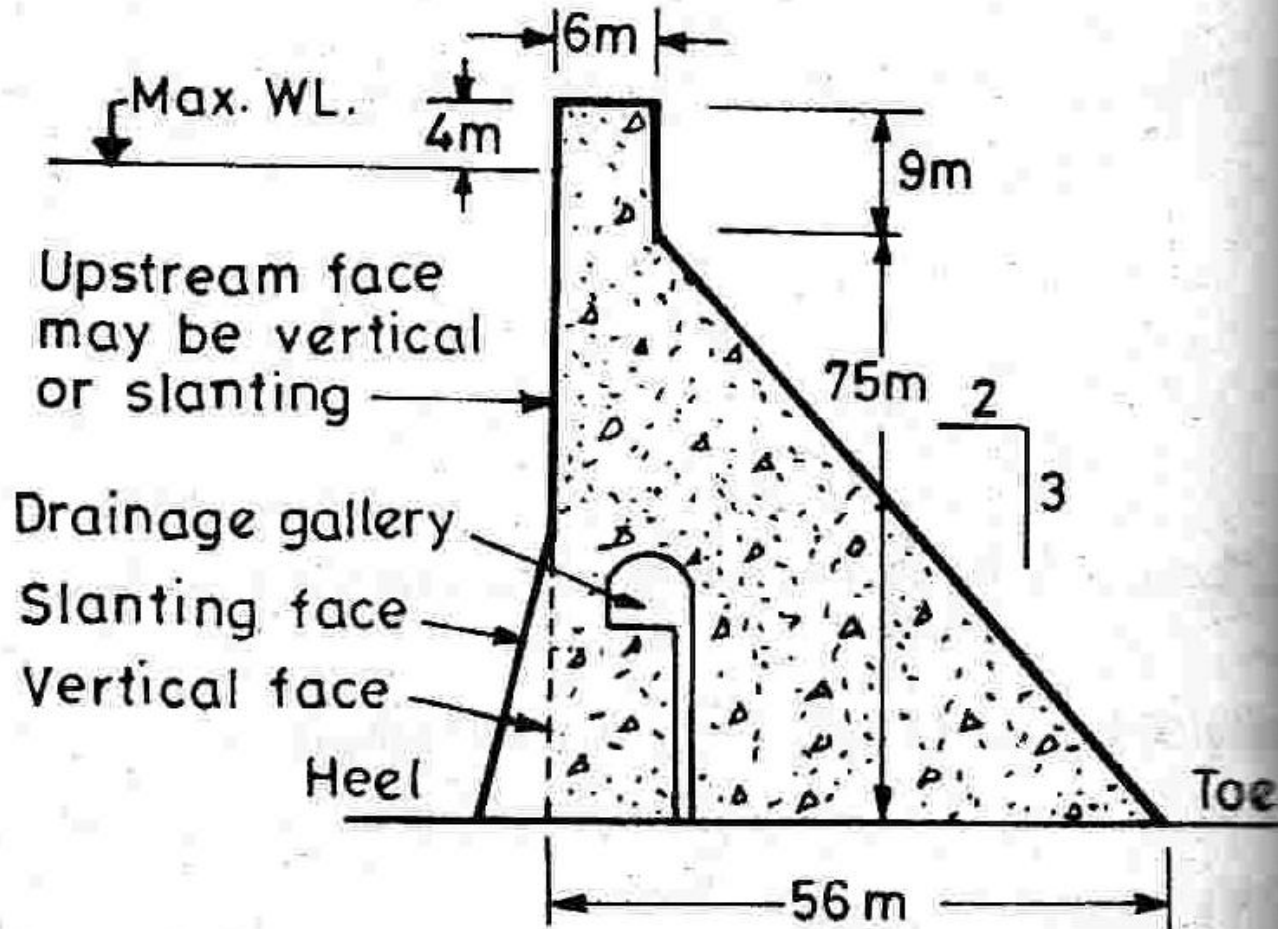# GRAVITY DAM

CONTANTS

- INTRODUCTION
- HISTORY OF GRAVITY DAM
- MATERIALS USED IN DAMS
- FORCES ACTING ON GRAVITY DAM
- STABILITY ANALYSIS
- REFERANCES

INTRODUCTION

- A Dam is a hydraulic structure constructed across a river or a stream to retain the water.

- The structure which resist external forces by its own weight.

- This type of structure is most durable, solid and required little maintenance.

- The dam may be constructed of masonry or concrete.

- They can be constructed on any dam site, where a natural foundation enough to bear the weight of the dam.

TYPICAL CROSS-SECTION

HISTORY

- Gravity dams were the first type of dam constructed, and were made from stone bricks.

- It was built by the Egyptians around 2950 to 2750 BC.

- The dam called Saddel-Kafara and meaning "Dam of the Pagans".

