JULY 2012
MARCH 2021

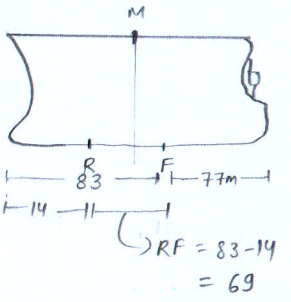
A ship of length of 160 m, disp W = 10500 t, CF = 3m abaft the midship, in MCTC = 160mt, TPC = 18t, KM = 7.0m, KG = 6.6m at draft of 6.9m forward, 7.3 m aft, grounds lightly on a rock 14m abaft the foreend. The tide then falls by 90cm. Calculate her virtual GM and draft forward and aft then.

Soln:-

falls by 90cm

That means, Reduction in draft = 90cm

RF = 69



$$\text{Reduction in draft at R} = \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$$

$$90 = \frac{P}{18} + \frac{P \times 69^2}{160 \times 160}$$

$$90 = 0.056P + 0.186P$$

$$90 = 0.242P$$

$$P = 371.901 \text{ ts}$$

Virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(solid)}{W - P}$$

$$= \frac{371.901 \times 6.6}{10500 - 371.901}$$

$$= 0.242m$$

FORMULA (B)

$$\frac{P \times KM(Final)}{W(initial)}$$

$$= \frac{371.901 \times 7.0}{10500}$$

$$= 0.248m$$

KM : 7.000m
KG : 6.600 m
GM : 0.400m

Initial GM : 0.400 m
V.loss of GM : 0.248 m
Residual GM : 0.152m

Ans

$$\text{Rise} = \frac{P}{TPC \times 100}$$

$$\text{Rise} = \frac{371.901}{18 \times 100}$$

$$= 0.207m$$

$$T_C = \frac{P \times RF}{MCTC \times 100}$$

$$= \frac{371.901 \times 69}{160 \times 100}$$

$$= 1.604\,m$$

$$Ta = \frac{T_C \times LCF}{LBP}$$

$$= \frac{1.604 \times 77}{160}$$

$$= 0.772m$$

$$Tf = T_C - Ta$$

$$= 1.604 - 0.772$$

$$= 0.832m$$

Draft	Fwd	Aft
Initial	6.900	7.300
Rise	(-) 0.207	(-) 0.207
Tf/Ta	(-) 0.832	(+) 0.772
Final :	5.861m	7.865

Ans

Similiar question : SEP 2021, JAN 2019, JAN 2022

JAN 2013

A vessel of displacement 7200 tonnes, length 120m, MCTC 110 tm, KG 6.0m, KM 6.4m, TPC 16 tonnes, center of floatation 2 mts forward of midship, grounds on a rock 10 mts abaft her forward perpendicular. Given initial draft F: 4.2m, A: 5.1m

a) Find the fall in tide which will make the vessel unstable?

b) What will be the drafts forward and aft at that moment?

Soln:-

a)

Initial GM: 0.4m

Final GM: 0.0m

V. loss of GM: 0.4m

Virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(solid)}{W-P}$$

$$0.4 = \frac{P \times 6.0}{7200-P}$$

$$2880 - 0.4P = 6.0P$$

$$2880 = 6.4P$$

$$P = 450 \text{ ts}$$

FORMULA (B)

$$\frac{P \times KM(Final)}{W}$$

$$0.4 = \frac{P \times 6.4}{7200}$$

$$2880 = 6.4P$$

$$P = 450 \text{ ts}$$

Fall in tide = Reduction in draft

$$\text{Reduction in draft at R} = \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times L}$$

$$= \frac{450}{16} + \frac{450 \times 48^2}{110 \times 120}$$

$$= 28.125 + 78.545$$

$$= 106.67 \text{ cm}$$

$$= 1.067 \text{ m}$$ = ANS

b)

$$\text{Rise} = \frac{P}{TPC}$$

$$\text{Rise} = \frac{450}{16}$$

$$= 28.125 \text{ cm}$$

$$= 0.281 \text{ m}$$

$$T_c = \frac{P \times RF}{MCTC \times 100}$$

$$= \frac{450 \times 48}{110 \times 100}$$

$$= 1.964\ m$$

$$Ta = \frac{T_c \times LCF}{LBP}$$

$$= \frac{1.964 \times 62}{120}$$

$$= 1.015\ m$$

$$Tf = T_c - Ta$$

$$= 1.964 - 1.015$$

$$= 0.949\ m$$

Draft	Fwd	Aft
Initial	4.200	5.100
Rise	(-) 0.281	(-) 0.281
Tf/Ta	(-) 0.949	(+) 1.015
Final	2.970 m	5.834 m

Ans

Similiar question: OCT 2014, OCT 2019

OCT 2013
JULY 2018
APRIL 2019

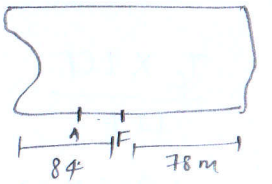
A vessel floating at a draft: forward 8.7m, Aft 9.4m, grounds at a point 30m aft of forward perpendicular. Find the drafts of the vessel and the GM after tide has fallen by 70 cm. If MCTC is 340 tm, TPC 28, KG 7.6m, KM: 8.4m, length 162m, LCF 78m forward of AP, Displacement 29000t

Soln:-

Reduction in draft = 70 cm

RF = 84 - 30

= 54m



Reduction in draft at R = $\frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$

