

Ship Stability Formulae

Maritime & Coastguard Agency

Certificate of Competency Examinations

NB. These formulae and symbols are for guidance only and other formulae which give equally valid results are acceptable

$$\rho = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{DWT} = \Delta - \Delta_{\text{Light}}$$

$$\text{TPC} = \frac{A_w \times \rho}{100}$$

$$\text{FWA} = \frac{\Delta_{\text{Summer}}}{4 \times \text{TPC}_{\text{SW}}}$$

$$\text{GG}_{\text{H/V}} = \frac{w \times s}{\Delta}$$

$$\text{KG} = \frac{\Sigma \text{ Vertical Moments}}{\Delta}$$

$$\tan(\text{List}) = \frac{\text{GG}_{\text{H}}}{\text{GM}}$$

$$\text{MSS} = \Delta \times \text{GZ}$$

$$\text{GZ} = [\text{GM} + (\frac{1}{2} \times \text{BM} \times \tan^2 \theta)] \times \sin \theta$$

$$\text{FSM} = I \times \rho_T$$

$$\text{FSC} = \frac{\text{FSM}}{\Delta}$$

$$\text{KM}_T = \text{KB} + \text{BM}_T$$

$$\text{BM}_T = \frac{I_T}{\nabla}$$

$$\text{BM}_T (\text{For Box Shape}) = \frac{L \times B^3}{12 \times \nabla}$$

$$\text{MCTC} = \frac{\Delta \times \text{GM}_L}{100 \times \text{LBP}}$$

$$\text{True mean draught} = \text{Draught aft} \pm \left(\text{Trim} \times \frac{\text{LCF}}{\text{LBP}} \right)$$

$$\text{Change of trim aft} = \frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$$

$$\text{Distance from Summer LL to Winter LL} = \frac{1}{48} \text{ Summer draught}$$

$$\text{Distance from Summer LL to Tropical LL} = \frac{1}{48} \text{ Summer draught}$$

$$\Delta = \nabla \times \rho$$

$$\nabla = L \times B \times d \times C_B$$

$$\text{Sinkage or Rise} = \frac{w}{\text{TPC}}$$

$$\text{RD} = \frac{\rho_{\text{Substance}}}{\rho_{\text{FW}}}$$

$$A_w = L \times B \times C_w$$

$$\text{TPC}_{\text{DW}} = \frac{\text{TPC}_{\text{SW}}}{1025} \times \rho_{\text{DW}}$$

$$\text{DWA} = \frac{(1025 - \rho_{\text{DW}})}{25} \text{ FWA}$$

$$\text{GG}_{\text{H/V}} = \frac{w \times s}{\Delta \pm w}$$

$$\text{GG}_{\text{H}} = \frac{\Sigma \text{ Horizontal Moments}}{\Delta}$$

$$\tan(\text{List}) = \frac{\text{Listing Moment}}{\Delta \times \text{GM}}$$

$$\text{GZ} = \text{GM} \times \sin \theta$$

$$\text{GZ} = \text{KN} - (\text{KG} \times \sin \theta)$$

$$I = \frac{l \times b^3}{12}$$

$$\text{FSC} = \frac{I \times \rho_T}{\Delta}$$

$$\text{KM}_L = \text{KB} + \text{BM}_L$$

$$\text{BM}_L = \frac{I_L}{\nabla}$$

$$\text{BM}_L (\text{For Box Shape}) = \frac{L^3 \times B}{12 \times \nabla}$$

$$\text{CoT} = \frac{\text{Trimming Moment}}{\text{MCTC}}$$

$$\text{Trim} = \frac{\Delta \times (\text{LCB} - \text{LCG})}{\text{MCTC}}$$

$$\text{Change of trim for'd} = \frac{\text{Trim} \times (\text{LBP} - \text{LCF})}{\text{LBP}}$$