- A covering of limestone was applied to the dam to protect it from erosion.

- Due to shoddy and hasty workmanship, the dam failed to be watertight eventually resulting in its erosion after only a few years.

HISTORY

- Another rudimentary form of gravity dam was supposedly fabricated around 3000 B.C. in the town of Jawa, located in Jordan.

- These gravity dams were part of a water supply system.

- The Romans built their gravity dams in the Iberian Peninsula region, North Africa and in the Middle East.

- A dam located at Homs, Syria in 284 A.D. impounded one of the largest reservoirs built by the Romans.

- The dam was 6,562 feet (2,000 m) in length and held back about 90 million m^3 of water.

HISTORY

- Around 100 A.D., the Romans became the first civilization to use concrete and mortar in the construction of gravity dams.

- One example was the dam at Ponti di San Mauro.

- Later gravity dams used a trapezoidal cross section.

- This cross section eventually evolved into the common triangular cross section design of today's gravity dams.

- The first version of a modern gravity dam was built between 1765 and 1800 in Mexico.

- After that they came to know, The most advantageous cross section for a gravity dam was triangular with a vertical upstream face.

HISTORY

- With the development of Portland cement came the development and construction of super gravity dams such as the Hoover dam that was nearly 60 percent higher than and two and half times the size of any other dam in existence.

- The amount of water this colossal gravity impounded was also record breaking 46,498 million cubic yards (38,550 million m^3) of water.

- Today, gravity dams are still being fabricated out of concrete, but with the incorporation of post-tensioned steel, a new development in their construction.

- However, the construction of gravity dams piqued in the 1960s and the building of these massive structures has slowly been tapering off due to the high labor and construction costs involved.

MATERIALS

- Concrete, masonry(stone, concrete bricks), sand, steel, timer etc.
- The materials required for its construction must be available locally or at short distances form the construction site.
- if the material to be transport from far off distance, then hollow concrete dam is better choice.
- Steel dams are not used for major work. Today steel dams are used as temporary dams for the construction of permanent dams.
- Timber dam life is not more than 30 to 40 years and must have regular maintenance during that time.

MATERIALS

- The design of concrete dams involves consideration of various construction materials during the investigations phase.

- An assessment is required on the availability and suitability of the materials needed to manufacture concrete qualities meeting the structural and durability requirements, and of adequate quantities for the volume of concrete in the dam.

- Construction materials include fine and coarse aggregates, cementitious materials, water for washing aggregates, mixing, curing of concrete and chemical admixtures.

MATERIALS

- One of the most important factors in determining the quality and economy of the concrete is the selection of suitable sources of aggregate.

- In the construction of concrete dams, it is important that the source have the capability of producing adequate quantitives for the economical production of mass concrete. The use of large aggregates in concret reduces the cement content.

