall
        3. Precast concrete Ret wall
        4. Pre-stressed retaining wall
2. Brick
    - Brick Masonry retaining wall
3. Stone
4. Reinforced Soil Walls
    - Reinforced Soil
    - Soil Nailing
5. Hybrid System
    - Anchored Earth ret wall
    - Tailed Gabion
    - Tailed Concrete Block
    - Miscellaneous

Gravity Retaining Walls



Retaining Wall

Gravity retaining walls relies on their huge weight to retain the material behind it and achieve stability against failures. Gravity Retaining Wall can be constructed from concrete, stone or even brick masonry. Gravity retaining walls are much thicker in section. Geometry of these walls also help them to maintain the stability. Mass concrete walls are suitable for retained heights of up to 3 m. The cross-section shape of the wall is affected by stability, the use of space in front of the wall, the required wall appearance and the method of construction.

Reinforced Retaining Walls

Reinforced concrete and reinforced masonry walls on spread foundations are gravity structures in which the stability against overturning is provided by the weight of the wall and reinforcement bars in the wall.

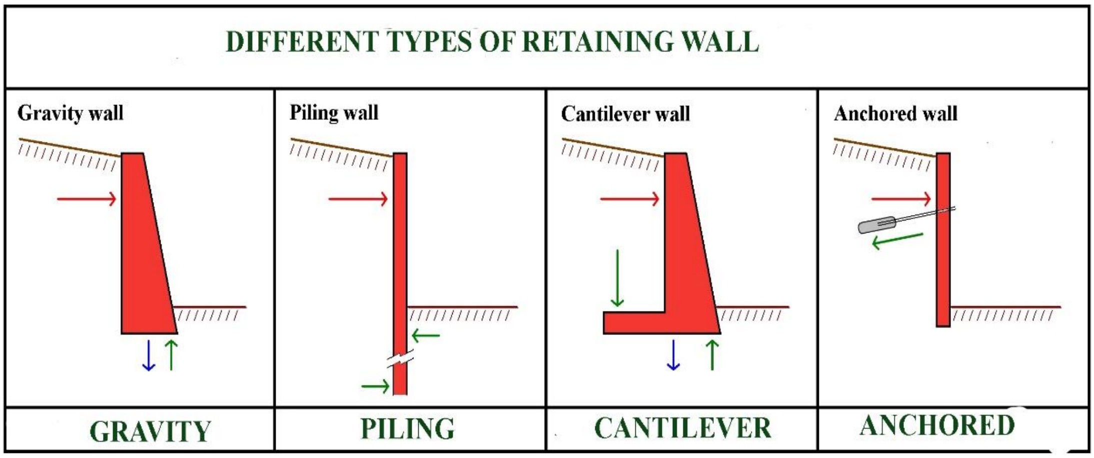
The following are the main types of wall:

Concrete Cantilever retaining wall

A cantilever retaining wall is one that consists of a wall which is connected to foundation. A cantilever wall holds back a significant amount of soil, so it must be well engineered. They are the most common type used as retaining walls. Cantilever wall rest on a slab foundation. This slab foundation is also loaded by back-fill and thus the weight of the back-fill and surcharge also stabilizes the wall against overturning and sliding.

Counter-fort / Buttressed retaining wall

Counterfort walls are cantilever walls strengthened with counter forts monolithic with the back of the wall slab and base slab. The counter-forts act as tension stiffeners and connect the wall slab and the base to reduce the bending and shearing stresses. To reduce the bending moments in vertical walls of great height, counterforts are used, spaced at distances from each other equal to or slightly larger than one-half of the height Counter forts are used for high walls with heights greater than 8 to 12 m.



Precast concrete retaining wall.

Prestressed ret wall.

Reinforced Soil Retaining Wall

Mechanically stabilized earth walls are those structures which are made using steel or **GeoTextiles** soil reinforcements which are placed in layers within a controlled granular fill. Reinforced soils can also be used as retaining walls, if they are built as:

1. As an integral part of the design.
2. As an alternative to the use of reinforced concrete or other solutions on the grounds of economy or as a result of the ground conditions.
3. To act as temporary works.
4. As remedial or improvement works to an existing configuration.

