Experiment-3

Metacentric Height

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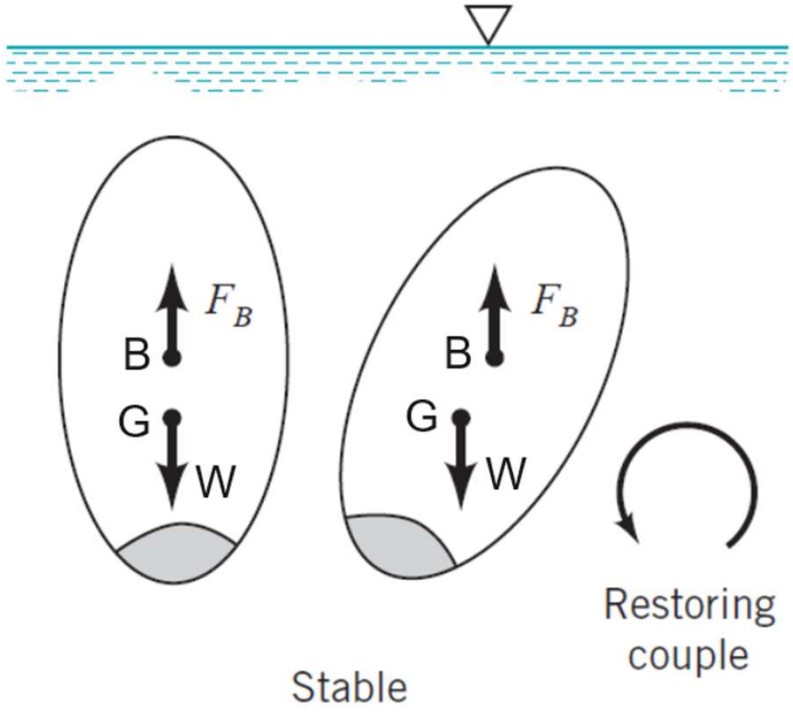
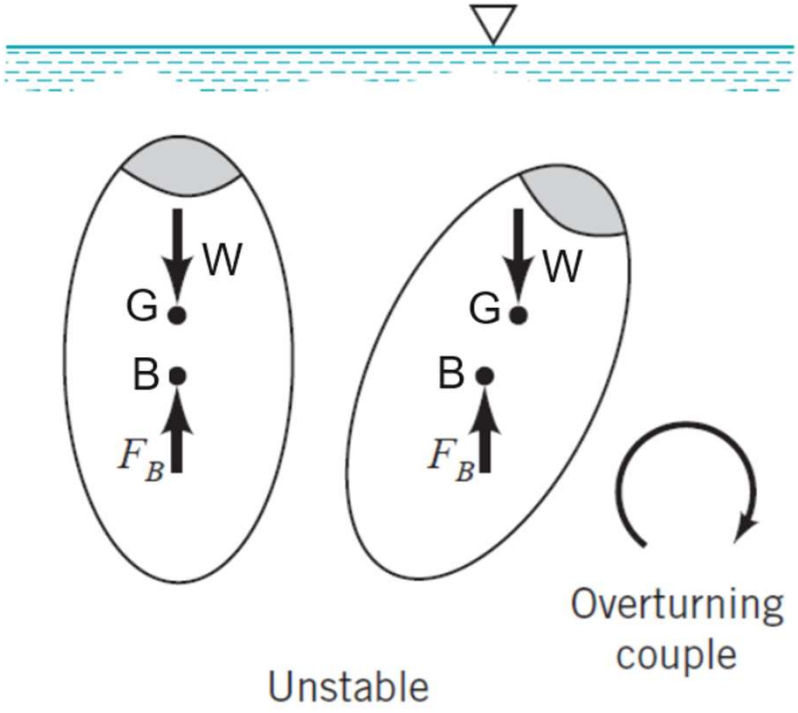
Objective

The objective of the present experiment is to corroborate the stability of the floating body theory through the experimental determination of the Metacentric Height of a floating body.

