

Ship Stability

Ch. 6 Free Surface Effect

Spring 2018

Myung-II Roh

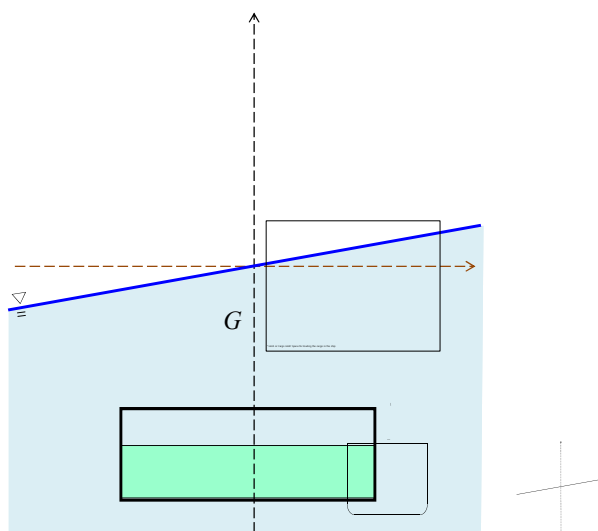
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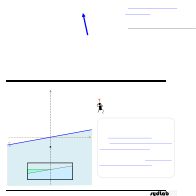
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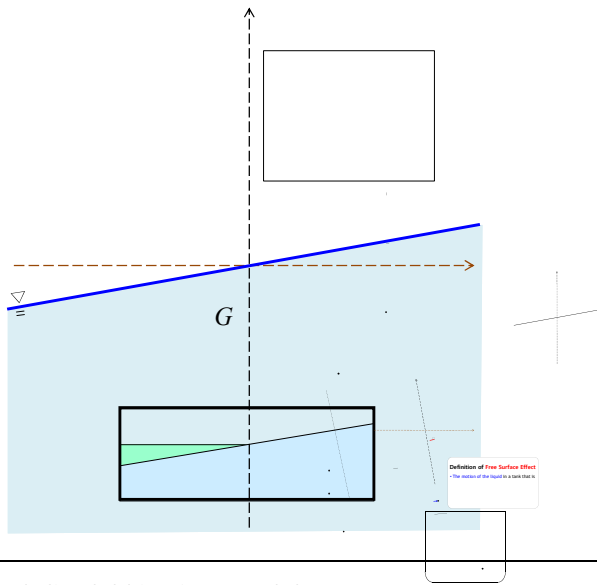
Ch. 6 Free Surface Effect

