SHIP DESIGN PROJECT AND PRESENTATION

TO DESIGN A TRAWLER OF 600 m^3 FISHING CAPACITY

Under the supervision of

Dr. SHAHJADA TARAFDER
Professor, Dept of NAME
BUET.

Prepared by
AL-ARAFAT SIDDIQUE
Std ID- 1212013
ABDULLAH AL SAAD
Std ID-1212019

OWNERS REQUIREMENT

Payload (Fishing Hold Capacity): 600 m^3
Gross Tonnage : 324
Speed:12 knots
FISHING VOYAGE:21 DAYS
TRAWLER TYPE :STERN TRAWLER

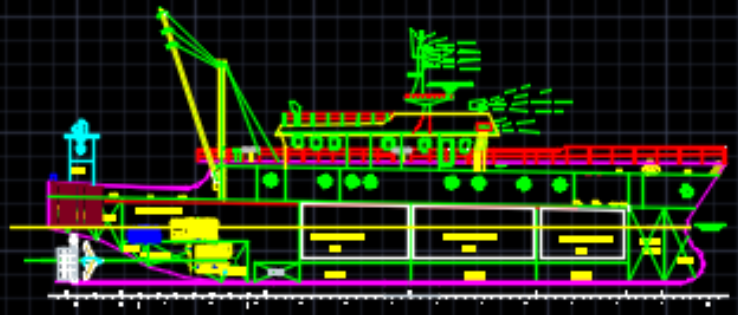
PRESENTATION CONTENTS

1. Principal Particulars
2. Updated General Arrangement
3. Lines Plan
4. Hydrostatic Calculations
5. Updated Scantling
6. Updated Midship Section Drawings
7. Updated Longitudinal Construction Drawings
8. Shell Expansion Drawings
9. Updated LWT and DWT
10. Updated Trim and Stability Calculation
11. Updated Resistance and power Calculation
12. Engine & Gearbox Selection
13. Rudder & Steering Arrangement
14. Propeller Design
15. Design of Shafting
16. Engine Foundation Drawings
17. Model presentation.

PRINCIPAL PARTICULARS

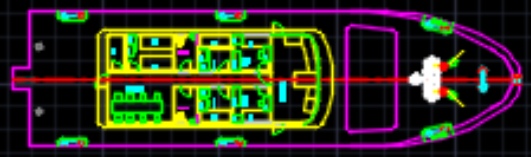
Length overall	: 45.04 m
Length between perpendiculars	: 40.69 m
Breadth MLD	: 9.0m
Depth MLD	: 4.8m
Draft MLD	: 3.65m

GENERAL ARRANGEMENT PLAN



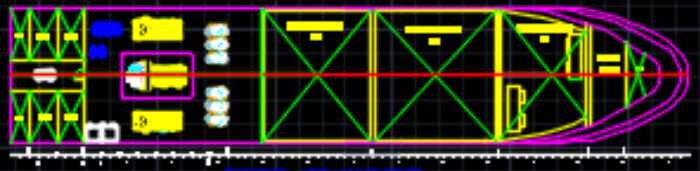
PROFILE

PRINCIPAL DIMENSIONS	
LENGTH OA	45.24m
LENGTH BETWEEN VA	37.77m
LENGTH BP	40.27m
BREADTH MLD	9.40m
DEPTH MLD	4.30m
DESIGN DRAUGHT	3.05m
DISPLACEMENT	965.27t
CAMBER	0.25m
MAINENGINE TYPE AND OUTPUT	
WARTSILA 9L20 1440kW×900r/min	
NAVIGATION AREA OCEAN AREA	
SPEED	12.00kn
ENDURANCE	3580 nauts
COMPLEMENT	27P
FUEL TANK	193.5m³
FRESH WATER TANK	115m³
FIRE TANK	240m³