$70 = \frac{P}{28} + \frac{P \times 54^2}{340 \times 162}$

$70 = 0.03571P + 0.05294P$

$70 = 0.08865P$

$P = 789.612$ ts

Virtual loss of GM

FORMULA (A)

$\frac{P \times KG\ (solid)}{W - P}$

$= \frac{789.612 \times 7.6}{29000 - 789.612}$

$= 0.213m$

FORMULA (B)

$\frac{P \times KM\ (Final)}{W\ (Initial)}$

$= \frac{789.612 \times 8.4}{29000}$

$= 0.229m$

KM: 8.400m
KG: 7.600m
GM: 0.800m

Initial GM: 0.800m
V. loss of GM: 0.229m
Residual GM: 0.571 Ans

Rise = $\frac{P}{TPC} = \frac{789.612}{28 \times 100} = 0.282m$

$T_c = \frac{P \times RF}{MCTC \times 100} = \frac{789.612 \times 54}{340 \times 100} = 1.254m$

$T_a = \frac{T_c \times LCF}{LBP} = \frac{1.254 \times 78}{162} = 0.604m$

$T_f = T_c - T_a = 1.254 - 0.604 = 0.650m$

Draft	Fwd	Aft
Initial	8.700	9.400
Rise	(-) 0.282	(-) 0.282
Tf/Ta	(-) 0.650	(+) 0.604
Final	7.768m	9.722m Ans

APR 2014 An oil tanker displacing 6000 m^3 floats at draft F: 5.1m, A: 5.8m. The vessel grounds on a falling tide, on a rock, at a position 28m forward of amidship. Calculate the up-thrust force on the ship's bottom and the F&A draft after the tide has fallen by 25 cms. The hydrostatic curve of the vessel for the above drafts show the following data: LBP = 166 m, centre of Floatation 6m abaft midship, Water plane area = 1850 m^2, GM_L = 550

Soln:

Displacement = $\frac{\text{Displacement}}{\text{density}}$

$= 6000 \times 1.025$

$= 6150\ t$

$MCTC = \frac{W \times GM_L}{100L}$

$= \frac{6150 \times 550}{100 \times 166}$

$= 203.765\ tm$

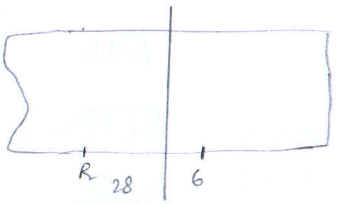
$TPC = \frac{A}{100} \times RD$

$= \frac{1850}{100} \times 1.025$

$= 18.963\ t/cm$

Reduction in draft = 25 cm

RF = 34 m



Reduction in draft at R $= \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$

$25 = \frac{P}{18.963} + \frac{P \times 34^2}{203.765 \times 166}$

$25 = 0.05273P + 0.03418P$

$25 = 0.08691P$

$P = 287.654\ ts$ → upthrust

Ans

Rise $= \frac{P}{TPC \times 100}$

$= \frac{287.654}{18.963 \times 100} = 0.152m$

$$T_c = \frac{P \times RF}{MCTC \times 100}$$

$$= \frac{287.654 \times 34}{203.765 \times 100}$$

$$= 0.480m$$

$$Ta = \frac{T_c \times LCF}{LBP}$$

$$= \frac{0.480 \times 77}{166}$$

$$= 0.223m$$

$$Tf = Tc - Ta$$

$$= 0.480 - 0.223$$

$$= 0.257m$$

Draft	Fwd	Aft
Initial	5.100	5.800
Rise	(-) 0.152	(-) 0.152
Tf / Ta	(-) 0.257	(+) 0.223
Final	4.691m	5.871m

OCT 2015 A vessel has the following particulars: LBP: 140m, MCTC: 130tm, COF: 3m forward of center, TPC = 18, Displacement: 6240 mt, KM: 6.4m, KG: 5.8m, Draft forward: 5.23m, Aft: 5.74m. She grounds lightly on a rock 12m abaft the stem. The tide then falls by 80 cm. Calculate the virtual GM and her draft forward and aft

Ans:-

Reduction in draft = 80cm

RF = 55m

$$\text{Reduction in draft at R} = \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$$

$$80 = \frac{P}{18} + \frac{P \times 55^2}{130 \times 140}$$

$$80 = 0.05556P + 0.16621P$$

$$80 = 0.22177P$$

$$P = 360.734 \text{ ts}$$

Virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(solid)}{W - P}$$

$$= \frac{360.734 \times 5.8}{6240 - 360.734}$$

$$= 0.356m$$

FORMULA (B)

$$\frac{P \times KM(Final)}{W(Initial)}$$

$$= \frac{360.734 \times 6.4}{6240}$$

$$= 0.370m$$

KM: 6.400m

KG: 5.800m

GM: 0.600m

Initial GM: 0.600m

V. loss of GM: 0.370m

Residual GM: 0.230m ≡ Ans

$$\text{Rise} = \frac{P}{TPC \times 100} = \frac{360.734}{18 \times 100} = 0.200m$$

$$T_c = \frac{P \times RF}{MCTC \times 100} = \frac{360.734 \times 55}{130 \times 100} = 1.526m$$

$$T_a = \frac{T_c \times LCF}{LBP} = \frac{1.526 \times 73}{140} = 0.796m$$

$$T_f = T_c - T_a = 1.526 - 0.796$$

$$= 0.730m$$

Draft	Fwd	Aft
Initial	5.230	5.740
Rise	(-) 0.200	(-) 0.200
Tf/Ta	(-) 0.730	(+) 0.796
Final	4.300m	6.336m

