Free Surface Effect of a Slack Tank on Ship Stability

Free surface moment and the virtual rise of the centre of gravity caused by a slack rectangular tank, with the fluid metacentric height of the ship.

Method: Free surface effect of slack tanks

Input parameters

Unit system: SI

Parameter	Value	Unit
Tank length	15.000	m
Tank breadth (athwartships)	10.000	m
Number of equal longitudinal subdivisions of the tank	1.0000	
Density of the liquid in the tank	1,025.0	kg/m³
Ship displacement	8,000.0	t
Solid metacentric height	0.90000	m

Calculated results

Parameter	Value	Unit
Second moment of the free surface	1,250.0	m⁴
Free surface moment ρ_f i	1,281.2	t
Virtual rise of the centre of gravity	0.16016	m
Fluid metacentric height	0.73984	m

Notes for this case

- A slack tank acts as if its liquid were raised by GG' = ρ_f i/Δ; dividing it into n equal longitudinal compartments cuts the effect by n².

Formula and method

$$i = \frac{lb^3}{12n^2}, \quad GG' = \frac{\rho_f i}{\Delta}, \quad GM_{fluid} = GM_{solid} - GG'$$

Variables

l	Tank length	m
b	Tank breadth (athwartships)	m
n	Number of equal longitudinal subdivisions of the tank	-
ρ_f	Density of the liquid in the tank	kg/m³
Δ	Ship displacement	kg
GM_{solid}	Solid metacentric height	m
i	Second moment of the free surface	m⁴
FSM	Free surface moment ρ_f i	kg
GG'	Virtual rise of the centre of gravity	m
GM_{fluid}	Fluid metacentric height	m

Method and standards

Free surface correction.

Assumptions and limits

- Rectangular wall-sided tank, small heel angles.

References

Free surface effect of slack tanks

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/marine/free-surface-correction

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.