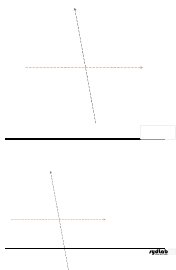
Free Surface Effect



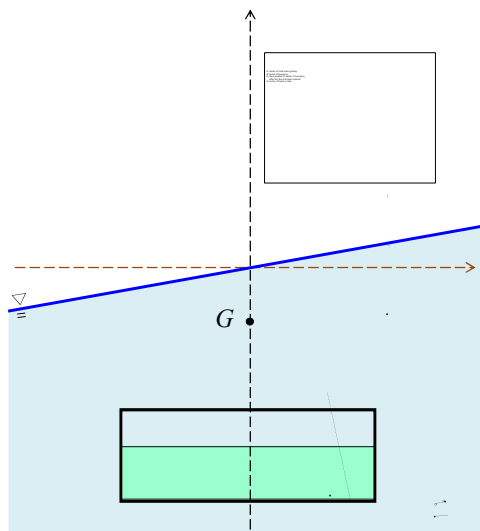


Definition of Free Surface Effect

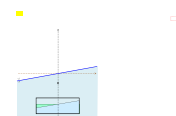




Transverse Righting Moment When there is no Effect of Free Surface

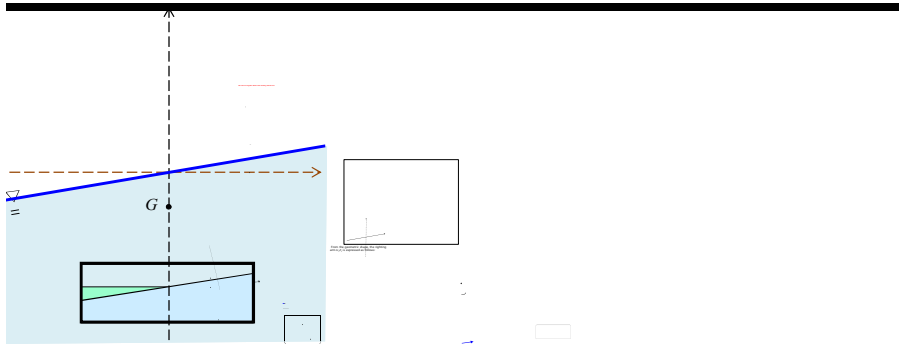
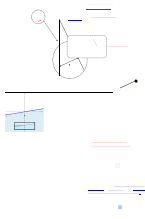


• Transverse Righting Moment



• Prediction of effect of free surface on
stability is complex





The Influence of Free Surface on the Initial Stability of Small Angle ($\alpha < 10^\circ$)

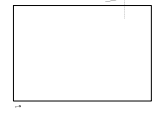
1. The free surface of the liquid in the vessel will shift towards the heel of the vessel.

2. The center of gravity of the liquid will shift towards the heel of the vessel.

3. The center of buoyancy will shift towards the heel of the vessel.

4. The metacenter will shift towards the heel of the vessel.

5. The initial stability of the vessel will be reduced.



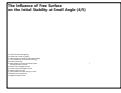
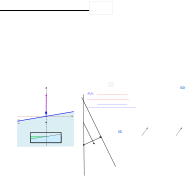
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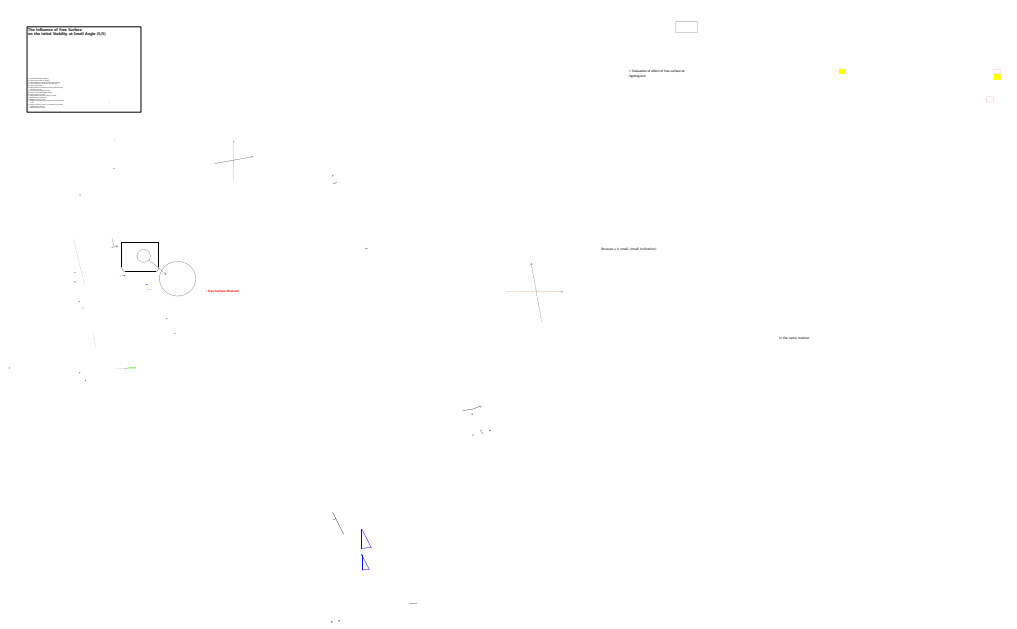
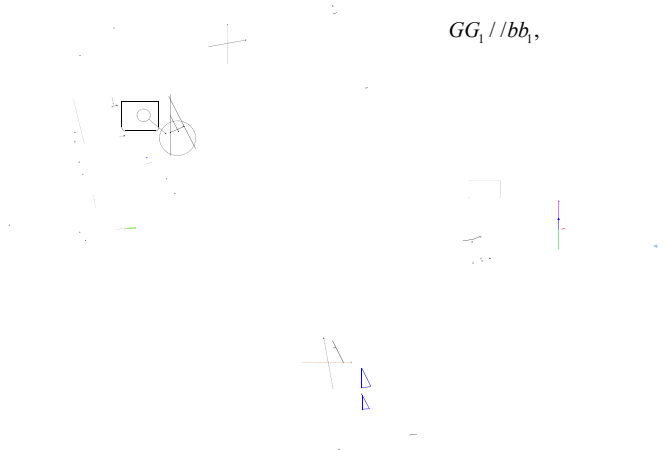
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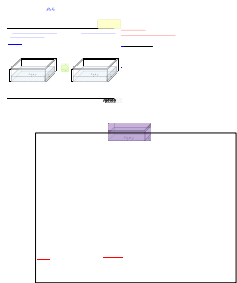