Ans

***

OCT 2014, APRIL 2015, JAN 2017 MAY 2022 OCT 2023

A vessel of L = 140m, W = 16000t, MCTC = 190mt, TPC = 24t, LCF = 72m, KM = 8.20m, KG = 7.2m, FSM = 1370 mt, draft FWD = 6.68m, Aft = 8.84m, Grounds on isolated rock, the draft then are FWD 5.88m and Aft 9.28m. Calculate following :-

(i) The upthrust provided by the rock
(ii) The position with respect to after perpendicular, where the grounding occured
(iii) The virtual GM(F) of the vessel then
(iv) The angle of heel if she had grounded 3m to stbd of centerline
(v) The rise in tide required for the vessel to refloat

Soln :-

(i) 1. Find initial H.D

$$\text{Trim} = 8.84 - 6.68$$
$$= 2.16\text{m}$$

$$\text{Corr}^n \text{ to after draft} = \frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$$
$$= \frac{2.16 \times 72}{140}$$
$$= 1.111\text{m}$$

Aft draft : 8.84m
Corr^n : (-) 1.111m
Initial H.D : 7.729m

2. Find Final H.D

$$\text{Trim} = 9.28 - 5.88$$
$$= 3.40\text{m}$$

$$\text{Corr}^n \text{ to after draft} = \frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$$
$$= \frac{3.4 \times 72}{140}$$
$$= 1.749\text{m}$$

Aft draft : 9.280m
Corr^n : 1.749m
Final H.D : 7.531m

3. Find P

Initial H.D : 7.729m
Final H.D = 7.531m
Rise = 0.198m

$$\text{Rise} = \frac{P}{TPC \times 100}$$

$$0.198 = \frac{P}{24 \times 100}$$

$$\boxed{P = 475.2 \text{ ts}}$$ —— Ans (i)

(ii) Position w.r.t AP, where grounding occurs

Initial trim : 2.160m
Final trim : 3.400m
T_c : 1.240m

$$T_c = \frac{P \times RF}{MCTC \times 100}$$

$$1.240 = \frac{475.2 \times RF}{190 \times 100}$$

$$23560 = 475.2 \times RF$$

$$RF = 49.579 \text{ m}$$

Posn w.r.t to AP = 49.579 + 72 = $\boxed{121.579 \text{ w.r.t AP}}$

(iii) virtual GM

virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(solid)}{W-P}$$

$$= \frac{475.2 \times 7.2}{16000 - 475.2}$$

$$= 0.220 \text{m}$$

FORMULA (B)

$$\frac{P \times KM(Final)}{W(Initial)}$$

$$= \frac{475.2 \times 8.2}{16000}$$

$$= 0.244 \text{m}$$

KM : 8.200m
KG : 7.200m
GM(solid) : 1.000m
FSC : 0.088m $\left(FSM/_{W-P} = 1370/_{15524.8}\right)$
GM(F) : 0.912m

Initial GM : 0.912m
V.loss of GM : 0.220m
Residual GM : 0.692m

Initial GM : 0.912m
V.loss of GM : 0.244m
Residual GM : $\boxed{0.668 \text{m}}$ Ans

(iv) $\tan\theta = \frac{LM}{W \times GM}$

$\tan\theta = \frac{P \times d}{W \times GM}$

$\tan\theta = \frac{475.2 \times 3}{15524.8 \times 0.668}$

$\tan\theta = 0.137466$

$\theta = 7.83^\circ$ to port

(v) Rise in tide required to afloat = Reduction at R

Reduction in draft at R $= \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$

$= \frac{475.2}{24} + \frac{475.2 \times 49.579^2}{190 \times 140}$

$= 19.8 + 43.913$

$= 63.713$

$= 0.637\,m$ Ans

APR 2018
APRIL 2023
OCT 2024
JAN 2025 PM

A vessel of L 148m, LCF 70m, draft forward 8.00m, draft aft 9.80m, TPC 32, MCTC 264 lightly grounds on gently sloping seabed. Sounding taken at that instant showed forward depth as 8.00m and aft depth as 10.9m. Find the draft after tide falls by (a) 30 cm (b) 2.00m.

Soln:-

For (a)

Reduction in fwd draft = 30 cm
(bcz fwd part grounded)

[Since depth & draft is same at forward end. Hence, fwd part is grounded]

