4. BUOYANCY AND FLOATATION

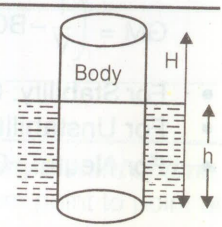
ARCHIMEDES PRINCIPLE

When a body is submerged either fully of partially then it is acted upon by a force of buoyancy vertically up which is equal to weight of liquid displaced by the body.

- This force of buoyancy always acts through the centroid of liquid displaced.
- Centre of Buoyancy is that point through which buoyant force act.

PRINCIPAL OF FLOTATION

$$H\rho_{Body} = h \cdot \rho_{fluid}$$ ← $mg = F_B$



Here, H = Height of body
h = Height of body that is submerge in fluid

CONDITION FOR EQUILIBRIUM FOR FLOATING/SUBMERGED BODY

- For stable equilibrium
  - In case of floating body, metacenter should be above centre of gravity.
  - In case of submerged body, center of buoyancy should be above centre of gravity.
  - Distance between metacenter and centre of buoyancy

$$B.M = \frac{I_{min}}{V_{immersed}}$$

Here, I_{min} = Moment of inertia of top view of floating body about longitudinal axis

V = Volume of body immersed in liquid

- Metacentric height for rolling condition will be less then metacentric height for pitching condition.

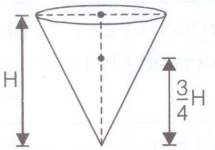
TIME PERIOD OF OSCILLATION

If a floating body oscillates then its time period of transverse oscillation is given by

$$T = 2\pi\sqrt{\frac{K_G^2}{g.GM}}$$

Here, K_G = Least radius of gyration
GM = Metacentric height

For cone the center of gravity lies at $\frac{3}{4}$H from the pointed end.



METACENTRIC HEIGHT (GM)

$$GM = (BM - BG)$$

$$GM = \left(\frac{I}{V} - BG\right);\ V \text{ is volume displaced}$$

- **For Stability:** $GM > 0 \Rightarrow BM > BG$
- **For Unstability:** $GM < 0 \Rightarrow BM < BG$
- **For Neutal :** $GM = 0 \Rightarrow BM = BG$

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