This category covers walls which use soil, reinforced with reinforcing bars, to provide a stable earth retaining system and includes **reinforced soil** and **soil nailing**.

Soil Nailing

Constructing a soil nailed wall involves reinforcing the soil as work progresses in the area being excavated by the introduction of bars which essentially work in tension, called **Passive Bars**. These are usually parallel to one another and slightly inclined downward. These bars can also work partially in bending and in shear. The skin friction between the soil and the nails puts the nails in tension.

Hybrid Systems Retaining Wall

The type of retaining walls that use both factors that is their mass and reinforcement for stability are called **Hybrid** or **Composite retaining wall systems**.

Anchored Earth walls

Any wall which uses facing units tied to rods or strips which have their ends anchored into the ground is an anchored earth wall. The anchors are like abutments. The cables used for tieing are commonly high strength, pre-stressed steel tendons. To aid anchorage, the ends of the strips are formed into a shape designed to bind the strip at the point into the soil.

Tailed Gabion

Gabions are cages, cylinders, or boxes filled with earth or sand that are used in civil engineering, road-building, and military application and many others. **OR** Gabion elements fitted to geo-grid 'tails' extending into supported soil. For erosion control caged rip-rap are used. For dams or foundation building, metal structures are used.

Sheet Pile Walls

Steel sheet pile walls are constructed by driving steel sheets into a slope or excavation up to the required depth. Their most common use is within temporary deep excavations. They are considered to be most economical where retention of higher earth pressures of soft soils is required. It cannot resist very high pressure.

RESERVOIR

A **reservoir** is a large man-made body of water. Reservoirs are used to store water and can be created by building a dam across a river, or building a dam over the outlet to a lake. Reservoirs are created in order to have continuous access to water. Reservoirs have been created and used since 3000 BCE. During this time, the first reservoir was made to store water that was used for watering crops. Water levels in other bodies of water can fluctuate depending on the amount of precipitation an area receives. During times of drought, these other bodies of water, such as lakes and rivers, do not contain enough water for populations to use. However, reservoir levels are controlled, so water is typically always available for people to access and use.

Types of Reservoirs

There are three common types of reservoirs: valley-dammed, bank-side, and service. These types of reservoirs can be man-made or naturally made.

Valley-Dammed Reservoirs

Valley-dammed reservoirs are generally the largest and most common of the types of reservoirs. Like the name suggests, valley-dammed reservoirs are contained by the walls of a valley, like those found in mountain ranges. This process forms a tighter water seal than other types of reservoirs. To construct a valley-dammed reservoir, a large dam is built and water from the river is diverted into the reservoir until it is filled. This process can take years to complete. One of the primary problems with building valley-dammed reservoirs is that the valley land becomes flooded, which can change an entire ecosystem for many plants and animals. Another problem with valley-dammed reservoirs is that water is taken from other bodies of water to fill the reservoir, resulting in decreased levels of water in other natural sources.

Bank-Side Reservoirs

Bank-side reservoirs are reservoirs made by diverting water from a river or other body of water into an existing reservoir. The existing reservoir has high embankments and is typically larger than 3.7 miles in circumference. A bank-side reservoir is easier to create than a valley-dammed reservoir because there are fewer geographical requirements, such as the presence of a valley. Water inside a bank-side reservoir stays there for several months. During this time, the amount of water pollution is reduced. One of the potential problems with a bank-side reservoir is that if the dam to a bank-side reservoir collapses, flooding can cause massive amounts of destruction to surrounding areas. Another problem with reservoirs is a decreased amount of oxygen in the water.