For afloat,

Reduction in fwd draft = Rise + T_f

$$\text{Reduction in fwd draft} = \frac{P}{TPC} + \frac{P \times (L-LCF)^2}{MCTC \times LBP}$$

$$30 = \frac{P}{32} + \frac{P \times (148-70)^2}{264 \times 148}$$

$$30 = 0.03125P + 0.15571P$$

$$30 = 0.18696P$$

$$P = 160.462 \text{ ts} \checkmark$$

For sitting overay

$$T_C = \frac{P \times (L-LCF)}{MCTC \times 100}$$

Initial trim = 1.8 m
Final trim = 2.9 m (If sitting overay slope of seabed will be final trim)
T_C = 1.1 m

$$1.1 = \frac{P \times (148-70)}{264 \times 100}$$

$$29040 = P \times 78$$

$$P = 372.30 \text{ ts}$$

P(afloat) < P(sitting overay

Hence, vessel is afloat

$$P = 160.462 \text{ ts}$$

$$\text{Rise} = \frac{P}{TPC} = \frac{160.462}{32 \times 100} = 0.050 \text{m}$$

$$T_C = \frac{P \times (L-LCF)}{MCTC \times 100} = \frac{160.462 \times (148-70)}{264 \times 100} = 0.474 \text{m}$$

$$Ta = \frac{Tc \times LCF}{LBP} = \frac{0.474 \times 70}{148} = 0.224\,m$$

$$Tf = Tc - Ta = 0.474 - 0.224$$
$$= 0.250\,m$$

Draft	Fwd	Aft
Initial	8.000	9.800
Rise	(-) 0.050	(-) 0.050
Tf/Ta	(-) 0.250	(+) 0.224
Final	7.700m	9.974m

= Ans

For (b)

For afloat,

Reduction in fwd draft = $\frac{P}{TPC} + \frac{P \times (L-LCF)^2}{MCTC \times LBP}$

$$200 = \frac{P}{32} + \frac{P \times (148-70)^2}{264 \times 148}$$

$$200 = 0.03125P + 0.15571P$$

$$200 = 0.18696P$$

$$P = 1069.748\,ts$$

For sitting overall

$$P = 372.30\,ts$$

P(afloat) > P(sitting overall)

Hence, vessel is sitting overall

Since, fwd already touch, fwd draft & fwd depth is 8.0m

So, if tide falls by 2.0m

Fwd draft = 8.0 - 2.0

= 6.0m

Since, vessel is sitting overall

Trim of vessel = slope of seabed = 2.9m

Fwd draft : 6.0m

Trim : 2.9m

Aft draft : 8.9m

JUNE 2022 A ship of L = 200m, W = 50000T, MCTC = 250tm, KM 10m, KG 5m, TPC = 50t, LCF 105m, Draft F: 10m/A: 11m, grounds lightly on an isolated rock in falling tide. At low water, the drafts are founds to be F 9.5m, A 11m. Calculate the following:

a) Position of grounding from the forward perpendicular

b) Rise in tide required to refloat the vessel

c) Position of grounding from the centerline, if ship listed 5° to port at low water.

Soln:- (a)

1. Find initial H.D

Initial Trim = 1.0m

Correction to after draft = $\frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$

$= \frac{1 \times 105}{200}$

$= 0.525\text{m}$

Aft draft : 11.000m

Corrn : 0.525m

Initial H.D : 10.475m

2. Find Final H.D

Final Trim = 1.5m

Correction to after draft = $\frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$

$= \frac{1.5 \times 105}{200}$

$= 0.788\text{m}$

Aft draft = 11.000m

Corrn = 0.788m

Final H.D = 10.212m

3. Find P

Initial H.D = 10.475m

Final H.D = 10.212m

Rise = 0.263m

$\text{Rise} = \frac{P}{\text{TPC} \times 100}$

$0.263 = \frac{P}{50 \times 100}$

$P = 1315 \text{ ts}$

Initial trim = 1.0m
Final trim = 1.5m

$T_C = 0.5m$

$$T_C = \frac{P \times RF}{MCTC \times 100}$$

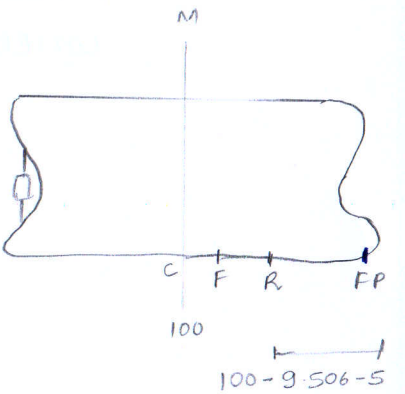
$$0.5 = \frac{1315 \times RF}{250 \times 100}$$

$$12500 = 1315 \times RF$$

$$RF = 9.506m$$

Posⁿ of grounding from FP = 100 − 9.506 − 5

= 85.495m Ans



(b) Rise in tide required to afloat = Reduction at R

Reduction in draft at R = $\frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$

$$= \frac{1315}{50} + \frac{1315 \times 9.506^2}{250 \times 200}$$

$$= 26.3 + 2.377$$

$$= 28.677 \text{ cm}$$

$$= 0.287m$$

(c) Virtual loss of GM

(A) $\frac{P \times KG(solid)}{W - P}$

$\frac{1315 \times 5}{50000 - 1315}$

$= 0.135m$

(B) $\frac{P \times KM(Final)}{W(Initial)}$

$\frac{1315 \times 10}{50000}$

$= 0.263m$

KM : 10.000m
KG : 5.000m
GM : 5.000m

Initial GM: 5.000m
V. loss of GM : 0.263m
Residual GM: 4.737m

$\tan\theta = \frac{LM}{W \times GM}$

$\tan\theta = \frac{P \times d}{W \times GM}$

$\tan 5^\circ = \frac{1315 \times d}{48685 \times 4.737}$

d = 15.344m Stbd of CL Ans

JULY 2022

A ship of L=150m drawing 5.0m forward and 7.0 aft. Her W = 13000t, TPC = 23, LCF = 73.50m runs aground at a point 20m aft of forward perpendicular. After grounding the drafts are found to be 4.6m forward and 7.0m aft. Find