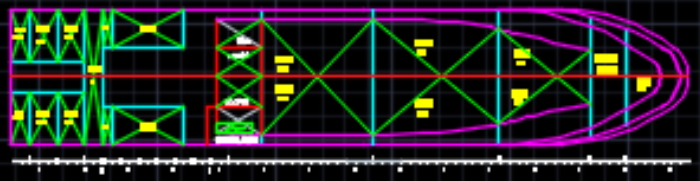


UPPER DECK

MAIN DECK

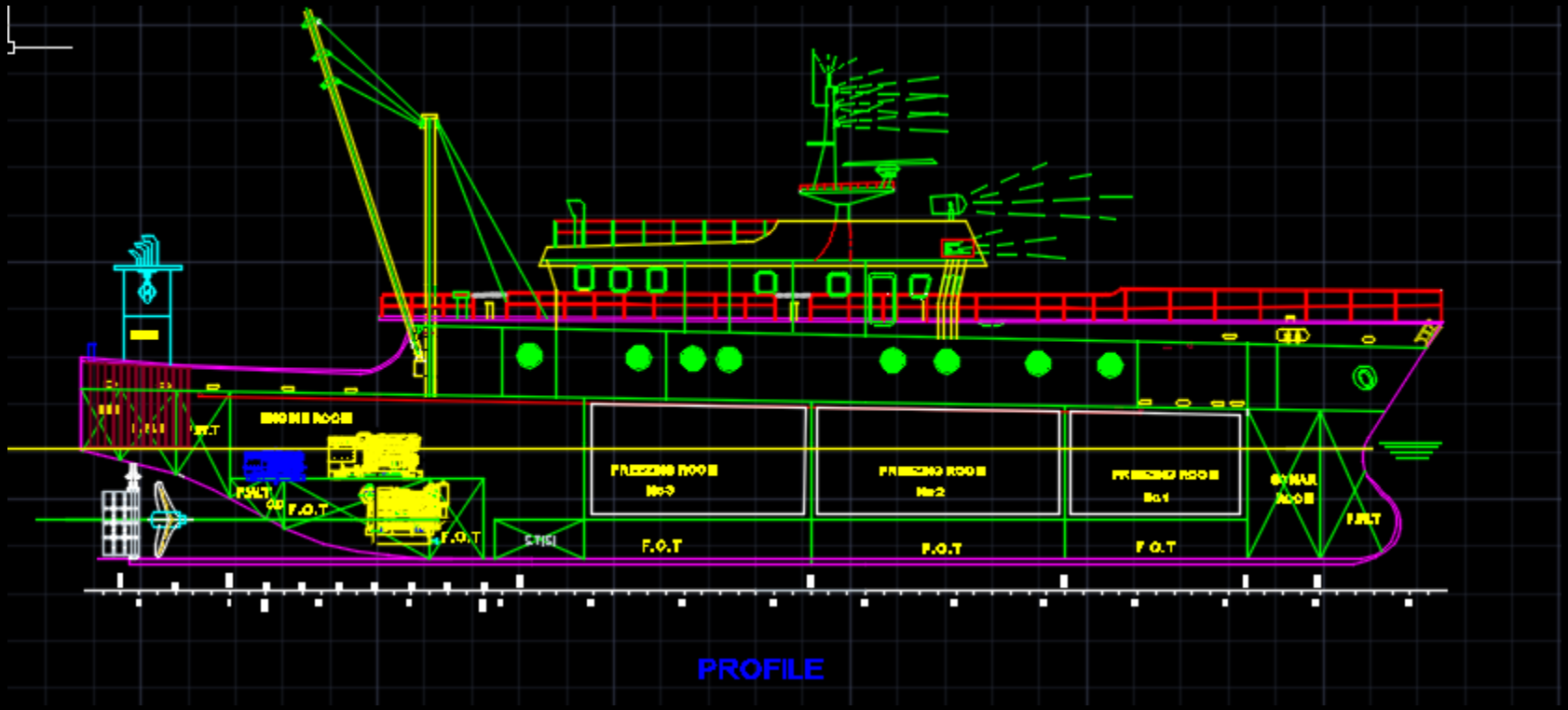


ENGINE ARRANGEMENT

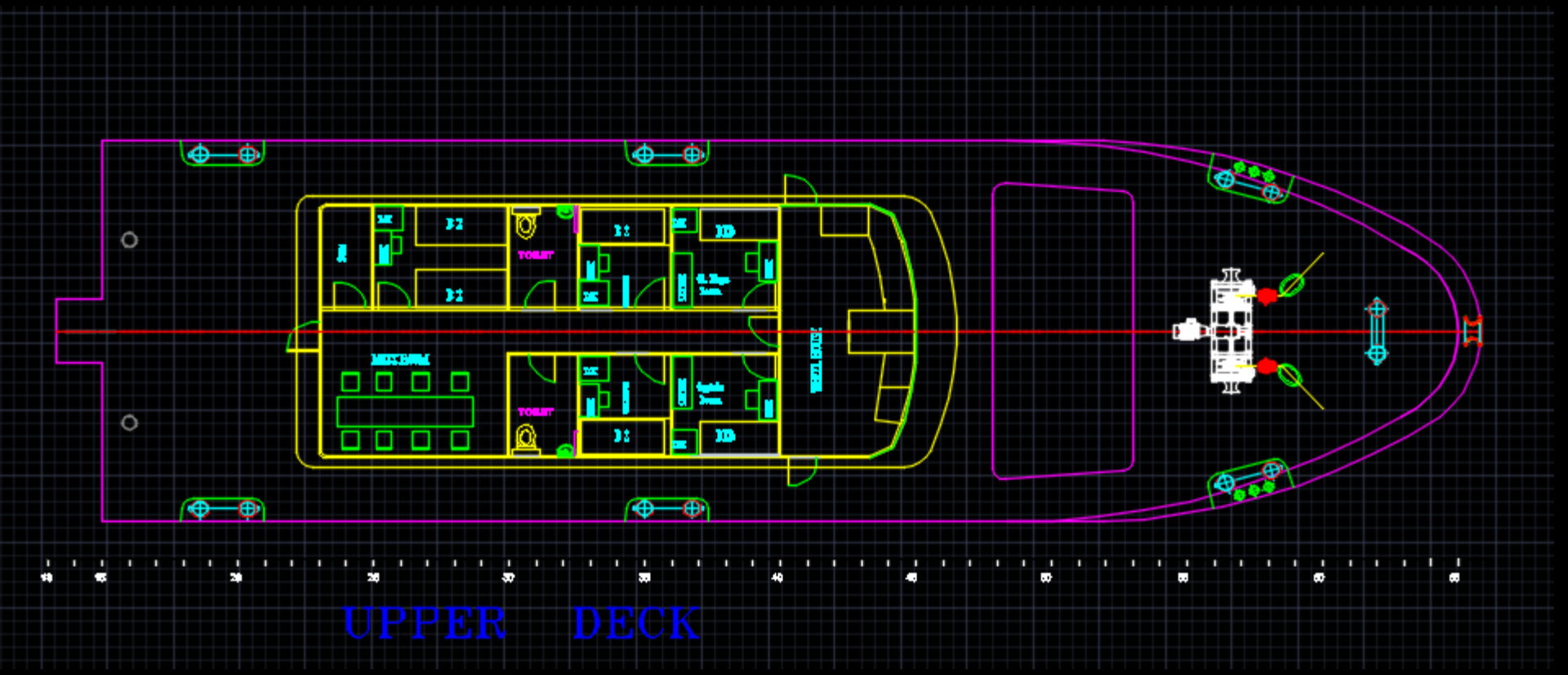


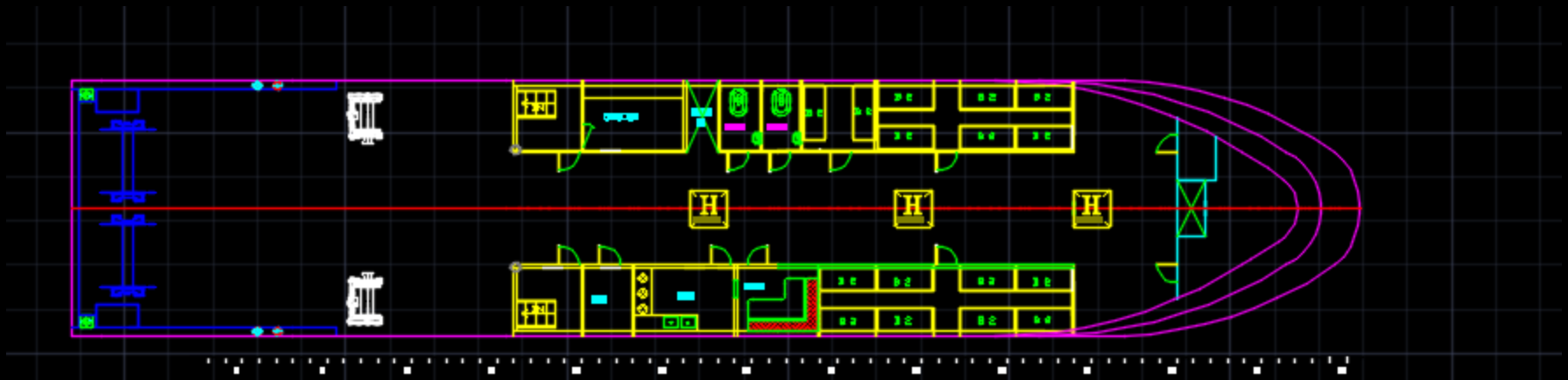
TANK ARRANGEMENT

600m3FISHING VESSEL
GENERAL ARRANGEMENT PLAN
NAME- ARAFAT, ABDULLAH
STD ID-1212013,1212019
SCALE-1100

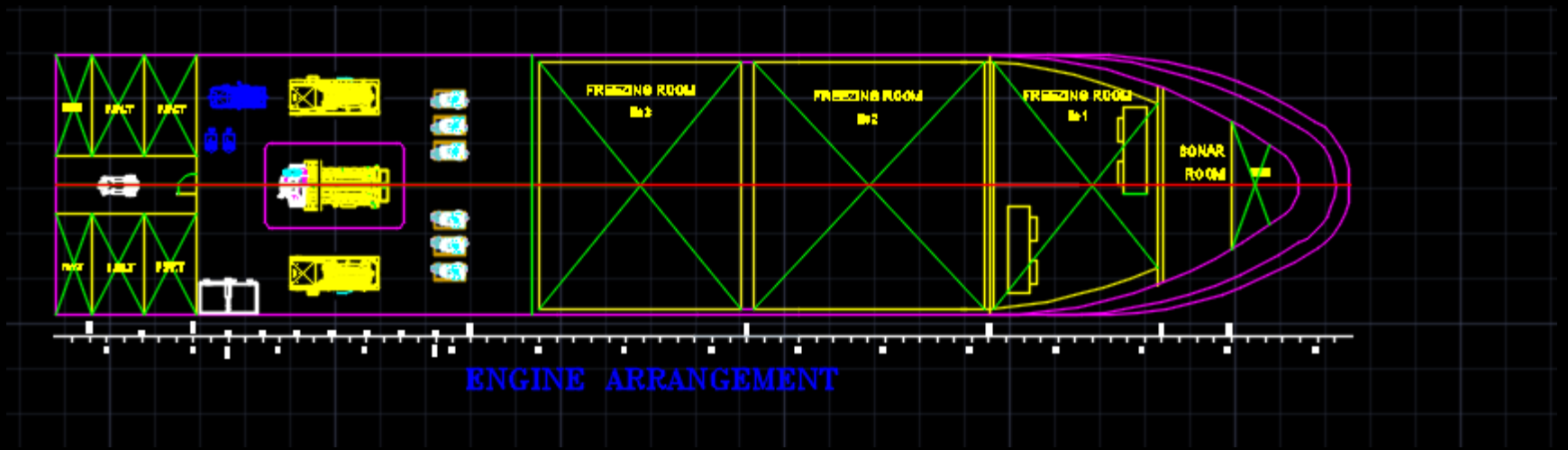


PROFILE

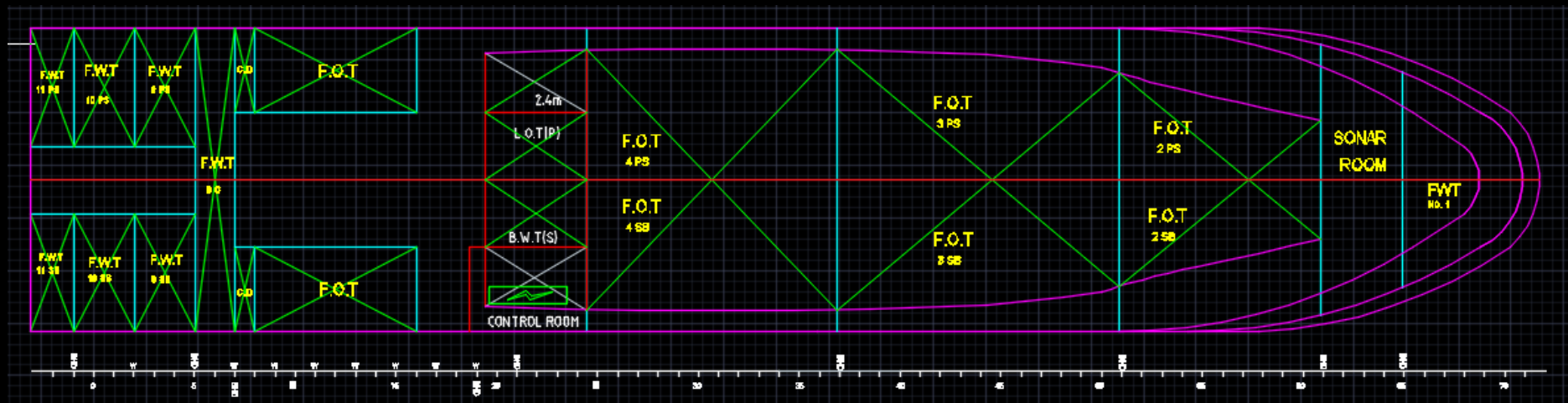

TOILET
TOILET
UPPER DECK



MAIN DECK



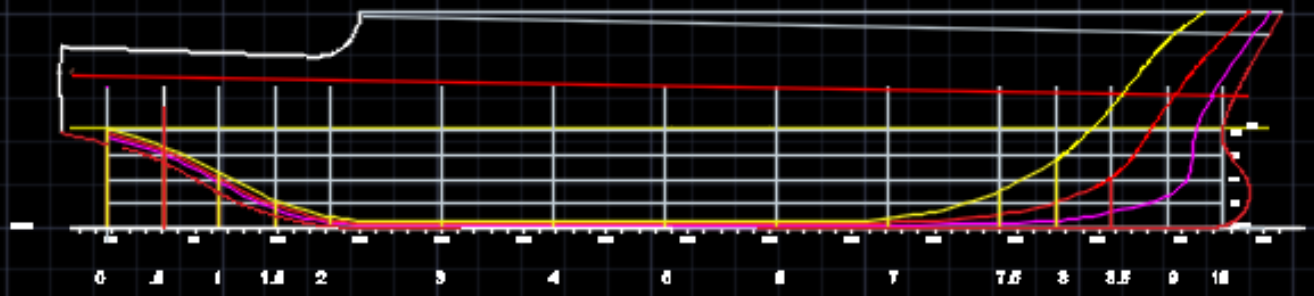
ENGINE ARRANGEMENT