Service Reservoirs

A service reservoir is a reservoir that is completely man-made. Service reservoirs can be built into the ground like bank-side or valley-dammed reservoirs, but they can also be above ground, like water tanks found in some cities. A service reservoir that is entirely underground is known as a cistern. A service reservoir contains water that has been purified at a water plant before being stored in the reservoir. They ensure that people have access to clean water at all times. A complication with service reservoirs, particularly those that are built in-ground, is that they must have a higher elevation than the areas they are servicing in order for the water to flow where it needs to go.

TANKS

Water tank is the generally used to store the water depends upon the requirements for the living organisms. The water is initially stored in the water tank then distributed to the living communities. Depending upon the various factors like number of people the capacity of the water tank varies.

Various water tanks used in construction

Based on the requirements the water tank is classified in to three major types which are specified below

- Resisting on ground water tank
- Under ground water tank
- Elevated water tank

Resisting on ground water tank

This is the most commonly used in the clear water reservoir and setting tanks. The concrete RCC structure is initially built on the ground surface and water is stored for the usage. The water distribution from one location to another location was done with the help of the motor pumps and sometimes distribution of water done with gravity force.

Under ground water tank

The underground water tank is the commonly used in the residential, apartments and commercial structures. The water tank structure was constructed under the ground for the specified capacity like 200000 liters, 300000 liters etc. Due to the water is exists below the ground surface distribution is takes place through the water pump system only.

Elevated water tank

The elevated type water tank systems will be commonly seen in the group of large scale of communities. In this type the water is stored above the ground level. Initially the construction of structure with beams and columns are carried out and then the water tank is made on the bare frame structure (Beams and columns). The water distribution is completely done with the help of the gravitational force only because of the water stored above the ground. The below specified figure shows the sample of elevated water tank used in the construction.

Various tank types based on the shape

The below specified are the various types of water tanks based on the shape of the structure

- Circular water tanks
- Square water tanks
- Rectangular water tanks
- Intez water tanks
- Spherical tanks
- Conical bottom type tanks
- Polygon water tanks
- Circular water tanks

Circular water tanks

The circular type of water tanks are frequently used now a day's for the elevated and underground type category. The circular shape models are made with the specified radius and diameter of the tank model. The complete reinforcement is made through the circular shape. Plate elements (slab elements) are made in the circular condition system.

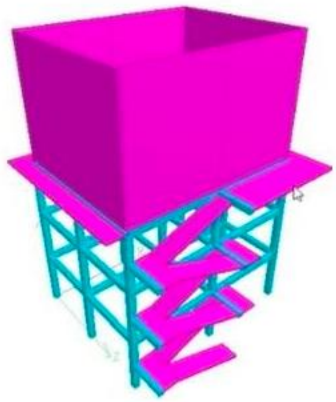
Circular water tank

Square water tank

The square water tanks are those which are having equal length and width values. This type of water tanks are also comes under the underground or elevated type structures. The full reinforcement is made at the four sides of the water tank with the equal dimensions of length and width values.

Rectangular water tank

The rectangular water tank is similar to that of the square water tank but the length and width of the structure having different values. These are also considered under elevated or underground type tanks.



Rectangular water tank

Intez water tank

Intez water tank are those in which the water tank structure is resisting on the circular beams with different radius values. The sample intez water tank 3d model is shown in the below specified figure. The most of the intez tanks are comes under the elevated category. The water distribution system will make through the gravity force in this tank.

Intez water tank

Spherical water tank

This type of the water tank under spherical shape is used in the industries. This tanks was made with steel or metal and used to store the chemicals, gases, ammonia, polypropylene, LPG ect.

Conical bottom type tanks

The conical bottom type tanks are generally used to store the chemicals, liquids, water. This type of water tanks generally has the conical shape at the bottom of the tank. The distribution of the water or liquid materials is easily done from this bottom conical tip.

Polygon water tanks

The water tanks under the polygon shapes are comes under this type of tank. In the polygon tanks the three or more sides of structure are considered. If the capacity of the water tank increases then the diameter of the structure increases in the same way number of sides in the tank also increases. The elevated, underground or resisting on ground type water tanks are considered under this type of tank.