(a) Rise in tide required for the vessel to refloat

(b) Upthrust experienced by the hull due to grounding

Soln:-

(b) To find initial H.D,

Initial trim = 2.0m

Correction to after draft = $\frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$

$= \frac{2 \times 73.50}{150}$

$= 0.980m$

Draft aft : 7.000m

corrn : 0.980m

Initial H.S draft : 6.020m

To find Final H.D,

Final trim = 2.4m

Correction to after draft = $\frac{2.4 \times 73.50}{150}$

$= 1.176m$

Draft aft : 7.000m

corrn : 1.176m

Final H.S draft : 5.824m

Initial H.S draft : 6.020m

Final H.S draft : 5.824m

Rise = 0.196m

$\text{Rise} = \frac{P}{TPC} \Rightarrow 0.196 = \frac{P}{23 \times 100} \Rightarrow \boxed{P = 450.8 \text{ ts}}$

(a) Rise in tide required to refloat = Reduction of draft at R

$\text{Reduction of draft at R} = \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$

$= \frac{450.8}{23} + \frac{450.8 \times 56.5^2}{636.755 \times 150}$

$= 19.6 + 15.067$

$= 34.67 \text{ cm}$

$= 0.347m$

In Question, MCTC not given

Initial trim = 2.0m

Final trim = 2.4m

0.4m

$T_c = \frac{P \times RF}{MCTC \times 100}$

$0.4 = \frac{450.8 \times 56.5}{MCTC \times 100}$

MCTC = 636 755 tm

JAN 2025AM A vessel of displacement 29,000t, length 200m, Fwd draft 7m and aft draft 8.5m runs aground without any damage to her hull. Her MCTC 250tm/cm and TPC 20t/cm, LCF 105m, FSM 1000tm, KM 8.5m, KG 7.8, Tide then falls by 50cm. The drafts then observed were to be Fwd 7.8m and aft 7.5m. Calculate with reference to COF:

(a) The location where the grounding occurred

(b) The residual GM

Soln:-

(a) Falls in tide = Reduction in aft draft = 50cm (bcz aft part is grounded)

For afloat,

Reduction in aft draft = $\frac{P}{TPC} + \frac{P \times LCF^2}{MCTC \times LBP}$ (Rise + Ta)

$$50 = \frac{P}{20} + \frac{P \times 105^2}{250 \times 200}$$

$$50 = 0.05P + 0.2205P$$

$$50 = 0.2705P$$

$$P = 184.843 \text{ ts}$$ ✓ 369.686

For sitting overall,

$$T_c = \frac{P \times LCF}{MCTC \times 100}$$

Initial trim = 1.5m

Final trim = 0.3m

T_c = 1.2m

$$1.2 = \frac{P \times 105}{250 \times 100}$$

$$P = 285.714 \text{ ts}$$ 428.571

P(afloat) < P(sitting overall)

Hence, vessel is afloat

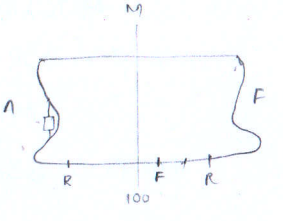
$P = 184.843$ ts

To calculate the position where grounding occured is

$$T_c = \frac{P \times RF}{MCTC \times 100}$$

$$1.2 = \frac{184.843 \times RF}{250 \times 100}$$

$$RF = 162.3 \text{ m}$$



JAN 2025 AM

A vessel of displacement 29,000t, length 200m, Fwd draft 7m and aft draft 8.5m runs aground without any damage to her hull. Her MCTC 250 tm/cm and TPC 20t/cm, LCF = 105m, FSM = 1000 tm, KM 8.5m, KG 7.8, Tide then falls by 50 cm. The draft then observed were to be Fwd 7.8m and aft 7.5m. Calculate with reference to COF:

(a) The location where the grounding occurred

(b) The residual GM

Soln:- (a) Fall in tide = Reduction in draft at R = 50cm

Initial H.D :-

Trim = 1.5

$$\text{Corr}^n \text{ to aft draft} = \frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$$

$$= \frac{1.5 \times 105}{200} = 0.7875$$

Aft draft : 8.500m

Corr^n : 0.7875m

Initial H.D : 7.7125m

Final H.D :

Trim = 0.3 m

$$\text{Corr}^n \text{ to aft draft} = \frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$$

$$= \frac{0.3 \times 105}{200} = 0.1575\text{m}$$

Aft draft : 7.5m

Corr^n : (+)0.1575m

Final H.D : 7.6575m

Initial H.D : 7.7125m

Final H.D : 7.6575m

Rise : 0.055m

$$\text{Rise} = \frac{P}{\text{TPC} \times 100}$$

$$0.055 = \frac{P}{20 \times 100}$$

$$P = 110 \text{ t}$$

$$\text{Reduction in draft at R} = \frac{P}{\text{TPC}} + \frac{P \times RF^2}{\text{MCTC} \times \text{LBP}}$$

$$50 = \frac{110}{20} + \frac{110 \times RF^2}{250 \times 200}$$

$$50 = 5.5 + (0.0022 \times RF^2)$$

$$44.5 = 0.0022 \times RF^2$$

$$RF^2 = 20227.272$$

$$RF = 142.223\text{m}$$

Virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(\text{solid})}{W-P}$$

$$= \frac{110 \times 7.8}{29000-110}$$

$$= 0.030\,m$$

FORMULA (B)

$$\frac{P \times KM(\text{Final})}{W(\text{Initial})}$$

$$= \frac{110 \times 8.5}{29000}$$

$$= 0.032\,m$$

KM : 8.500 m

KG : 7.800 m

GM : 0.700 m

FSC : 0.035 m $\left(FSM/_{W-P} = 1000/_{28890}\right)$

GM(F) : 0.665 m

V.loss of GM : 0.032 m

Residual GM : 0.633 m Ans

THEORY FOR M.V HINDSHIP GROUNDING QUESTION

1) In M.V Hindship, if initial & final draft is given, find H.S draft & displacement for each of these draft.
Difference between displacement will give P