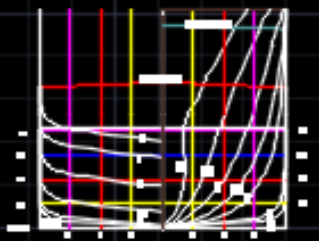
TANK ARRANGEMENT

LINES PLAN

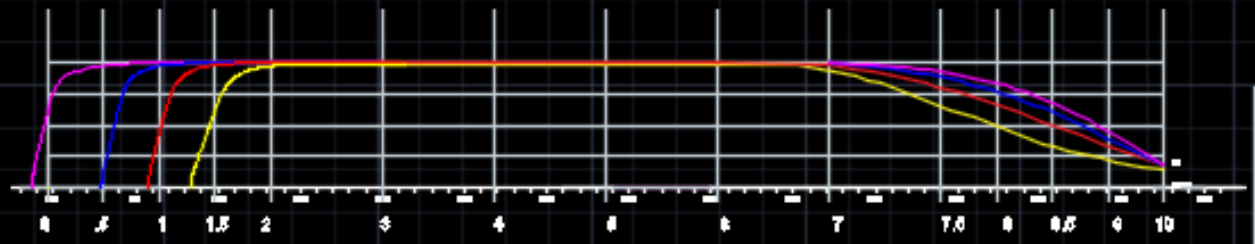
LINES PLAN



PROFILE

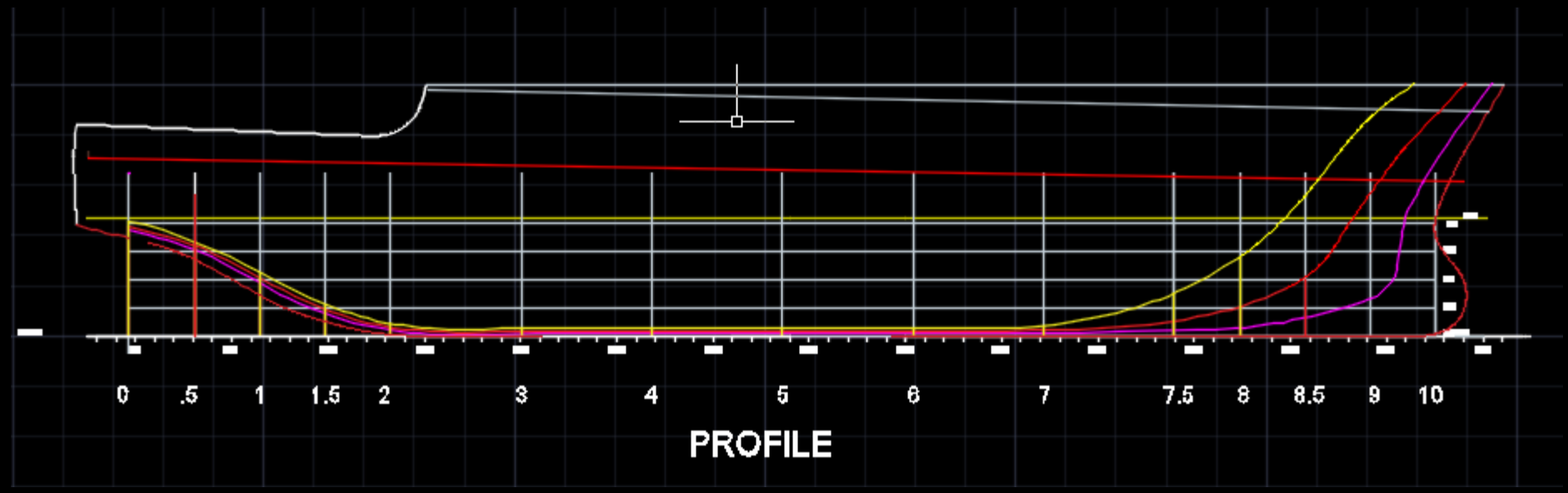


BODY PLAN

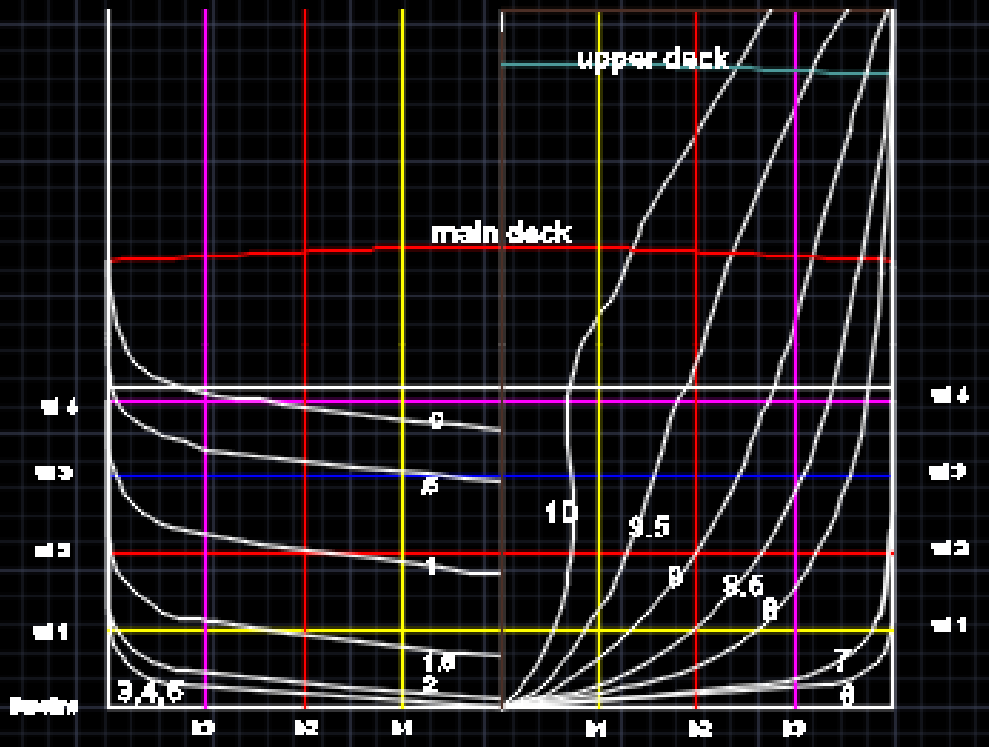


HALF BREADTH

FISHING VESSEL
LINES PLAN DRAWING
NAME- ARAFAT, ABDULLAH
STD ID-1212013,1212019
SCALE-1:100


0 .5 1 1.5 2 3 4 5 6 7 7.5 8 8.5 9 10
PROFILE


0 .5 1 1.5 2 3 4 5 6 7 7.5 8 8.5 9 10
HALF BREADTH



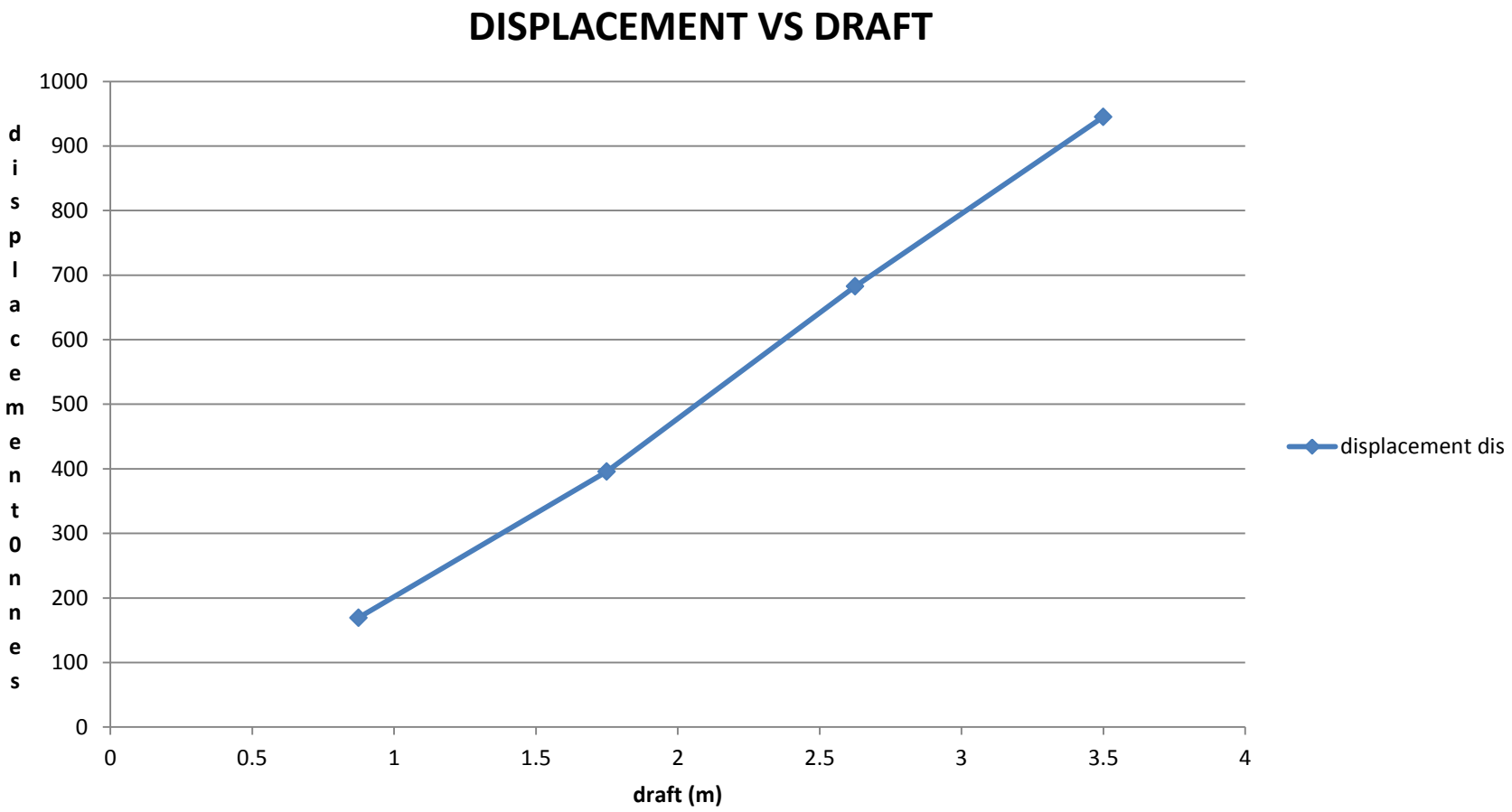
BODY PLAN

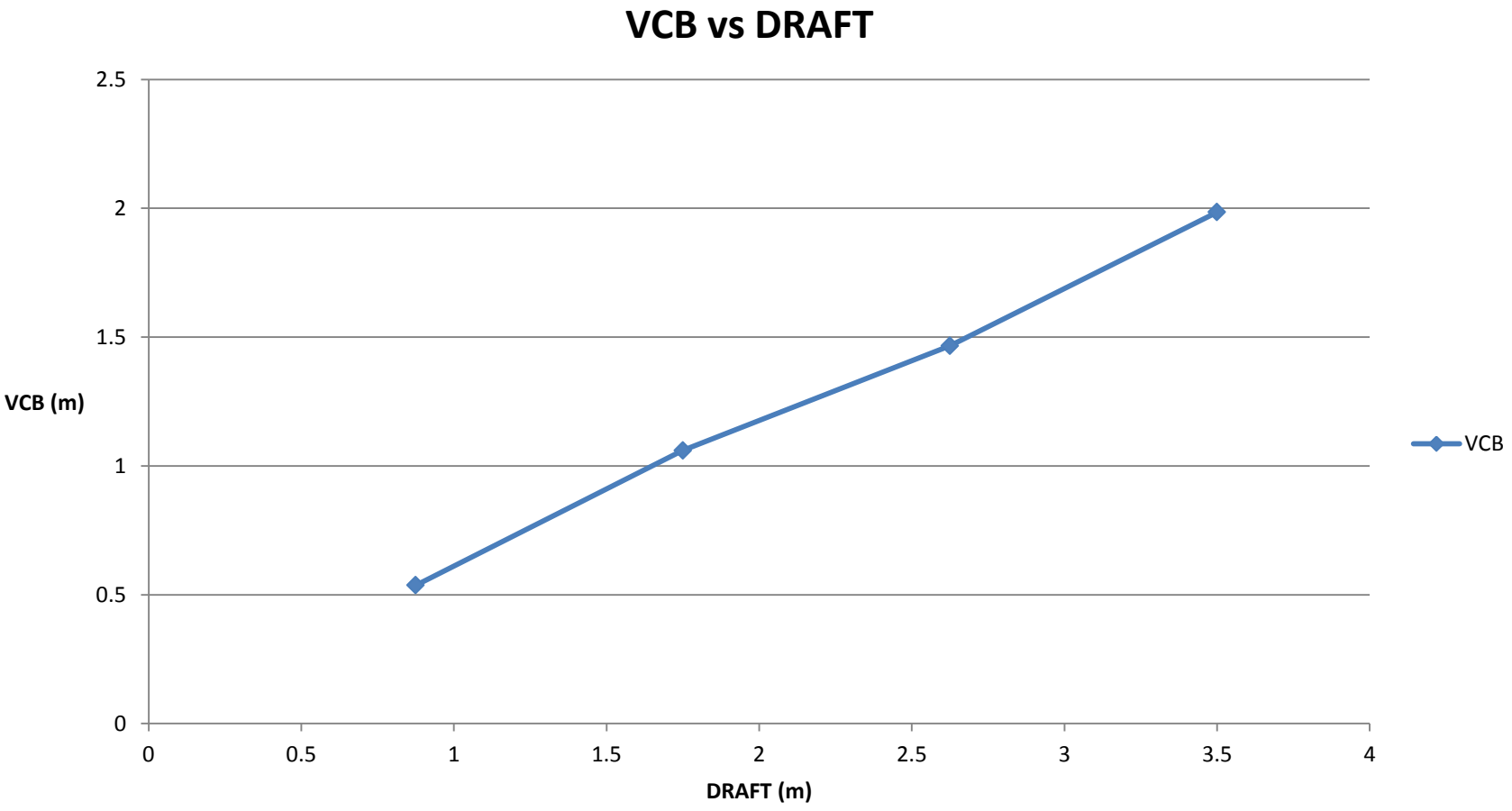
