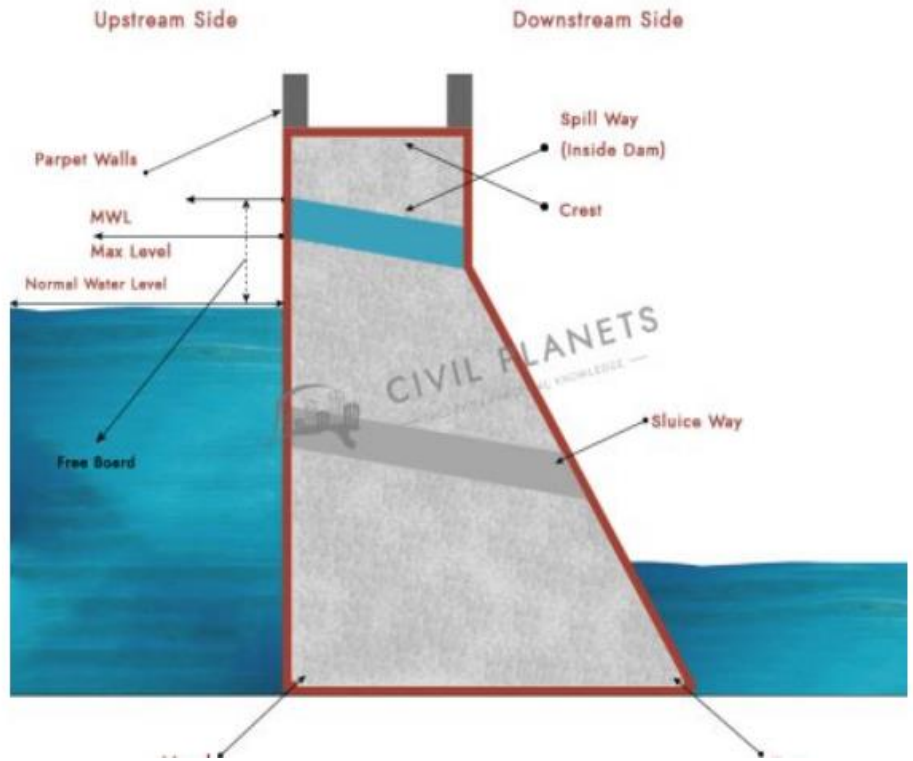
Forces acting on dams

What is a gravity dam?

A structure that is constructed in such a way that its own (self) weight of the material is used to resist the external force (pressure) created by the water and other materials is known as gravity dam. It is constructed either by concrete or by masonry.

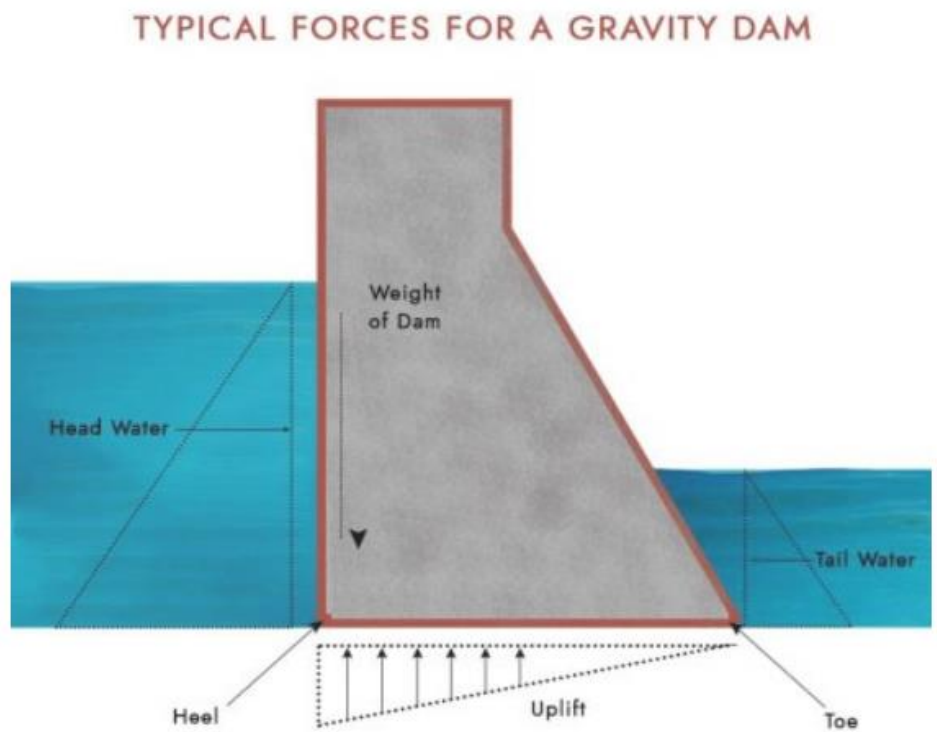
Components of Gravity Dam

Each section of a dam is designed to achieve the self-sufficient weight to resist the water pressure and to protect the structure without any damage.