FORCES ACTING ON GRAVITY DAM

- Water pressure
- Weight of the dam
- Uplift pressure
- Silt pressure
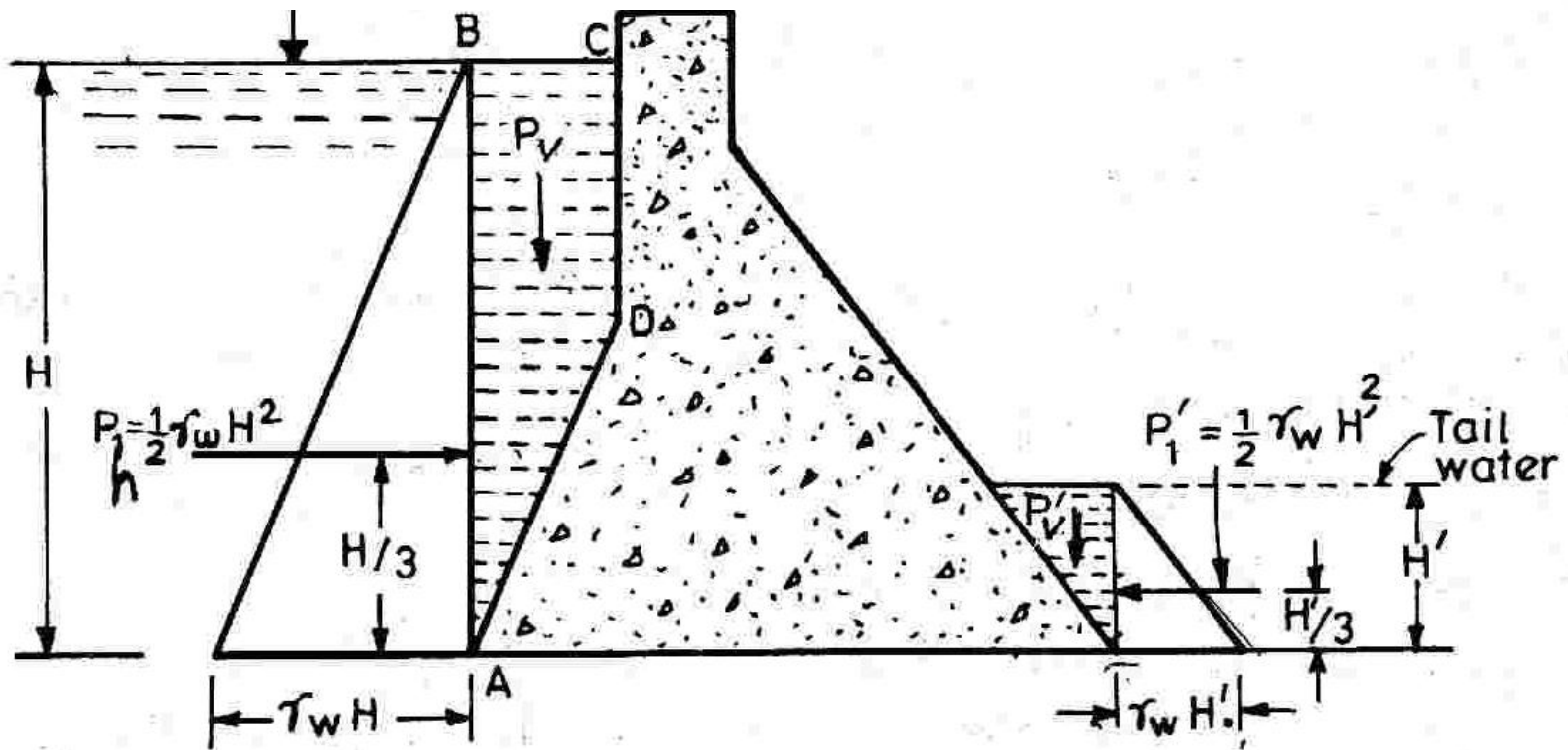- Wave pressure
- Ice pressure

WATER PRESSURE

- It is the major external force acting on a dam.
- The intensity of the pressure varies triangularly, with a zero intensity at the water surface, to a value "wh" at depth h below the water surface.
- Force due to water pressure

$$P = W H2 / 2$$

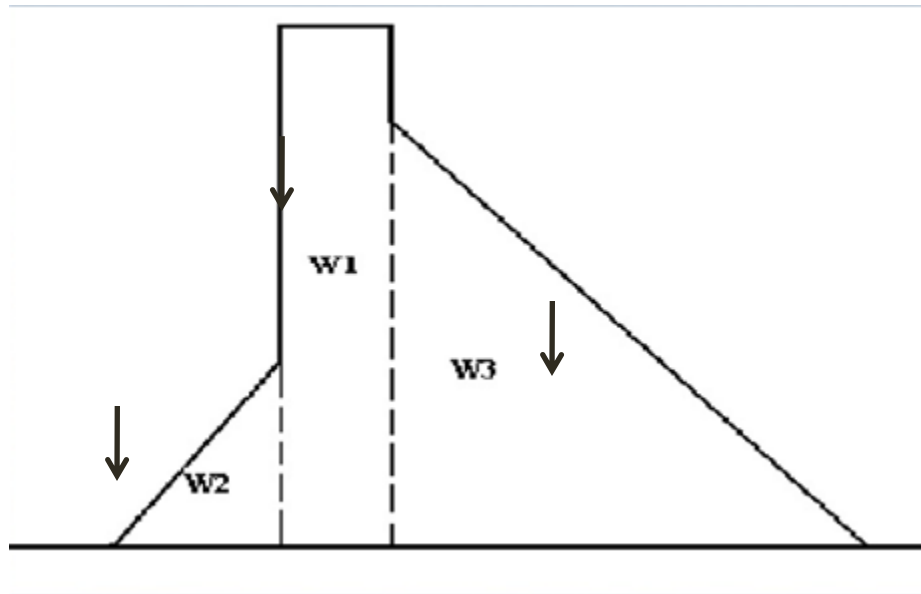- This acts at a height of h/3 from base of the dam.