RESULTS FROM HYDROSTATIC CALCULATION

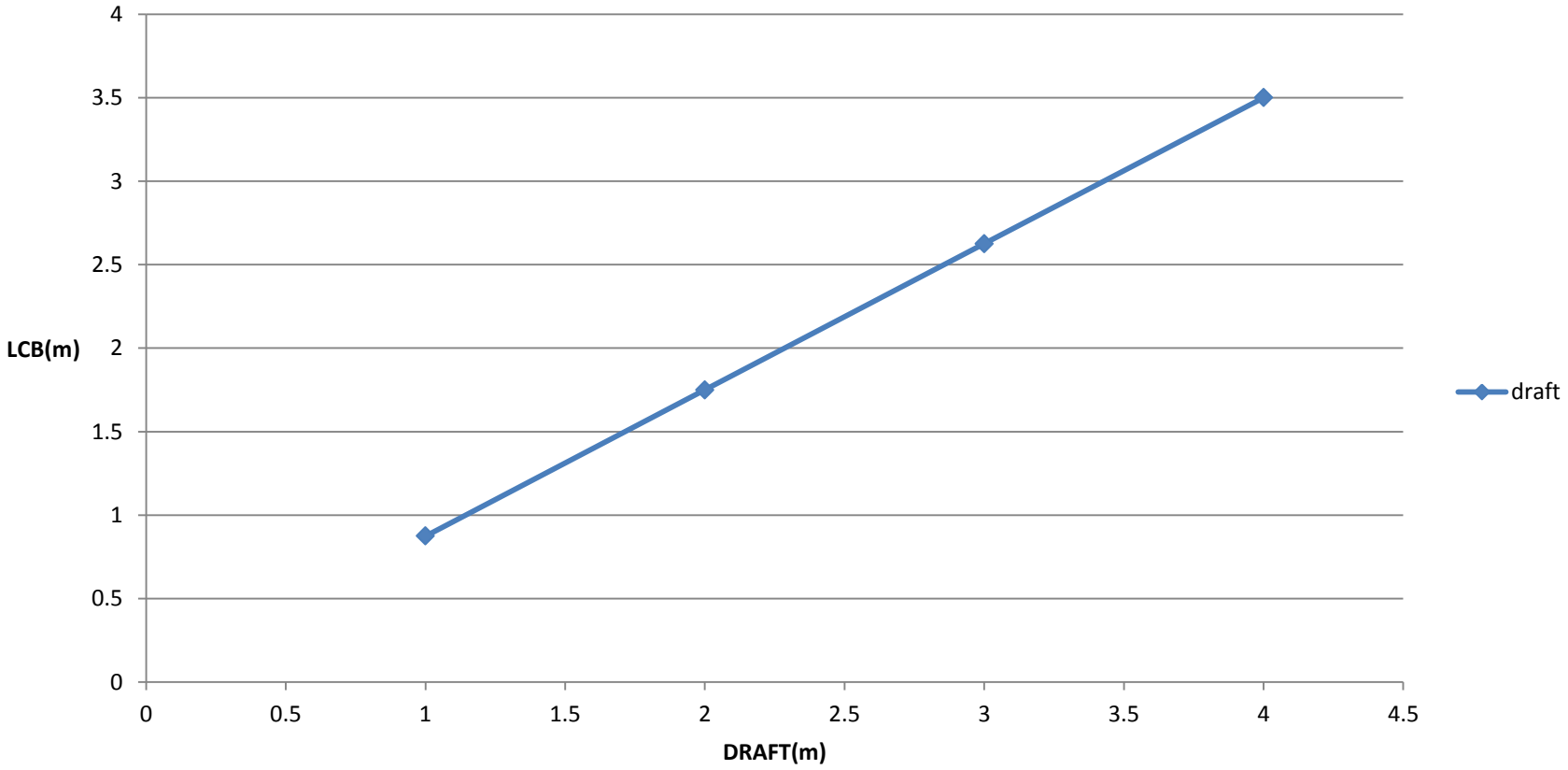
WL	DRAFT,m	DISPLACEMENT,t	VCB,m	LCB,m	BML,m	BMT,m
1	0.875	169.299	0.537	0.455	160.8	10.44
2	1.75	395.7185	1.06	0.149	68.79	4.46
3	2.625	682.6363	1.466	0.173	45.07	2.81
4	3.5	945.097	1.985	-0.045	43.7	2.26

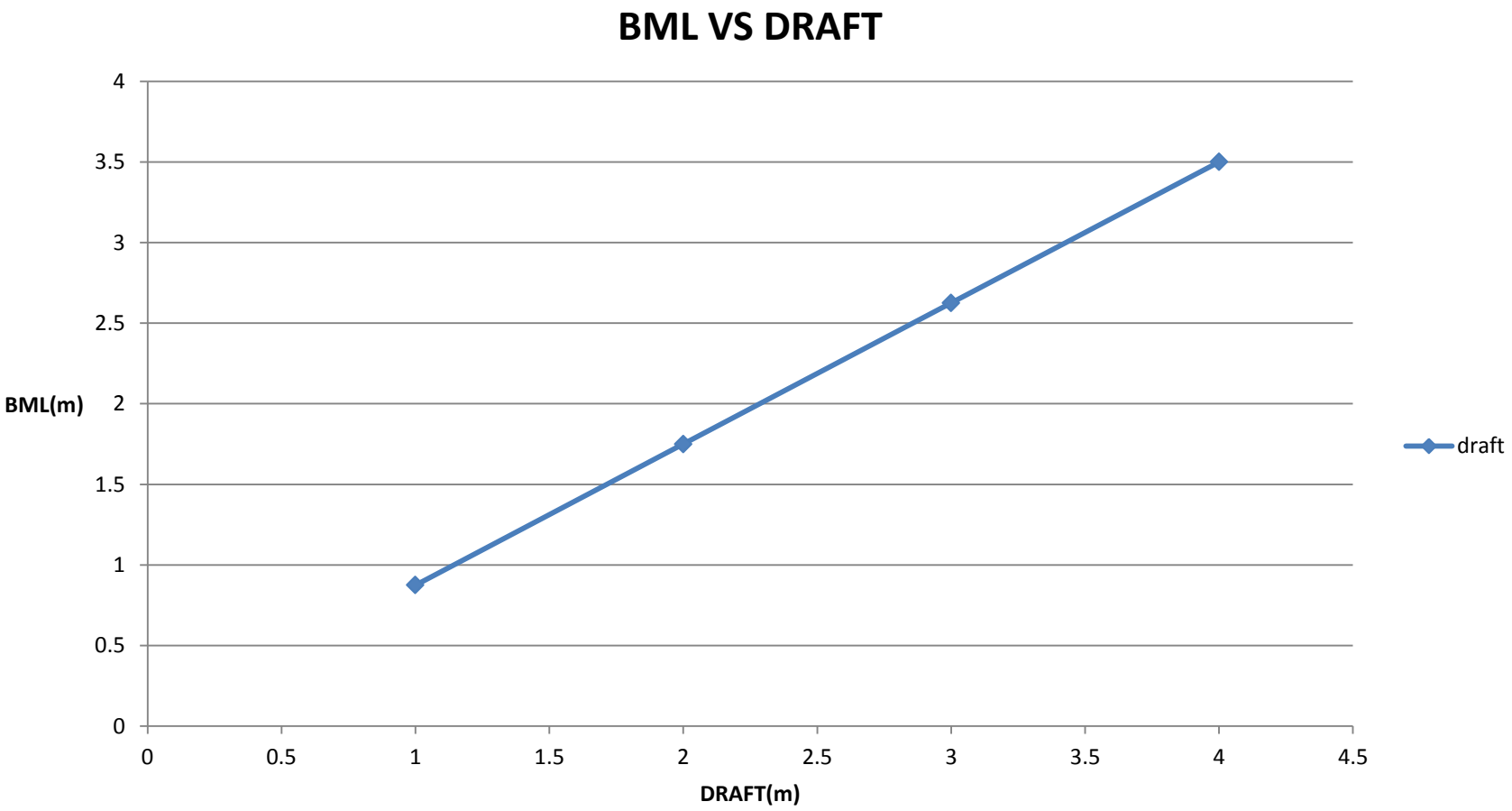
WL	DRAFT,m	WPA,m2	LCF,m	MCTC,tonne-m	TPC,t	CB	CP	CW
1	0.875	258.71	0.173	5.08	2.65	0.51	0.31	0.72
2	1.75	288.78	0.066	6.69	2.96	0.6	0.72	0.805
3	2.625	303.22	0.054	7.56	3.1	0.69	0.77	0.845
4	3.5	335.95	-1.27	10.15	3.44	0.71	0.78	0.91