HYDRAULIC STRUCTURES

DAMS

A dam is a structure whose building takes place across a river or stream. Holding back water is the main purpose of the dam.

TYPES OF DAMS

The types of dams can be classified according to the material of construction and according to their shape.

TYPES OF DAMS ACCORDING TO THEIR CONSTRUCTION MATERIAL

1. **Concrete dams**

They are the most commonly used as they have very good performance in terms of durability, strength, impermeability and ease of construction, as well as a relatively low price. Concrete dams can be of the conventional type or of dry consistency that can be compacted with rollers.

2. **Masonry dams**

These are usually smaller dams, which mainly employ a structure of stone, sand and cement. Their construction is usually perpendicular to the gullies - the undercuts in the ground - in order to reduce the velocity of water runoff by forming steps that reduce erosion.

3. **Loose material dams**

Due to their low cost, they are the most commonly used in developing countries. They are filled with uncemented earth, normally stones and gravel, which provide the necessary resistance to the thrust of the water. To this are added impermeable screens made of other materials.

TYPES OF DAMS ACCORDING TO THEIR SHAPE OR STRUCTURE

1. **Gravity dams**

They are known as gravity dams because it is their own weight that is responsible for resisting the thrust of the water. Normally built of concrete, which has a high density, the frictional force between the foundations and the dam is very high and is thus responsible for preventing sliding due to the thrust of the water. It is **very important that the soil is very stable** as it is responsible for supporting the weight of both the dam itself and the reservoir. For this reason, their shape resembles that of an isosceles triangle, the width of the base is usually around 80% of the height, and they can have a straight or curved axis.

2. **Arch Dams**

As the name suggests, in this type of dam the predominant shape is that of an arch, and it is precisely its curvature that resists the thrust of the water. It is important that a very high-strength material is used in the abutments of the downstream boundary - the sides of the dam - as this is where the greatest stress is produced. For this reason, **this type of dam is limited by the topographical conditions**, the more symmetrical the better, and by the orographic conditions of the terrain. In turn, there are two other types of arch dams:

- **The dams with vaults or double arches**, in which, due to their curved shape in plan and elevation, the stress is transmitted to the sides and bottom. An example of this type of dam is the Almendra dam in Spain, which is emblematic for being the highest dam in the country.

- **Arch-gravity dams** combine elements of the arch dam and the gravity dam, i.e., it is curved but the weight of the body of the dam helps the abutments to resist the stresses. Large Iberdrola dams in Spain, such as those at Cedillo, Aldeadávila and San Esteban, are of the arch-gravity type.

3. **Hollow dams or buttress dams**

These types of dams are somewhat similar to gravity dams in that, in terms of their resistance mechanism, they have a series of buttresses to provide stability against sliding and overturning. Less material is used than in gravity dams, but they are more technically complex.

Advantages of Dams

- With the assistance of hydroelectric power, the generation of electricity takes place at a steady rate.
- For the preservation of water.
- For irrigation or other activities, the reservoir built behind may also be used.
- The buildup of water within the lake is ensured when required.
- They facilitate storing energy when the release of water takes place for electricity production.
- The electricity generated by the **dams** minimizes the production of greenhouse gases.

Negative Impact of Dams

In spite of the several advantages that **dams** offer, they do pose some challenges to the environment. The below points bring out the negative point of **dams**:

- **Impact on Aquatic Animals:** The flow of streams and rivers is very important for aquatic animals. This is because these animals rely on this flow for the purpose of reproduction. Most noteworthy, **water dams** construction can endanger this as it acts as a blockade for aquatic animals.
- **Impact on Erosion:** The construction of **dams** contributes to soil erosion as it eats up most of the surrounding landmass. Furthermore, landslides near the shoreline are often witnessed at a landmass that encompasses reservoirs. This causes significant destruction in the surrounding landmass in a gradual manner.
- **Impact on Cost:** The construction of **dams** is a very expensive affair and it also has a huge labour requirement. Moreover, even if the utilization of a dam takes place for power generation, it would still take several years or decades to recover the investment cost.
- **Impact on Relocation:** Relocation can follow the construction of a dam. Furthermore, the need for relocation comes due to the threat of landslides or earthquakes. As such, humans have to relocate their properties and business to avoid potential danger or harm.
- **Impact on Water Bodies: Dams** can sometimes block beneficial sediments. Furthermore, aquatic life depends on these sediments. Besides, these sediments play a crucial role in the carbon cycle.
- **Impact on Groundwater:** The reservoir can lead to the reduction of groundwater due to the gradually deepening of the river bed. As such, access to groundwater will be denied to the trees and plants in the landmass. Consequently, this leads to the ruining of both marine and terrestrial life forms balance.

<u>CANALS</u>

A canal is an artificial waterway. The word "canal" originates from the Old French word chanel, which means “channel.” Sometimes it is also known as navigation. In ancient time, A canal is used to connect waterfalls with the intention of shortening routes. Now it is constructed to allow the passage of boats or ships inland or to convey water for irrigation, human-made strip of water used for irrigation or boat access to a more significant body of water. A canal plays a vital role when it comes to transportation and global commerce. We use the canal for irrigation, land drainage, urban water supply, hydroelectric power generation, transportation of cargo and people, power generation, the canal is also used to connect industrial centers with ports to speed movement of raw materials. Water filled canals at high levels can deliver water to any place where there is a water crisis. However, Canals weaken the foundation of the dam.

Types of Canals

Canal Types Based on Usage

1. **Aqueducts**

Aqueduct is a significant watercourse which carries water from a source to the far distribution point. There are many versions of aqueducts. The simplest types are mostly small ditches cut into the earth. They run through underground tunnels. However, modern aqueducts use the pipeline as their path. These types of canals are used for the conveyance and delivery of water for consumption, and agricultural irrigation.

2. **Waterways**

Waterways are the type used for carrying ships and boats and conveying people. Waterway paths are known as a secondary by-product of our country's extensive historical waterway network, and their essential contribution to everyday life has mostly gone unrecognized. They include water features like river, canal, streams, as well as lakes, reservoirs, and docks. Related features of waterways include weirs, locks, rapid, etc. Waterways provide a safe operating environment by reflecting the local conditions. Mostly waterways are used for transformation, irrigation, headrace, trail race, penstock, spillway, etc. They cater to a wide range of boating and water activities as well as control of pests. Waterways act as refuges for terrestrial fauna species during times of drought and as corridors for dispersal. Waterway paths attract more commuting, tourism. It helps to decrease carbon footprints, reduce road congestion and improve the health of local communities.

Canal Types Based on Discharge

1. **Main Canal**

Canals are having discharge more significant than ten cumecs are called as main canals. The main canal is also known as the arterial canal. In drainage, the main canal is the superior canal of the drainage system; it collects water from the drainage canals and conducts it to the water intake. The main canal carries discharge directly from the river. It takes off directly from the upstream side of weir head works or dam. Usually, no direct cultivation is proposed. It supplies water from a river, reservoir, or canal to irrigated lands by gravity flow. It supplies water to a branch canal. We cannot use the main canal for direct irrigation.

2. **Branch Canal**

Branch canals have discharge in the range of 5-10 cumecs. The branches of the main canal go in either direction at regular intervals. It offtakes from the main canal where the head discharge is not more than 14-15 cumecs. Branch canal also plays the role of feeder channel for major and minor distributaries. Branch canals do not carry out direct irrigation, but they provide direct outlets.

3. **Major Distributary**

Canals who offtake from the main canal or branch canal with head discharge from 0.028 to 15 cumecs are termed as significant distributaries. It takes off water from branch canals. Sometimes getting supply from the main canal, their discharge is less than branch canal. These are mostly known as irrigation channels because of their supply of water to the field directed through outlets.