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$$AHM = \frac{TVHM}{SF}$$

$$\lambda_0 = \frac{\text{Total VHM}}{SF \times \Delta}$$

$$\lambda_{40} = 0.8 \times \lambda_0$$

$$\text{Approximate Angle of Heel} = \frac{AHM}{MPGHM} \times 12^\circ$$

$$\text{Reduction in GZ} = (GG_H \times \cos \theta) + (GG_V \times \sin \theta)$$

$$\text{Area under curve (SR1)} = \frac{1}{3} \times h \times (y_1 + 4y_2 + y_3)$$

$$\text{Area under curve (SR2)} = \frac{3}{8} \times h \times (y_1 + 3y_2 + 3y_3 + y_4)$$

$$\text{Wind Heeling Lever } lw_1 = \frac{P \times A \times Z}{1000 \times g \times \Delta}$$

$$\text{Rolling Period T (Sec)} = \frac{2 \times C \times B}{\sqrt{GM}}$$

$$C = 0.373 + 0.023 \left(\frac{B}{d} \right) - 0.043 \left(\frac{L_{wl}}{100} \right)$$

$$GM = \frac{w \times s \times \text{length}}{\Delta \times \text{deflection}}$$

$$\text{GM at Angle of Loll} = \frac{-2 \times \text{Initial GM}}{\cos \theta}$$

$$\tan(\text{Angle of Loll}) = \sqrt{\frac{-2 \times GM}{BM_T}}$$

$$\tan(\text{List}) \text{ Zero GM} = \sqrt[3]{\frac{2 \times w \times s}{\Delta \times BM_T}}$$

$$M_R = 0.200 \times \frac{v_0^2}{L_{WL}} \times \Delta \times \left(KG - \frac{d}{2} \right)$$

$$\tan(\text{Angle of DEI}) = \frac{\text{Freeboard}}{\frac{1}{2} \times B}$$

$$\text{Draught when Heeled} = (\text{Upright Draught} \times \cos \theta) + (\frac{1}{2} \times B \times \sin \theta)$$

$$P = \frac{\text{Trim} \times MCTC}{LCF}$$

$$P = \text{Reduction in TMD} \times TPC$$

$$\text{Loss of GM} = \frac{P \times KM}{\Delta}$$

$$\text{Loss of GM} = \frac{P \times KG}{\Delta - P}$$

$$\text{Effective Length} = l \times \mu$$

$$\text{Solid Factor} = \frac{1}{RD}$$

$$\text{Permeability}(\mu) = \frac{\text{Volume available for water}}{\text{Volume available for cargo}}$$

$$\text{Permeability}(\mu) = \frac{\text{SF of Cargo} - \text{Solid Factor}}{\text{SF of Cargo}}$$

$$\text{Volume of lost buoyancy} = l \times b \times d \times \mu$$

$$\tan(\text{List}) = \frac{BB_H}{GM_{\text{Bilged}}}$$

$$\text{Sinkage} = \frac{\text{Volume of lost buoyancy}}{\text{Intact water plane area}}$$

$$I_{\text{Parallel Axis}} = I_{\text{Centroid Axis}} + As^2$$

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Accepted Abbreviations

LOA	Length Over All
LBP	Length Between Perpendiculars
AP	After Perpendicular
FP	Forward Perpendicular
C_W	Coefficient of Water Plane Area
C_B	Block Coefficient
WPA	Water Plane Area
IWPA	Intact Water Plane Area
KG/Kg	Height of Centre of Gravity from Keel
VCG/Vcg	Vertical Centre of Gravity
KM	Height of Metacentre from Keel
GM	Metacentric Height
KB	Height of centre of Buoyancy from Keel
LCG/Lcg	Longitudinal Centre of Gravity
LCF	Longitudinal Centre of Floatation
LCB	Longitudinal Centre of Buoyancy
TCG/Tcg	Transverse Centre of Gravity
GG_H	Horizontal shift in Centre of Gravity
GG_V	Vertical shift in Centre of Gravity
GZ	Righting Lever / Arm
BM	Height of Metacentre from Centre of Buoyancy
FSM	Free Surface Moments
FSC	Free Surface Correction
FSE	Free Surface Effect
TPC	Tonnes Per Centimetre Immersion
MCTC	Moment to Change Trim by one Centimetre
FWA	Fresh Water Allowance
RD	Relative Density
MSS	Moment of Statical Stability
RM	Righting Moment
RDS	Residual Dynamic Stability
AMD	Arithmetic Mean Draft
TMD	True Mean Draft
CoT	Change of Trim
WHM	Wind Heeling Moment
AHM	Actual Heeling Moment
VHM	Volumetric Heeling Moment
TVHM	Total Volumetric Heeling Moment
MPGHM	Maximum Permissible Grain Heeling Moment
MR	Heeling moment on account of turning
L_{WL}/L_{wl}	Length of the ship at waterline
θ_{dei} or φ_{dei}	Angle of Deck Edge Immersion
θ_f or φ_f	Angle of Flooding

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