Stability of a Floating Body

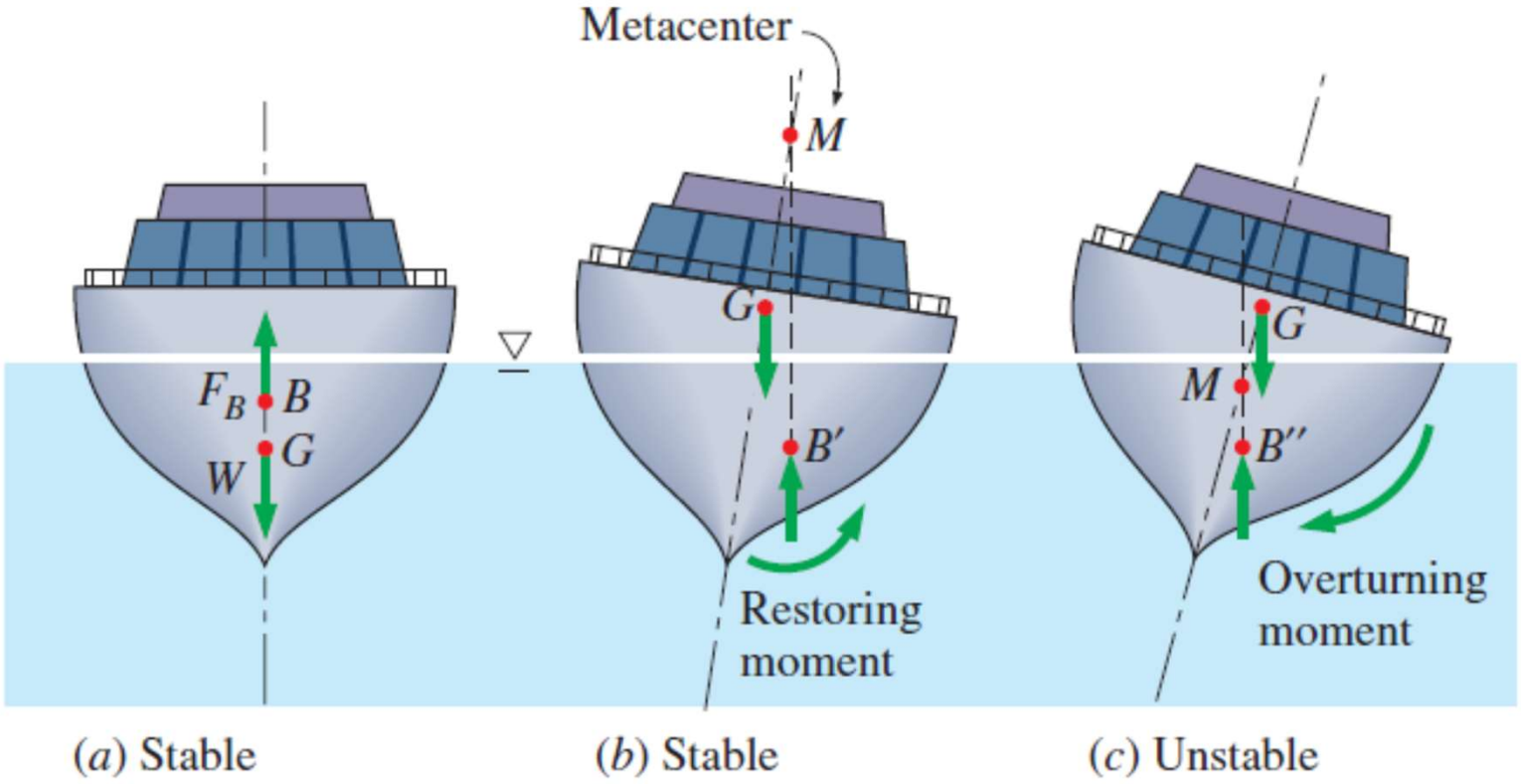


Stability of a completely immersed body - center of gravity below centroid.



Stability of a completely immersed Body - center of gravity above centroid.