4. **Minor Distributary**

Canals in which discharge ranged from 0.25 up to 3 cumecs are termed as minor distributors. It offtakes from a major distributary carrying discharge less than 0.25 cumecs are termed as minor distributary. Sometimes minor distributary gets supply from the branch canals. The discharge in minor distributary is less than in the major distributary. They also provide water to the courses through outlets provided along with them.

5. **Watercourse or Field Channel**

The discharge in watercourses is less than 0.25 cumecs. A field channel either take off from a significant distributary or minor- it solely depends on which extent the irrigation will happen. In a few cases, it also takes off water from the branch canal for the field. Small channels which carry water from the outlet of a major or minor distributary or a branch canals to the areas to be sprayed. There are small channels for feeding water to the irrigation fields.

Canal Types Based on the Provider

1. **Unlined Canals**

Unlined canals consist of beds and banks made of natural soil. They are not provided with a lining of impervious materials. It produces the growth of aquatic weed retards the flow which leads to massive maintenance cost. Unlined canals can tolerate velocities no more than 0.7 m/s because of erosion. In unlined canals, there is a danger of canal bank breakage caused by overtopping, erosion and animal burrowing. Weeds had severely slowed down the water flow of the canals, preventing up to 50% of the water from reaching the tail end of the canal. It also causes waterlogging of the adjacent net.

2. **Lined Canal**

Lined canals are provided with a lining of impervious materials on its bed and banks to prevent the seepage of water. The most commonly used types of padding are concrete, shotcrete, brick or burnt clay tile, boulder, concrete blocks, stone masonry, sand-cement, plastic, and compacted clay. Possible benefits of lining a canal include water conservation; no seepage of water into adjacent land or roads; reduced canal dimensions; and reduced maintenance.

Canal Types Based on the Alignment

1. **Contour Canal**

A contour canal is an artificial canal also renowned for being dug navigable by following the contour line of the land. it traverses to avoid costly engineering works (eg: boring a tunnel through the higher ground, constructing a canal lock to change the level of the canal, building a dam over lower ground, or). Contour canals are distinguished by the meandering course. They can increase the risk of erosion if not properly established.

2. **Watershed Canal**

A Watershed is a secure area whose runoff drains into any water substance. The watershed canal aligns with any natural watershed (ridgeline). That's why it is also known as the ridge canal. Aligning a canal (central canal or branch canal or distributary) on the ridge ensures gravity irrigation on both sides of the canal. Water runs downhill. Watershed boundary is the divide that distinct one drainage area from another.

3. **Side Slope Canal**

Side slope canals are personalized at the right gradient reaching the contours. It is not on watershed or valley. It does not expropriate drainage channels.

WEIRS

A **weir** is a barrier across the width of a river that alters the flow characteristics of water and usually results in a change in the height of the river level. Weirs are also used to control the flow of water for outlets of lakes, ponds, and reservoirs. There are many weir designs, but commonly water flows freely over the top of the weir crest before cascading down to a lower level.

BARRAGE

When adjustable gates are installed in a weir to keep up the surface of the water at a diverse level at various times, is known as a barrage.

In this method, the water level is balanced by operating the shutters or gates. The gates are provided at different levels and operated by cables from a cabin. These gates are supported on piers on either side. The pier to pier distance is known as the bay.