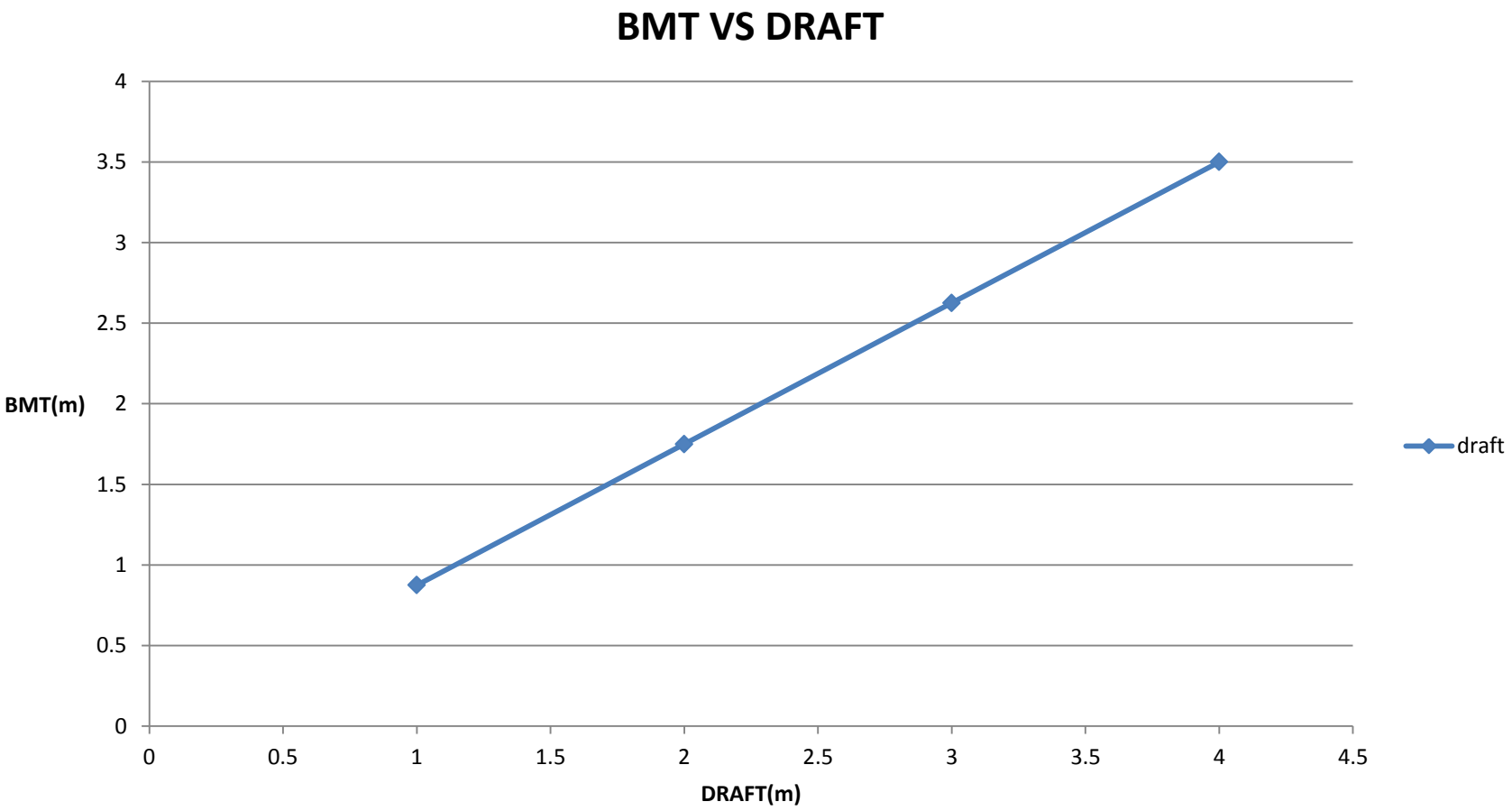
HYDROSTATIC CURVES

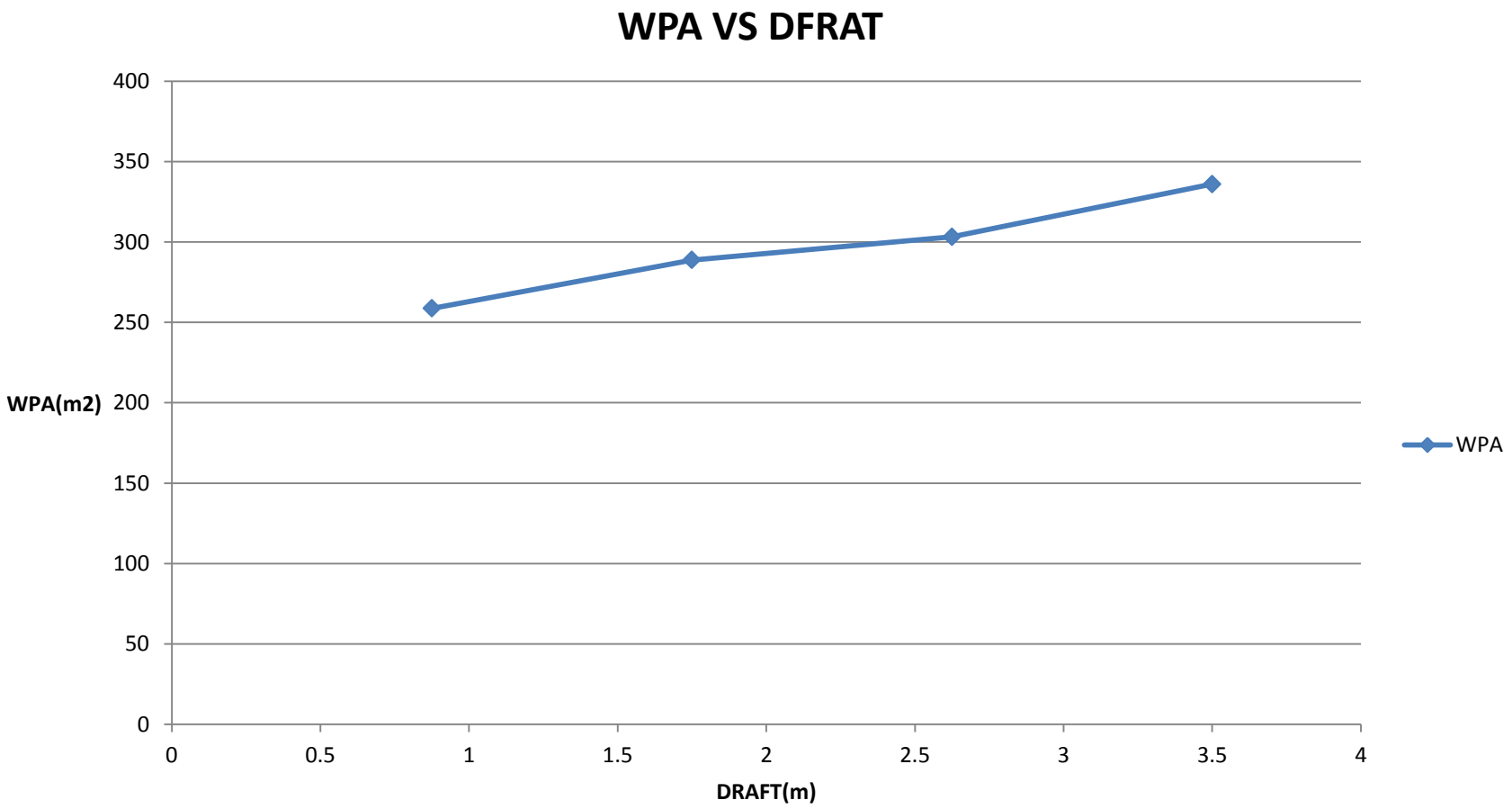


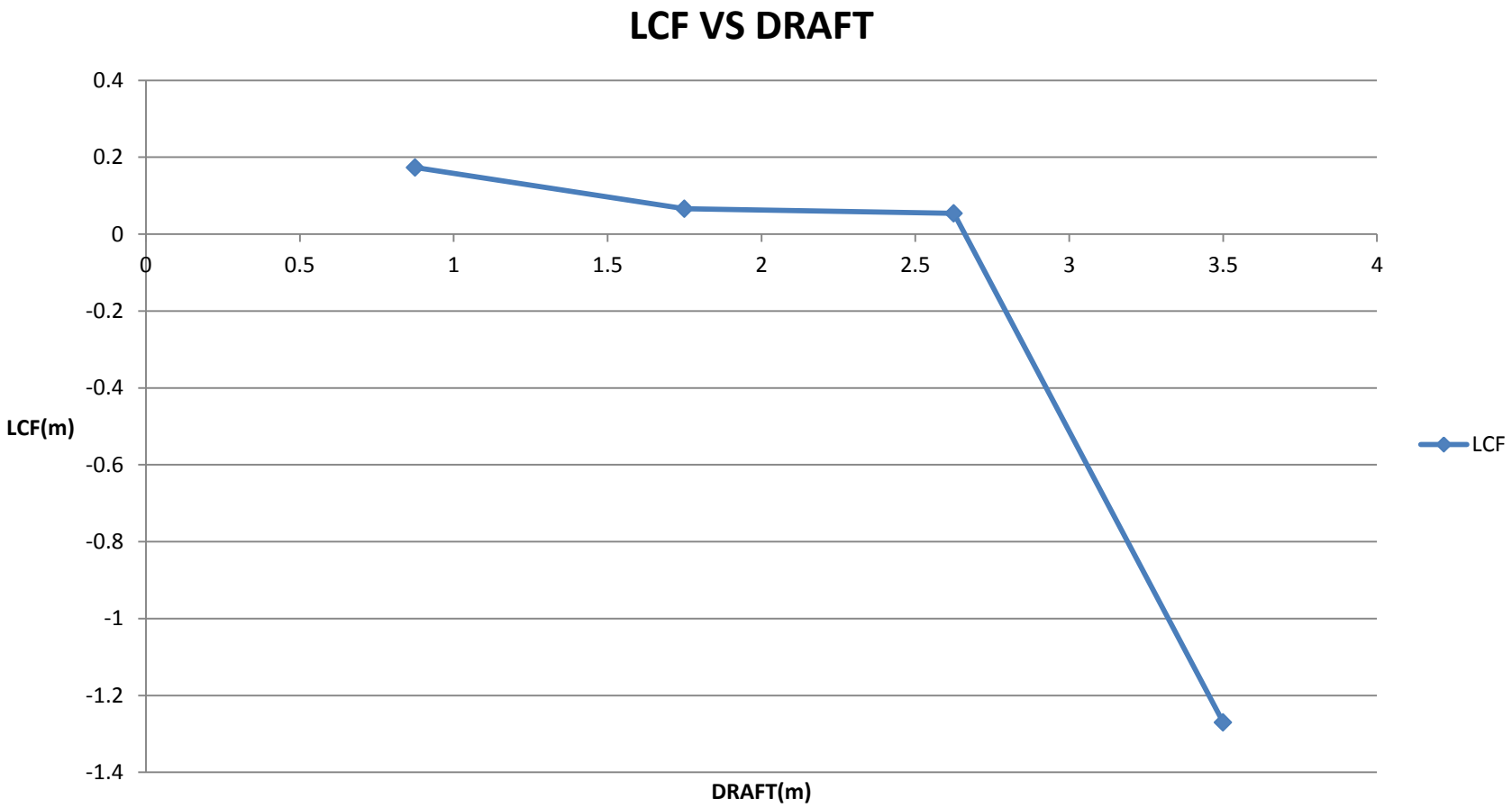

VCB vs DRAFT
2.5
2
1.5
1
0.5
0
VCB (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
DRAFT (m)
VCB