✓ Evaluation of effect of free surface on righting arm



$$GG_1 / bb_1,$$





The Effects of Free Surface

G : Center of total mass (gravity)
 G' : New position of center of total mass (gravity)
 w : Weight of liquid in tank
 i_x^2 : Moment of inertia of liquid plane area in tank about x' axis

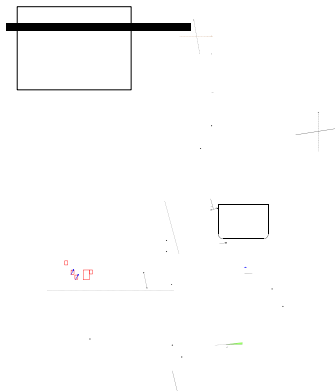
- Free Surface Effect

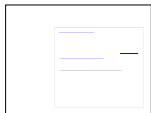
$$GM = KB + BM - KG_0,$$

Free surface correction

• The effects of free surface depend on the ratio of

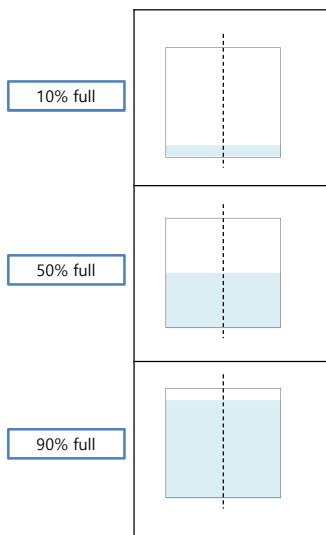
See Surface Moment

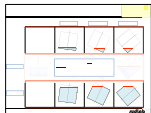




The Influence of Free Surface at Large Angles of Heel (1/5)

$$GG_0 = \frac{w}{W} \frac{i_T}{v} = \frac{\rho_F}{\rho_{SW}} \frac{i_T}{\nabla}$$



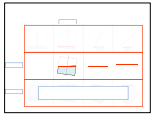


$$GG_0 = \frac{w}{W} \frac{i_r}{v} = \frac{\rho_F}{\rho_{SW}} \frac{i_r}{\nabla}$$

: free surface correction

		25° Inclination	50° Inclination





$$GG_0 = \frac{w}{W} \frac{i_r}{v} = \frac{\rho_F}{\rho_{SW}} \frac{i_r}{\nabla}$$

: free surface correction

		25° Inclination	50° Inclination