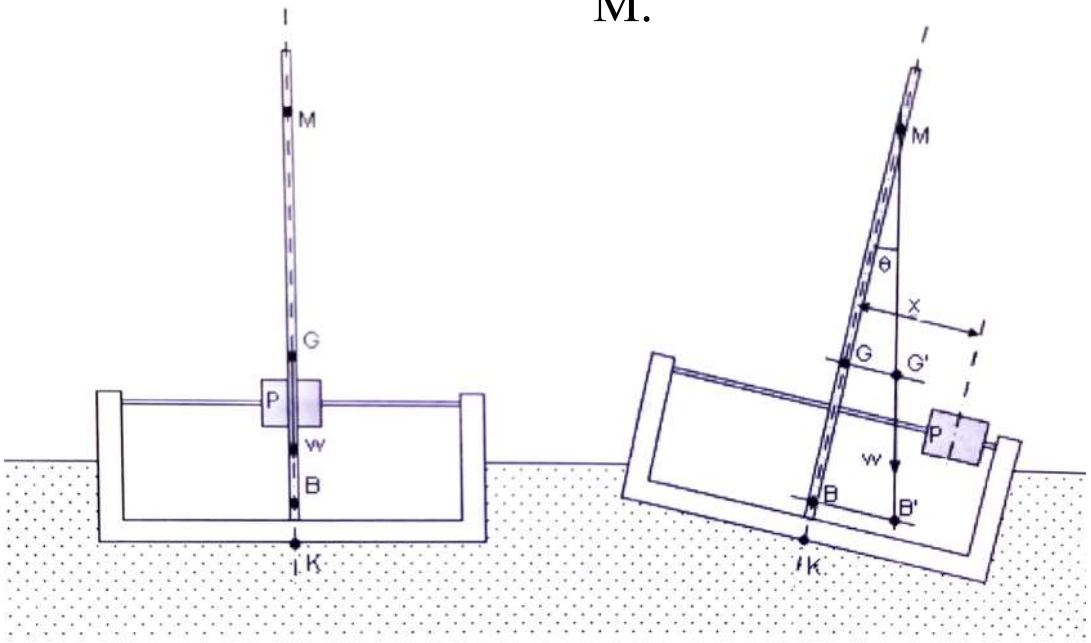
Stability of a Floating Body



Stability of a floating body

Analytical Determination of the Metacentric Height

Metacentric Height (GM) – Distance between the center of gravity, G, and the metacenter, M.



Floating bodies

$$P \cdot x = W\ \overline{GG'}$$

W : Pontoon (or float) weight

F_B : Buoyancy force.

P : Jockey weight

x : Distance the jockey is moved

θ : Angle

$$\overline{GM} = \frac{\overline{GG'}}{\tan\theta}$$

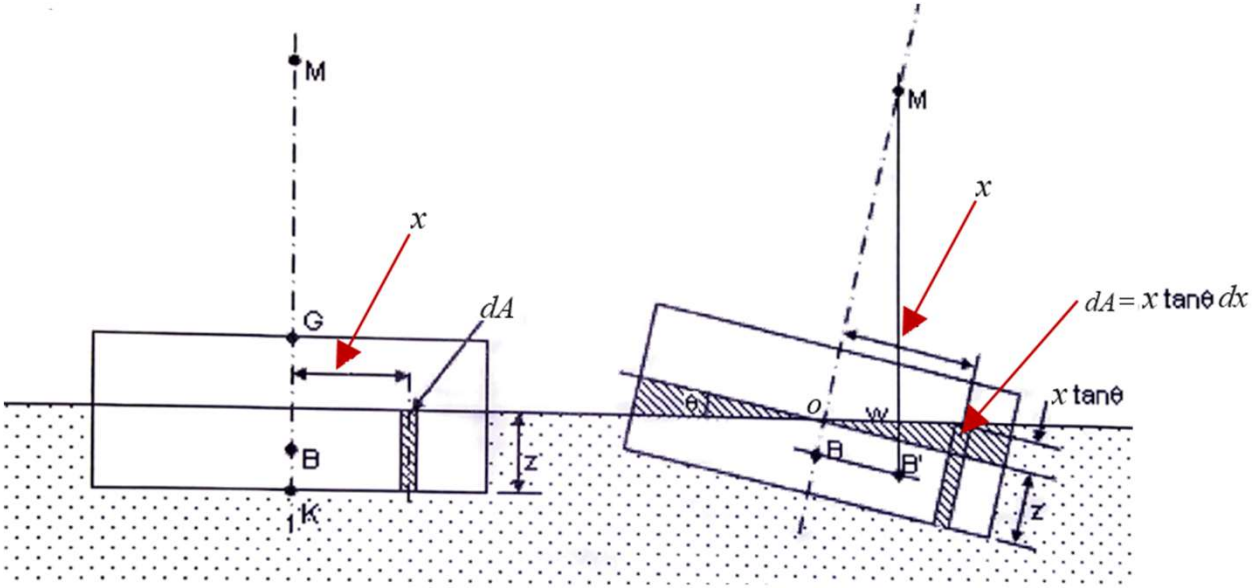
➡

Experimental

$$\overline{GM} = \frac{P \cdot x}{W \cdot \tan\theta}$$

Analytical Determination of the Metacentric Height

Moment exerted by the buoyant force (M_B)