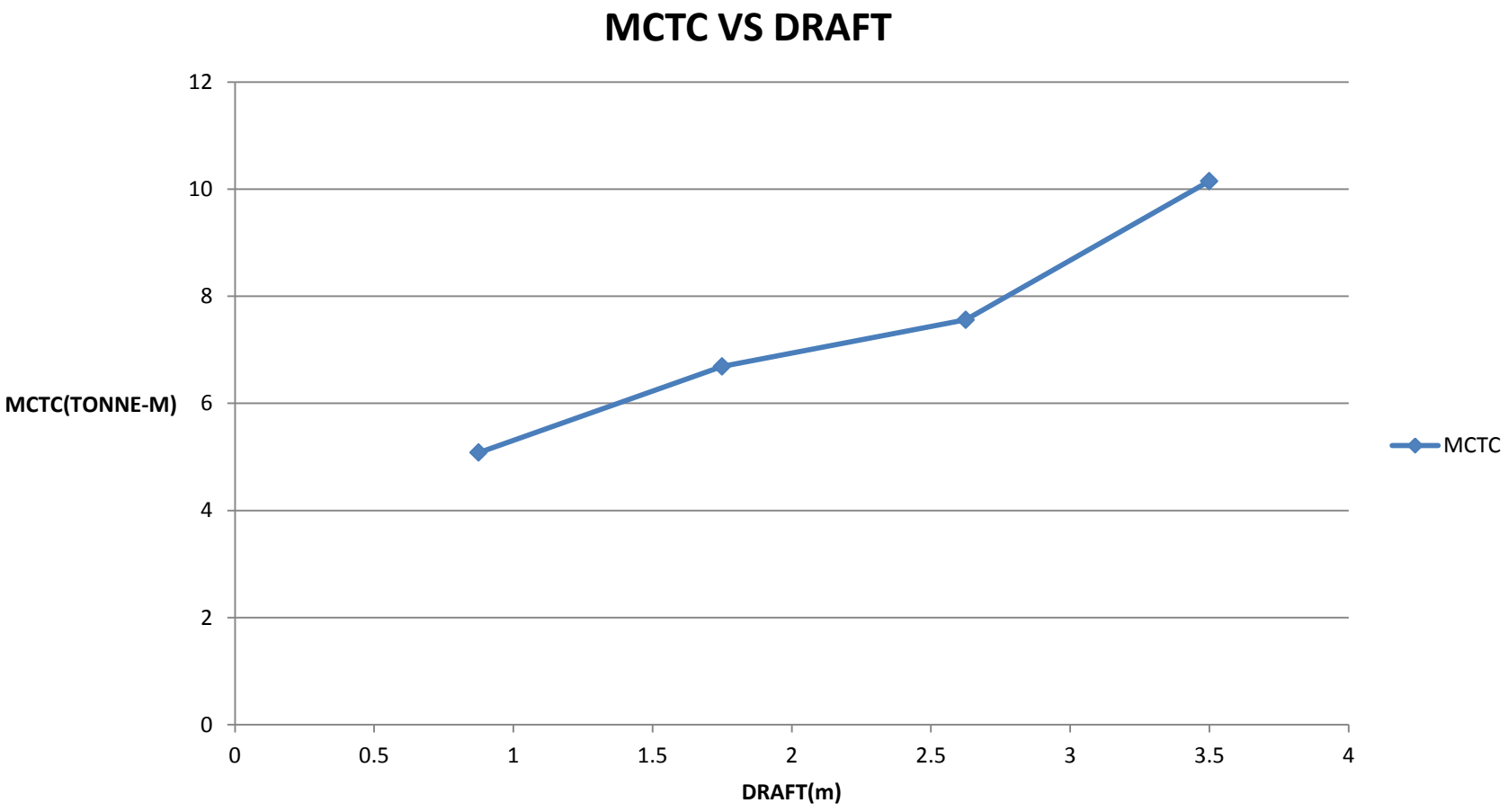

LCB(m)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
DRAFT(m)
draft

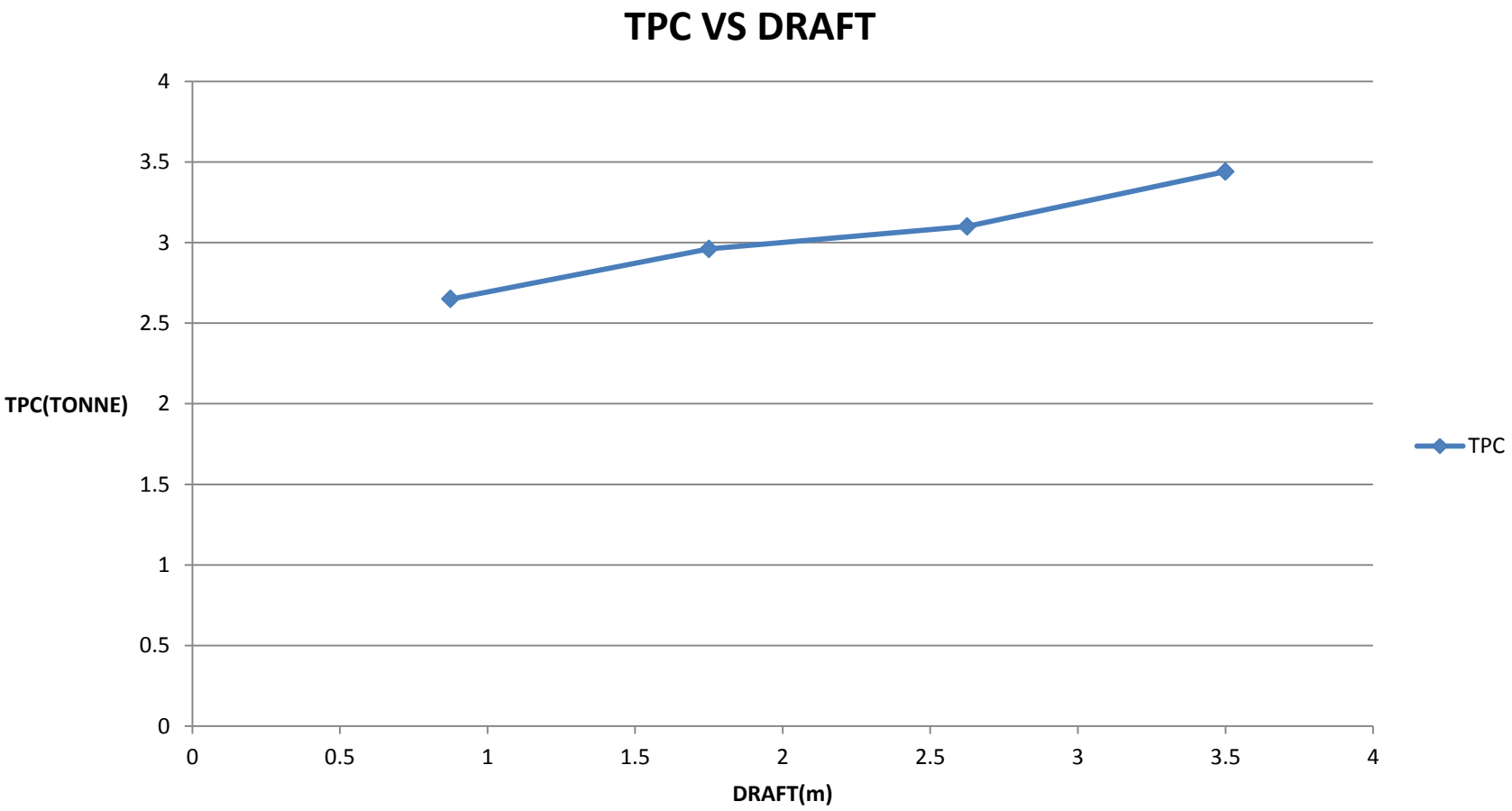

BML VS DRAFT
BML(m)
DRAFT(m)
draft
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