Forces acting on Gravity Dam

As we already discussed in types of loads acting on a structure, every structure has it's set of dead load, live load & environmental loads.



There are 7 loads acting on a gravity dam such as,

- Water Pressure
- Uplift Pressure
- Silt Pressure
- Earthquake Forces
- Wave Pressure
- Ice Pressure
- Self Weight of Dam

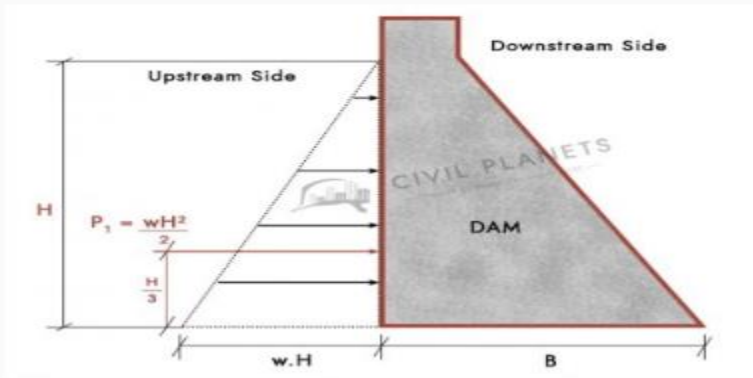
Water Pressure

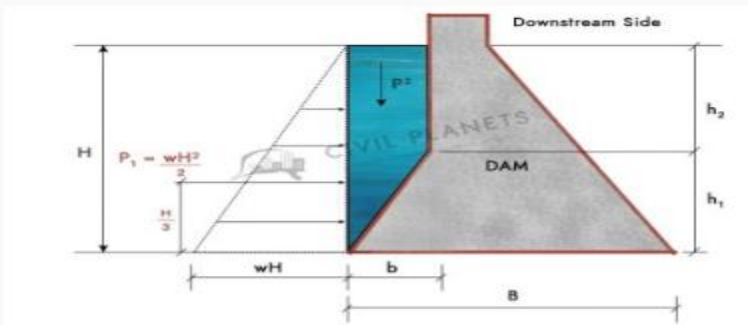
The main force or pressure that acts on a dam.

The water stored creates horizontal forces on the upstream side of the dam. The total pressure created at H/3 level can be collected from hydrostatic pressure distribution.

The water pressure distribution at H/3 level will be analyzed for **2 typical cases**,

1. There is no water in the upstream side; Upstream face is vertical.
2. There is water in the upstream side; the Upstream face is sloping; no water on the downstream side.





“ $P1 = wH^2/2$

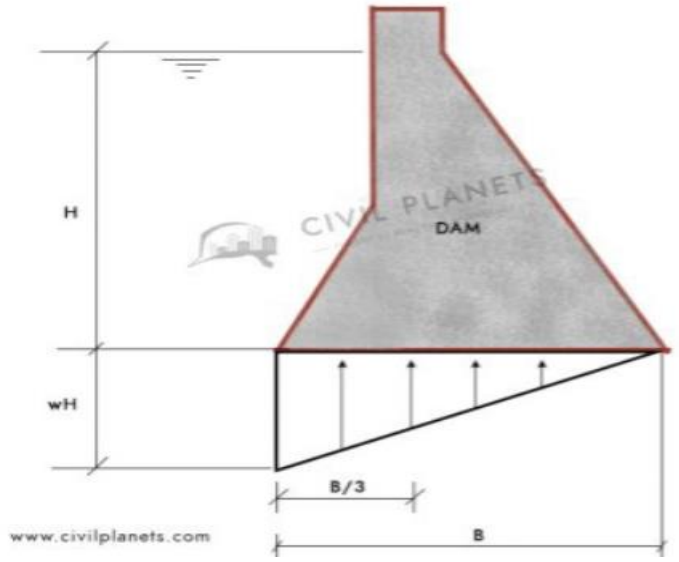
“ $P2 = (b \times h_2 \times w) + (0.5b \times h_1 \times w)$

Uplift pressure

When you are at the seashore, the waves seep under your feet and run off the sand, which makes you feel that you are going to fall.

The Uplift pressure is also more like that. When the upstream side has water, it seeps through cracks, pores & fissures of the footing material of the dam creates a hydraulic gradient between the upstream and downstream side.

The gradient will create a massive uplift force which will eventually reduce the effective weight of the dam.