$d\forall = LdA$ $\qquad dF = \gamma d\forall$

$dM_O = x \cdot dF$

$$\rightarrow M_O = \gamma \tan\theta \int Lx^2 dx = \gamma \,\mathbf{tan\theta}\, I_O \qquad (1)$$

I **:** Second moment about the tilt axis.

On the other hand

$$M_O = \gamma \forall_{sub} \cdot BB' = \gamma \forall_{\text{sub}} \tan\theta \, BM \qquad (2)$$

(1) = (2) $\rightarrow$ $BM = \dfrac{I_o}{\forall_{sub}}$

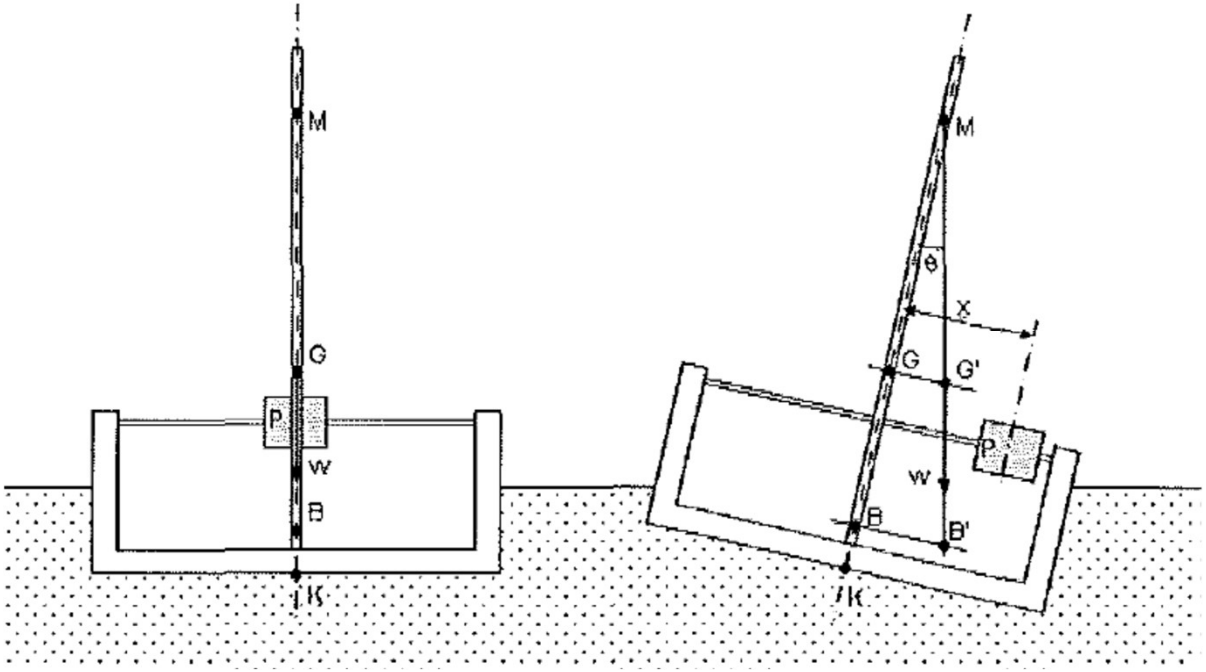
Analytical Determination of the Metacentric Height

$$I_O = \frac{Lb^3}{12}$$

$$\forall = Lbd$$

d : Distance from *k* to the free surface.

b : Pontoon width.



$$GM = BM - BG$$

$$GM = \frac{I_O}{\forall_{sub}} - BG$$

Theoretical

$$GM = \frac{b^2}{12d} - \left(y - \frac{d}{2}\right)$$

y : Distance from *k* to *G*.

Analytical Determination of the Metacentric Height