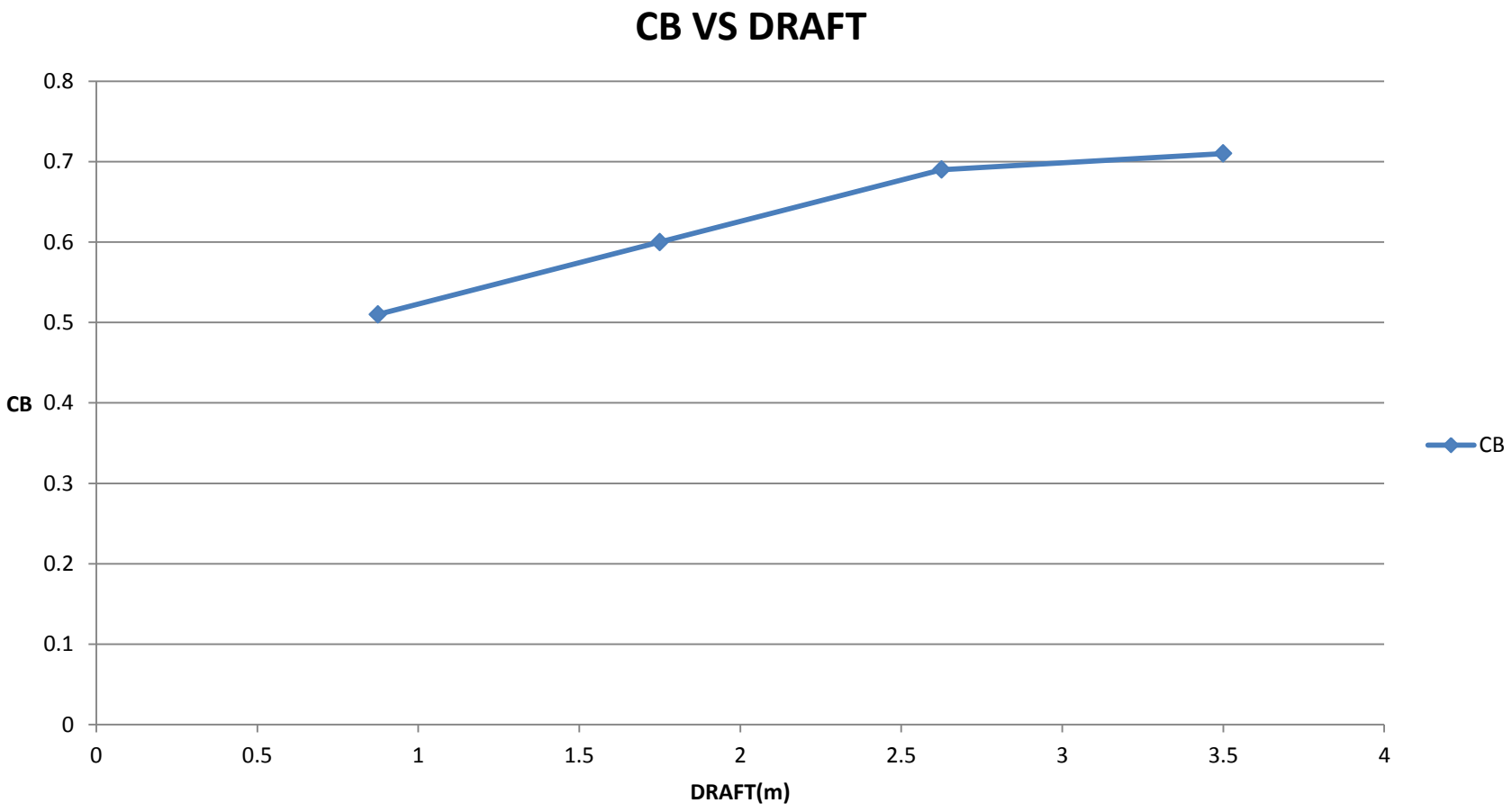

BMT VS DRAFT
BMT(m)
DRAFT(m)
draft
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

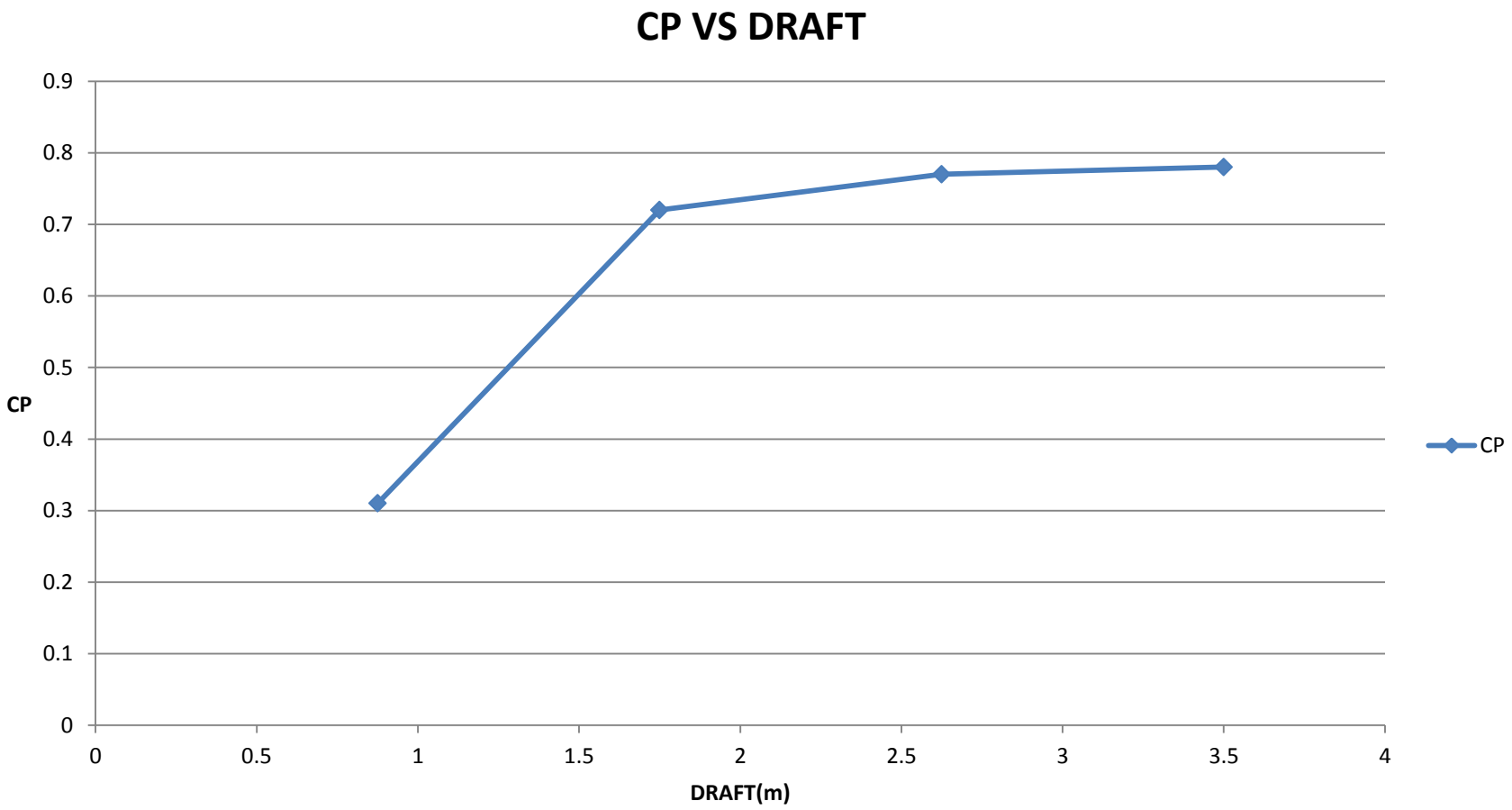

WPA VS DFRAT
400
350
300
250
200
150
100
50
0
WPA(m2)
0
0.5
1
1.5
2
2.5
3
3.5
4
DRAFT(m)
WPA

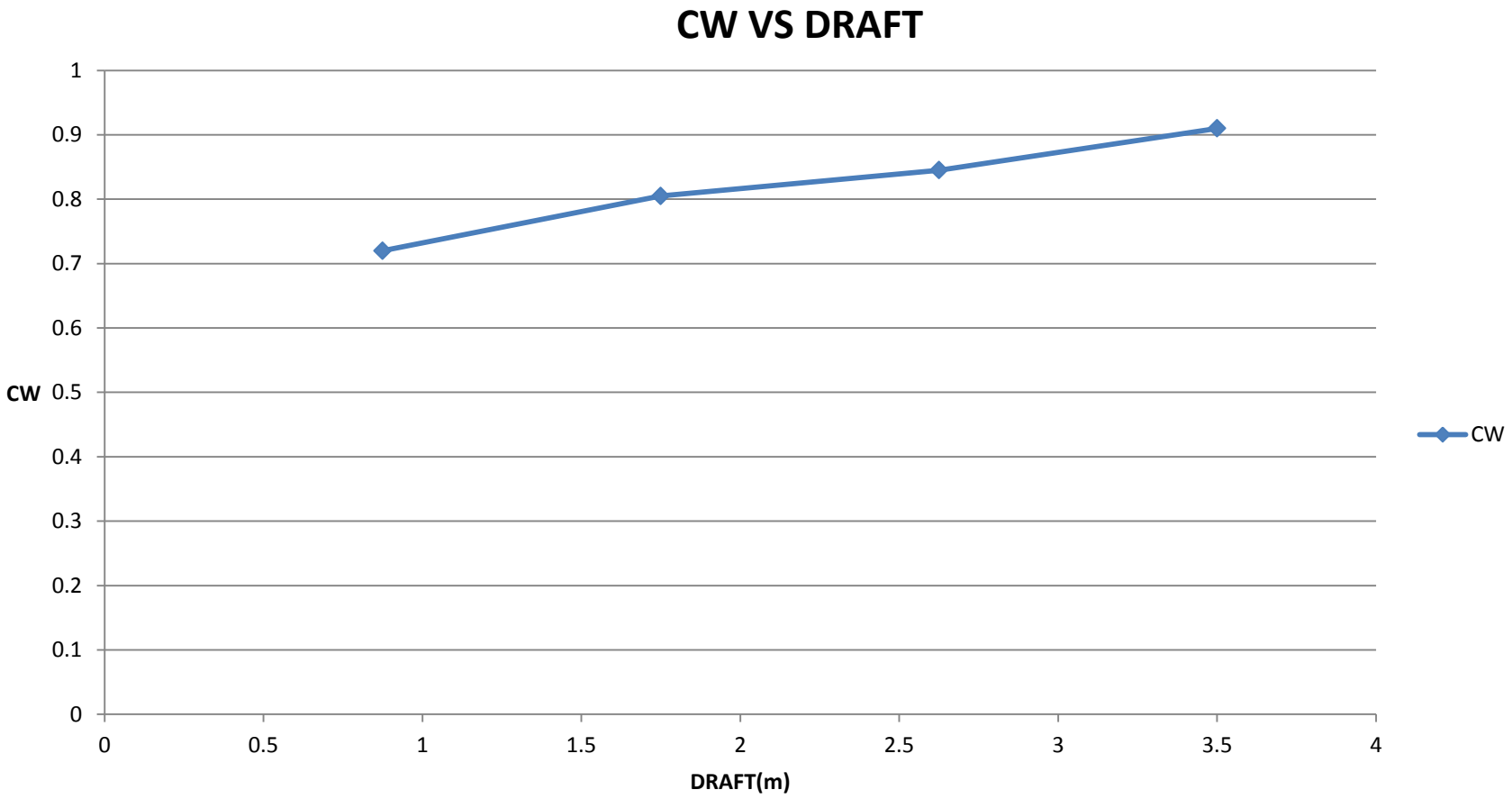

LCF VS DRAFT
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
0.5
1
1.5
2
2.5
3
3.5
4
LCF(m)
DRAFT(m)
LCF