2) Distance of the rock will be converted to LCG

Step① - From initial draft, find initial LCG by trim formula

$$\text{Trim} = \frac{(LCB - LCG)}{MCTC \times 100} \times \text{disp.}$$

Step② - Similarly from final draft, find final LCG

Now assume x as posⁿ of grounding.
Find value of P by moment method

Remarks	W	LCG	L.moment
Initial	disp	I. LCG	L.moment
Grounding	P	x	L.moment

Final W: Final L.moment:

$$\text{Final LCG} = \frac{\text{Final L.moment}}{\text{Final W}}$$

we get value of x i.e. posⁿ of grounding

3) Rise of tide required to refloat =

Initial draft at R ~ Final draft at R

To find initial/final draft at R,

$$\text{corrⁿ to aft draft} = \frac{\text{trim} \times \text{dist(R) from AP}}{LBP}$$

Aft draft
(-) corrⁿ
draft at R

OCT 2012

M.V Hindship floating at draft F: 7.95m, A: 8.75m, KG 8.0 and FSC 0.09m, runs aground on a sloping beach at the forward end. External sounding showed that the depth of water at the aft end was 2.5m more than at the forward end. If the tide is expected to fall by 1m, what will be the new draft and GM(F)?

Soln:-

Reduction in fwd draft = 1m = 100cm
(bcz forward end is aground)

For afloat,

Reduction in fwd draft = Rise + Tf

$$\text{Reduction in fwd draft} = \frac{P}{TPC} + \frac{P \times (L - LCF)^2}{MCTC \times LBP}$$

To find H.S draft,

Trim = 0.8m

$$\text{Mean draft} = \frac{7.95 + 8.75}{2} = 8.35m$$

LCF at mean draft 8.35m = 70.281

8.2 70.409
0.2
8.4 70.238

$\frac{0.171}{0.2} \times 0.15$

$$\text{Corrn to after draft} = \frac{\text{Trim} \times LCF}{LBP}$$

$$= \frac{0.8 \times 70.281}{143.16}$$

$$= 0.393$$

Aft draft : 8.750m
Corrn : 0.393 m
H.S draft : 8.357m

Find TPC, MCTC, LCF, KM at draft 8.537m

8.2	23.66	200.2	70.409	8.270	17116
8.4	23.78	203.1	70.238	8.292	17598

$\frac{}{0.2} \times 0.157$

TPC = 23.754 t/cm

MCTC = 202.477 tm

LCF = 70.275m

KM = 8.287m

Disp = 17494.37 t

$$100 = \frac{P}{23.754} + \frac{P \times (143.16 - 70.275)^2}{202.477 \times 143.16}$$

$$100 = 0.04210P + 0.18326P$$

$$100 = 0.22536P$$

$$P = 443.734 \text{ ts}$$ ✓

For sitting overall,

$$T_C = \frac{P \times (L - LCF)}{MCTC \times 100}$$

Initial trim = 0.8m

Final trim = 2.5m (If sitting overall slope of seabed is final trim)

T_C = 1.7m

$$1.7 = \frac{P \times (143.16 - 70.275)}{202.477 \times 100}$$

$$P = 472.266 \text{ ts}$$

P(afloat) < P(sitting overall)

Hence, vessel is still afloat

$$P = 443.734 \text{ ts}$$

$$W - P$$
$$= 17494.37 - 443.734$$
$$= 17050.636 \text{ ts}$$

Find H.S draft, TPC, MCTC, LCF, KM at 17050.636 t,

16635	8.00	23.54	197.4	70.595	8.250
17116	8.20	23.66	200.2	70.409	8.270

$$\frac{0.2}{481} \times 415.636$$
$$=$$

H.S draft = 8.173m

TPC = 23.644 t/cm

MCTC = 199.820 tm

LCF = 70.434 m

KM = 8.267m

For afloat,

H.S draft : 8.357m

Fwd draft after tide falls : 6.950 m

T_f = 1.407

$$T_f = \frac{T_C \times (L - LCF)}{LBP}$$

$$1.407 = \frac{T_C \times (143.16 - 70.275)}{143.16}$$

T_C = 2.764m

$$T_C = \frac{P \times (L - LCF)}{MCTC \times 100}$$

$$2.764 = \frac{P \times (143.16 - 70.275)}{202.477 \times 100}$$

P = 767.849 ts

For sitting overall

P = 443.734

P(afloat) > P(sitting overall)