WATER PRESSURE

WEIGHT OF THE DAM

- Weight of the dam is the major resisting force.
- Unit length of the dam is consider.
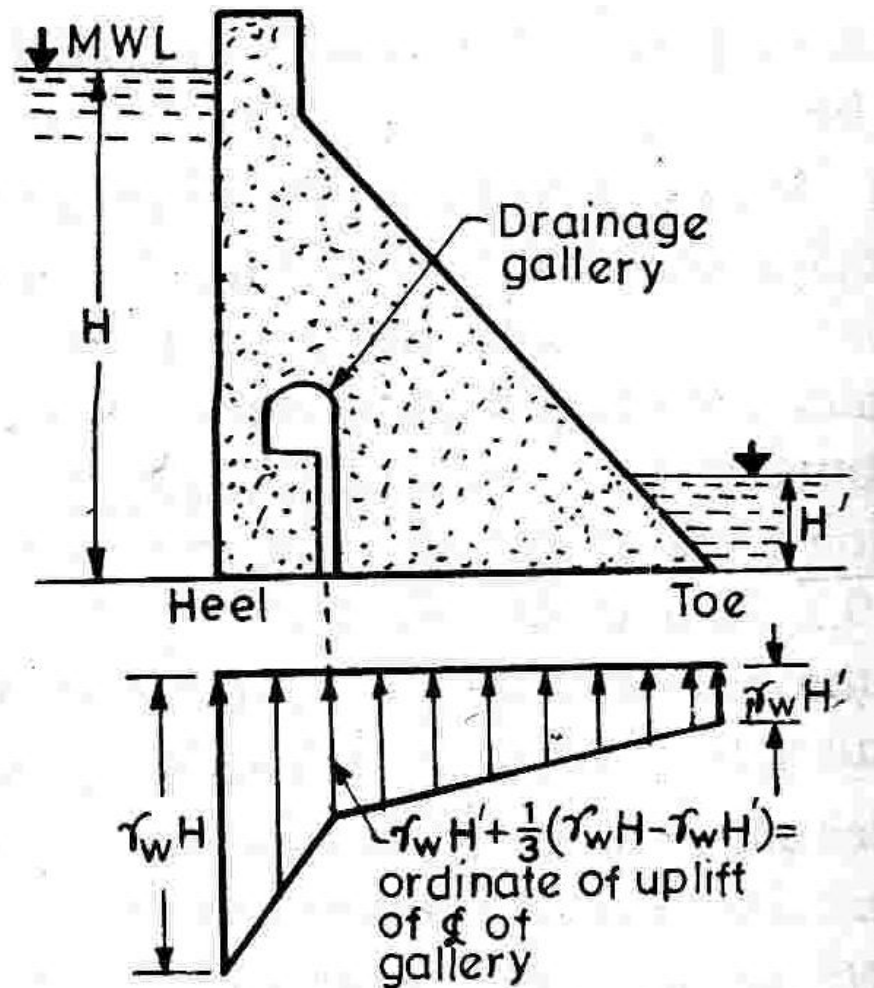- Total weight of the dam acts at the center of gravity of this section.

WEIGHT OF THE DAM

W = W1 + W2 + W3

UPLIFT PRESSURE

- Uplift pressure is the upward pressure exerted by water as it seeps through the body of the dam or its foundation.

- Seeping water exerts pressure on the base of the dam and it depends upon water head.

UPLIFT PRESSURE

SILT PRESSURE

- Silt gets deposited against the upstream face of the dam.
- If h is the height of the silt deposited, then the force exerted by this silt in addition to external water pressure, can be

$$P_{silt} = \gamma_{sat} . h2 . Ka / 2$$

- It acts at h/3 from base.

WAVE PRESSURE

- Waves are generated on the surface of the reservoir by the blowing winds, which cause pressure towards the downstream side.

- Waves pressure depends upon the wave height.

$$H_w = 0.032\sqrt{V.F} + 0.763 - 0.271\ F^{3/4}$$

$$P_w = 2.4\ \gamma w\ .\ H_w$$

- It acts at hw/2 above the still water surface.

ICE PRESSURE

- The ice may be formed on the water surface of the reservoir in cold countries, may sometimes melt and expand.

- The dam face has to resist the thrust exerted by the expending ice.

- The magnitude of this force varies from 250 to 1500 KN/m2 depending upon the temperature variations.

STABILITY ANALYSIS

1) OVERTURNING

- If the resultant of all the force acting on a dam at any of the section, passes outside the toe, the dam shall rotate and overturn about the toe.

$$F.O.S = \frac{Resisting\ moments}{overturning\ moments}$$

- Its value generally varies between 2 to 3.

STABILITY ANALYSIS

2) SLIDING

- A dam may fail in sliding at its base.
- Sliding will occur when the net horizontal force exceeds the frictional resistance developed at that level.

$$F.O.S = \frac{\mu . \Sigma V}{\Sigma H} > 1$$

Where μ = coefficient of static earth pressure

= 0.65 to 0.75

STABILITY ANALYSIS

3)   COMPRESSION OR CRUSHING
  - A dam may fail by the failure of its materials.
  - The compressive stress may exceed the allowable stress and the dam material may get crushed.

4) TENSION
  - Masonry and concrete gravity dam are usually designed in such a way that no tension is developed anywhere,

    because the materials can not withstand sustained tensile stresses.
  - If it subjected to such stresses, these materials may crack.