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

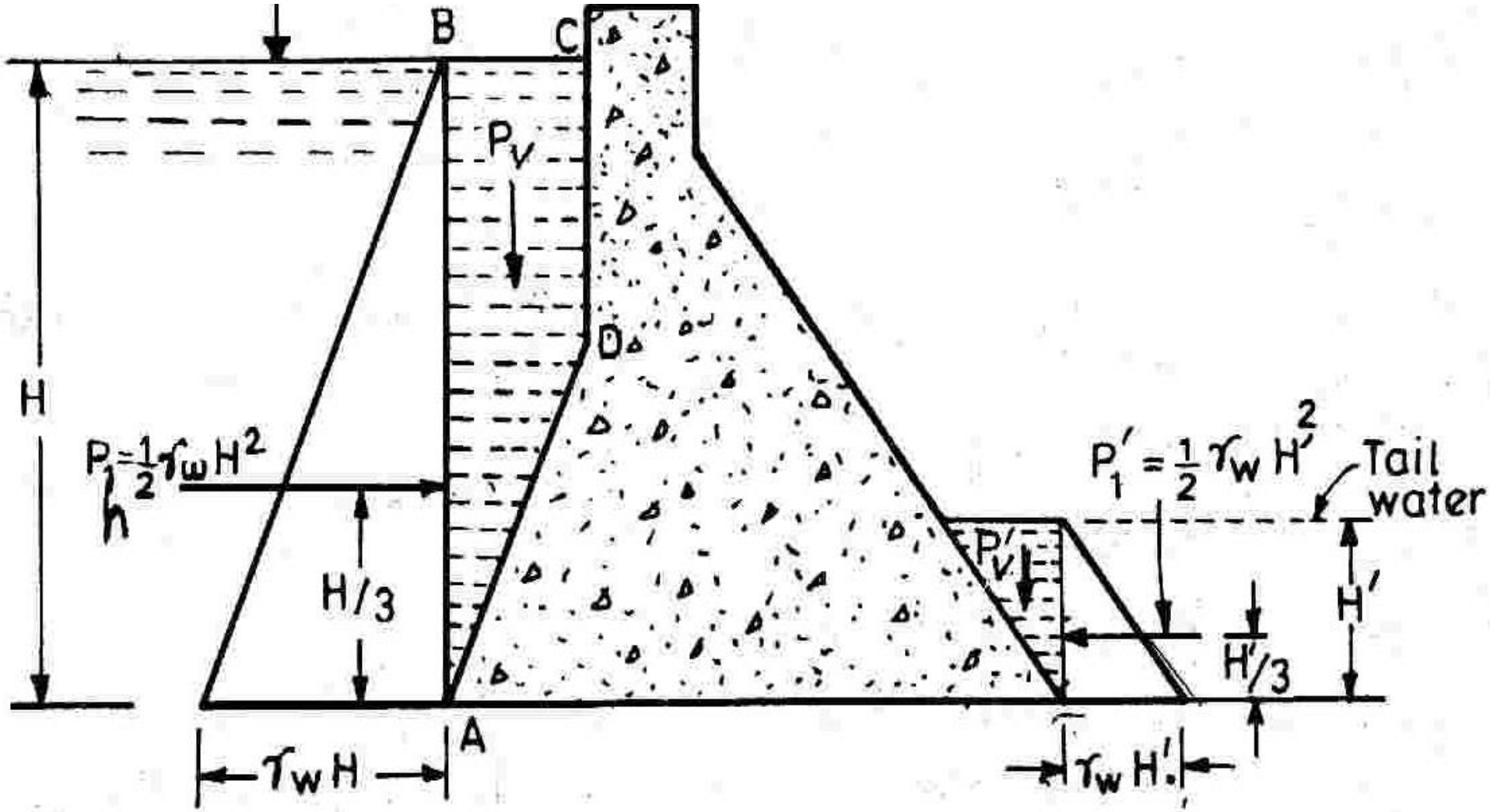
2) SLIDING

- 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.

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

Where μ = coefficient of static earth pressure

= 0.65 to 0.75


B
C
A
H
P_V
$P_1 = \frac{1}{2}\gamma_w H^2$
h
H/3
$P_1' = \frac{1}{2}\gamma_w H'^2$
Tail water
P_V'
H'
H'/3
$\gamma_w H$
$\gamma_w H'$

The schematic represents the Keswick Gravity dam in California. The dam stores 100 ft of water upstream as shown, with 30 ft of tailwater. The dam is made of concrete with a specific weight of 150 lb/ft3. The coefficient of friction between the base of the dam and the foundation is 0.65. Is the dam likely to slide downstream? Consider a unit length of dam (b=1 ft)