Hence, vessel is sitting overall

Fwd draft : 6.95m

Trim : 2.50 m

Aft draft : 9.45m

Trim = 2.50m

LCF at mean draft 8.20m = 70.409

Corrⁿ to aft draft = $\frac{\text{Trim} \times LCF}{LBP}$

$$= \frac{2.5 \times 70.409}{143.16}$$

= 1.230m

Aft draft = 9.450m

Corrⁿ = 1.230m

Final H.S draft = 8.220m

$$T_C = \frac{P \times (L - LCF)}{MCTC \times 100} = \frac{443.734 \times (143.16 - 70.434)}{199.820 \times 100}$$

$$= \frac{443.734 \times 72.726}{19982}$$

$$= 1.615m$$

$$T_a = \frac{T_C \times LCF}{LBP} = \frac{1.615 \times 70.434}{143.16}$$

$$= 0.795m$$

$$T_f = T_C - T_a = 1.615 - 0.795 = 0.820m$$

Draft	Fwd	Aft
Final H.S	8.173	8.173
Tf/Ta	(-) 0.820	(+) 0.795
Final	7.353m	8.968m

W at F.HD 8.220m = 17164.2

W at I.HD 8.357m = 17494.37

P = 330.17 ts

KM at 17164.2 = 8.272m

(A) $\frac{330.17 \times 8.0}{17164.2} = 0.154$

(B) $\frac{330.17 \times 8.272}{17494.37} = 0.156m$

KM = 8.272m

KG = 8.000m

GM(S) = 0.272m

FSC = 0.092m $\left(\frac{1574.493}{17164.2}\right)$

GM(F) = 0.180m

V.loss of GM = 0.156m

Residual GM = 0.024m

Virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(solid)}{W - P}$$

$$= \frac{443.734 \times 8.0}{17050.636}$$

$$= 0.208m$$

FORMULA (B)

$$\frac{P \times KM(Final)}{W(initial)}$$

$$= \frac{443.734 \times 8.267}{17494.37}$$

$$= 0.210m$$

Before, FSC = $\frac{FSM}{W}$

FSM = 0.09 × 17494.37

= 1574.493

After, FSC = $\frac{FSM}{W}$

$= \frac{1574.493}{17050.636} = 0.092m$

KM : 8.267m

KG : 8.000m

GM(S): 0.267m

FSC : 0.092m

GM(F): 0.175m

V.loss of GM: 0.210m

Residual GM: **-0.035m** Ans

JAN 2018
JAN 2023

M.V Hindship sailed from port with draft F 8.800m and A 9.200m respectively with KG 7.850m and FSM 1950 tm. On her voyage she grounded on a isolated rock, without damage to her hull. The draft then were observed to be F 8.300m and A 9.300m. Determine (i) The position w.r.t AP where the grounding occurred
(ii) Virtual GM of the ship in this condition
(iii) Rise in tide required to refloat the vessel.

Soln:-

Step ① : Find Initial H.S draft & disp.

Trim = 0.4m

Mean draft = 9.0m

LCF at mean draft = 69.768m

Corrn to aft draft = $\frac{0.4 \times 69.768}{143.16}$

= 0.195m

After draft = 9.200m

Corrn = 0.195m

H.S draft = 9.005m

Initial disp at draft 9.005m = 19063.15t

Step ② : Find Final H.S draft & disp

Trim = 1.0m

Mean draft = 8.8m

LCF at mean draft 8.8m = 69.911m

Corrn to aft draft = $\frac{1 \times 69.911}{143.16}$

= 0.488m

After draft = 9.300m

Corrn = 0.488m

H.S draft = 8.812m

Final disp at draft 8.812m = 18594.16t

P = Initial disp - Final disp

P = 19063.15 - 18594.16

P = 468.99 ts

Step ③ : Find Initial LCG

LCB at 9.005m = 72.286m

MCTC at 9.005m = 211.868 tm

Trim = 0.4m

$$\text{Trim} = \frac{(LCB - LCG)}{MCTC \times 100} \times \text{disp}$$

$$0.4 = \frac{(72.286 - LCG)}{211.868 \times 100} \times 19063.15$$

$$0.444 = 72.286 - LCG$$

$$\text{Initial } LCG = 71.841\,m$$

Step ④ : Find Final LCG

LCB at 8.812m = 72.347m

MCTC at 8.812m = 209.168tm

Trim = 1.0m

$$\text{Trim} = \frac{(LCB - LCG)}{MCTC \times 100} \times \text{disp}$$

$$1.0 = \frac{(72.347 - LCG)}{209.168 \times 100} \times 18594.16$$

$$1.125 = 72.347 - LCG$$

$$\text{Final } LCG = 71.222\,m$$

(i)

Remarks	W	LCG	L.moment
Initial	19063.15	71.841	1369515.759
P	(-) 468.99	x	(-) 468.99x

Final W : 18594.16 Final L.moment : 1369515.759 − 468.99x

$$\text{Final LCG} = \frac{\text{Final L.moment}}{\text{Final W}}$$

$$71.222 = \frac{1369515.759 - 468.99x}{18594.16}$$

$$1324313.264 = 1369515.759 - 468.99x$$

$$468.99x = 45202.496$$

$$\boxed{x = 96.383m \text{ from AP}}$$ Ans

(ii) KM at final disp 18594.16 t = 8.354m

Virtual loss of GM

FORMULA Ⓐ

$$\frac{P \times KG\,(solid)}{W - P}$$

FORMULA Ⓑ

$$\frac{P \times KM\,(Final)}{W\,(Initial)}$$

$= \frac{468.99 \times 7.85}{18594.16}$ $= \frac{468.99 \times 8.354}{19063.15}$

$= 0.198$ $= 0.206\,m$

KM : 8.354m

KG : 7.850 m

GM(s) : 0.504 m

FSC : 0.105 m ($FSM/W = 1950/18594.16$)