Differences Between Weir & Barrage

Weir	Barrage
A weir is a low-level barrier built across a river or stream to control its flow.	A barrage is a high-level barrier constructed across a river to store water and control its flow.
Weirs are typically used for water level control, water diversion, and river navigation.	Barrages are mainly used for water storage, irrigation, and hydropower generation.
Weirs are typically shorter in height compared to barrages, usually less than 6 feet.	Barrages are usually higher in height compared to weirs, often ranging from 6 to 60 feet.
Weirs are built on a natural riverbed and do not require a foundation.	Barrages require a strong foundation and are usually built on a concrete base.
Weirs do not create a significant change in water level, usually less than 1 meter.	Barrages create a significant change in water level, sometimes more than 10 meters.
Weirs have a low storage capacity and do not hold water for long periods.	Barrages have a large storage capacity and can hold water for several months or even years.
Weirs are often used for recreational purposes like fishing and kayaking.	Barrages are not suitable for recreational activities due to their size and high-water level.
Weirs are relatively simple and cheap to construct.	Barrages are more complex and expensive to construct due to their size and requirements.
Weirs can be made of natural materials like stones, timber, or concrete.	Barrages are usually made of concrete or steel.
Weirs are usually constructed perpendicular to the river’s flow direction.	Barrages can be built perpendicular or parallel to the river’s flow direction.
Weirs do not have gates or sluice systems to control the water flow.	Barrages have gates and sluice systems to regulate the water flow.

Weir	Barrage
Weirs have a low environmental impact and do not significantly alter the river’s natural flow.	Barrages can have a significant environmental impact and alter the river’s natural flow, affecting the ecosystem and aquatic life.
Weirs are not suitable for large-scale irrigation or hydropower generation.	Barrages are ideal for large-scale irrigation or hydropower generation.
Weirs require less maintenance and can be easily repaired if damaged.	Barrages require regular maintenance and repairs due to their size and complexity.
Weirs can be removed or modified more easily than barrages if they are no longer needed.	Barrages are difficult to remove or modify once constructed due to their size and impact on the river.
Weirs do not pose a significant flood risk to downstream areas.	Barrages can pose a significant flood risk to downstream areas if not managed properly.
Weirs can be easily monitored and managed by local authorities.	Barrages require more sophisticated monitoring and management systems due to their size and complexity.
Weirs can be used in conjunction with other river management strategies like bank stabilization and erosion control.	Barrages do not usually work in conjunction with other river management strategies.
Weirs can be used to control sedimentation and prevent riverbed erosion.	Barrages do not have the same benefits for controlling sedimentation or preventing riverbed erosion.
Weirs are not suitable for deep-water navigation or transport.	Barrages can be used for deep-water navigation or transport.
Weir is not expensive compared to the barrage.	It is a highly expensive structure.
Weirs are obstacles to the watercourse.	They are also obstacles to the watercourse.
A weir is an impermeable boundary that is worked across a stream to raise the water level on the upstream side. Here, the water level is at the required	Barrage has customizable gates which are installed over a dam to maintain the water surface at various levels and at different times. The water level can be decades or increase by opening the valves or gates. Pillar provides the structural support to these gates at both ends and is

Weir	Barrage
height, and abundant water then can stream over the weir.	also positioned at different levels. They are normally operated by cables from the cabin.

Difference between a dam, a weir and a barrage

A weir is an impervious barrier constructed across a river to raise the water level on the upstream side. The water is raised up to the required height and the water then flows over the weir. In a weir the water overflows the weir, but in a dam the water overflows through a special place called a spillway. Weirs have traditionally been used to create mill ponds. They are also used to prevent flooding, measure discharge, and help render a river navigable.

The crest of an overflow spillway on a large dam is often called a weir. Weirs can be built of wood, concrete or moraine material (rocks, gravel, boulders). Small weirs are used many times as one possible mitigation measure in large hydropower developments, along with fish ladders, fish stocking and substrate improvement because low weirs can improve fish recruitment, stabilize groundwater levels and lessen the effects of river regulation that often accompanies very large hydro projects. Small weirs usually have positive benefits on winter fish survival, increased biodiversity and the landscape aesthetics. However, they can also can result in increased sedimentation, changes in the fish community and can pose migration barriers.

A barrage is a weir that has adjustable gates installed over top of it, to allow different water surface heights at different times. The water level is adjusted by operating the adjustable gates.

A dam is a high impervious barrier constructed across a river valley to form a deep storage reservoir. The surplus water is not allowed to flow over the dam, but it flows through the spillways provided at some level built into the dam.