GM(F) : 0.399 m

V. loss of GM : 0.206 m

Residual GM : **0.193 m** Ans

(iii) Rise of tide required to refloat =

Initial draft at R ~ Final draft at R

To find Initial draft at R,

$$\text{corrn to aft draft} = \frac{\text{Trim} \times \text{dist (R) from AP}}{\text{LBP}}$$

$$= \frac{0.4 \times 96.383}{143.16}$$

$$= 0.269\,m$$

After draft = 9.200m

corrn = 0.269 m

Initial draft at R = 8.931 m

To find Final draft at R,

$$\text{corrn to aft draft} = \frac{\text{Trim} \times \text{dist (R) from AP}}{\text{LBP}}$$

$$= \frac{1.0 \times 96.383}{143.16}$$

$$= 0.673\,m$$

After draft = 9.300m

corrn = 0.673 m

Final draft at R = 8.627m

So, tide required to refloat = 8.931 − 8.627

= **0.304 m** Ans

OCT 2019

M.V Hindship in Condition No. 5 grounds at a single point, port off her centerline and 60m forward of her AP, without rupturing her bottom plating. The tide then falls by 20cm, listing her 3° to starboard. Calculate the following:

a) The upthrust provided at the point of grounding

b) The virtual GM(F) then

Soln:-

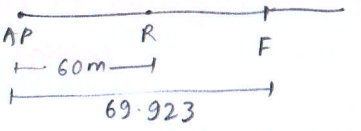
From cond. NO.5:- $W = 18529.3$ t

$TPC = 24.011$ t (by interpolation)

$MCTC = 208.8$ tm

$LCF = 69.923$ m

Grounding occurs 60m forward of AP



Hence $RF = LCF - 60$

$= 69.923 - 60$

$= 9.923$ m

Reduction in draft at $R = \frac{P}{TPC} + \frac{P \times RF^2}{MCTC \times LBP}$

$$20 = \frac{P}{24.011} + \frac{P \times 9.923^2}{208.8 \times 143.16}$$

$$20 = 0.04165P + 0.0003P$$

$$20 = 0.04494P$$

$$\boxed{P = 444.997 \text{ ts}}$$ Ans (a)

$W - P$

$= 18529.3 - 444.997$

$= 18084.3$ ts

Virtual loss of GM

FORMULA (A)

$$\frac{P \times KG(solid)}{W - P}$$

$$= \frac{444.997 \times 7.539}{18084.3}$$

$= 0.186$ m

FORMULA (B)

$$\frac{P \times KM(Final)}{W(Initial)}$$

$$= \frac{444.997 \times 8.319}{18529.3}$$

$= 0.200$ m

KM : 8.319 m

KG : 7.539 m

GM(S) : 0.780 m

FSC : 0.086 m (1552/18084.3)

GM(F) : 0.694 m

V. loss of GM : 0.200 m

Residual GM : 0.494 m Ans (b)

AN
024
CT
24 PM

M·V Hindship sailed from port in condition NO·8 soon after departure grounded on an isolated rock, without damage to her hull. The draft then were observed to be F 5·90m, A 9·30m. Calculate the following:

(i) The upthrust provided by the rock

(ii) The position with respect to AP, where the grounding occured.

Soln:-

Step①: Initial disp.

From condition NO·8 = 16133 t

Step②: Find Final H·S draft & disp

Trim = 3·4m

Mean draft = 7·6m

LCF at mean draft 7·6m = 70·979m

$$\text{Corrn to aft draft} = \frac{\text{Trim} \times \text{LCF}}{\text{LBP}}$$

$$= \frac{3·4 \times 70·979}{143·16}$$

$$= 1·686\text{m}$$

After draft = 9·300m

Corrn = 1·686m

H·S draft = 7·614m

Displacement at H·S draft 7·614m = 15725·76 t

(i) Upthrust, P = Initial disp − Final disp

= 16133 − 15725·76

= 407·24 ts Ans

(ii) Step③: Find Initial LCG

From condition NO·8,

LCG = 70·045m

Step④: Find Final LCG

LCB at 7·614m = 72·687m

MCTC at 7·614m = 191·996

Trim = 3·4m

$$\text{Trim} = \frac{(\text{LCB} - \text{LCG})}{\text{MCTC} \times 100} \times \text{disp}$$

$$3.4 = \frac{(72.687 - LCG)}{191.996 \times 100} \times 15725.76$$

$$4.151 = 72.687 - LCG$$

Final LCG = 68.536 m

Remarks	W	LCG	L.moment
Initial	16133	70.045	1130041
P	(-) 407.24	x	(-) 407.24x

Final W: 15725.76

Final L.moment : 1130041 - 407.24x

$$\text{Final LCG} = \frac{\text{Final L.moment}}{\text{Final W}}$$

$$68.536 = \frac{1130041 - 407.24x}{15725.76}$$

$$1077780.687 = 1130041 - 407.24x$$

$$407.24x = 52260.31264$$

$$x = \boxed{128.328 \text{ m}}$$

posn w.r.t AP where grounding occurs.