MCTC VS DRAFT
MCTC(TONNE-M)
12
10
8
6
4
2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
DRAFT(m)
MCTC


TPC VS DRAFT
TPC(TONNE)
DRAFT(m)
TPC
0
0.5
1
1.5
2
2.5
3
3.5
4


CB VS DRAFT
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CB
0
0.5
1
1.5
2
2.5
3
3.5
4
DRAFT(m)
CB


CP VS DRAFT
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CP
0
0.5
1
1.5
2
2.5
3
3.5
4
DRAFT(m)
CP


CW VS DRAFT
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CW
0
0.5
1
1.5
2
2.5
3
3.5
4
DRAFT(m)
CW

SCANTLING

Reference:

- Germanischer Lloyd's Rulebook (2012)

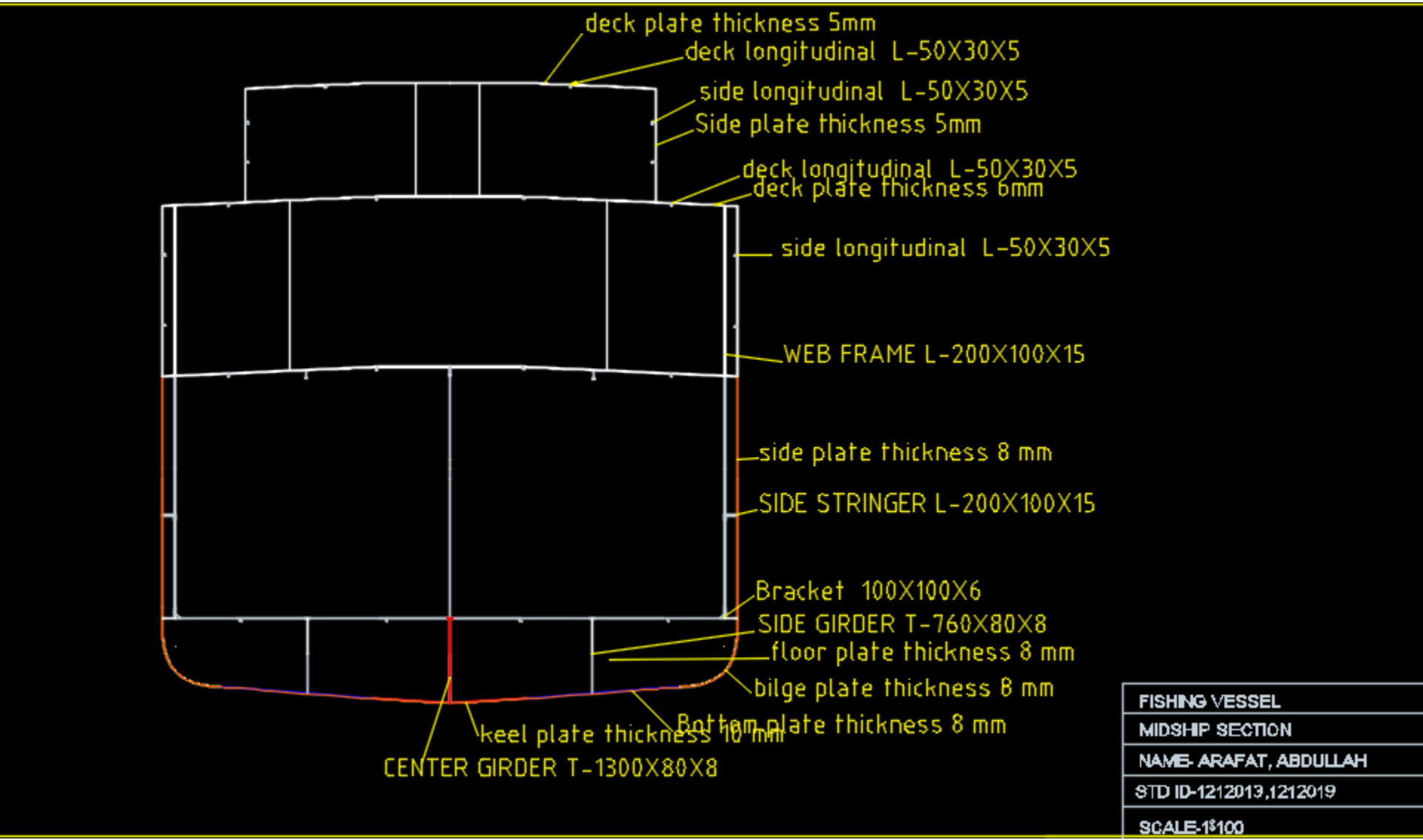
SUMMARY OF SCANTLING PLATE THICKNESS

Flat plate keel	**10mm**
Bottom plate	8 mm
Bilge plate	8 mm
Side shell plate	8 mm
Deck plate	6mm
Bracket thickness	6mm
Floor plate	8mm
Deck plate of deckhouse	5mm
Side plate of deckhouse	5mm

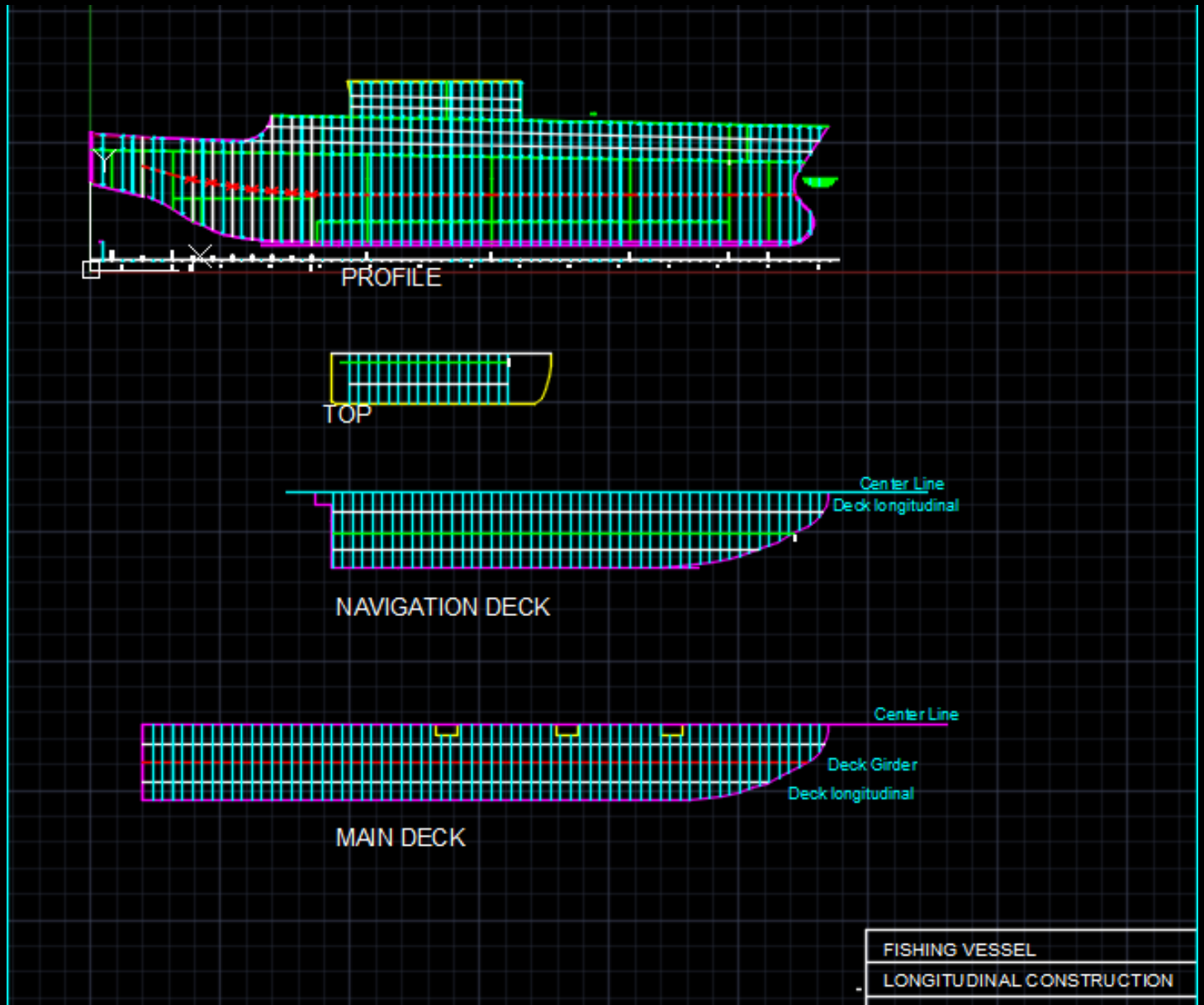
MEMBER DIMENSION

Center Keelson	**T-1300x80x8**
Side Keelson	T-1160x80x8
Web Frame and Side stringer	L-200x100x15
Main frame	L-100x75x10
Deck web Deck girder	L-100x100x7
Side longitudinal	L-50x30x5
Deck longitudinal	L-50x30x5
Bracket	100x100x6

MIDSHIP SECTION



LONGITUDINAL CONSTRUCTION



SHELL EXPANSION

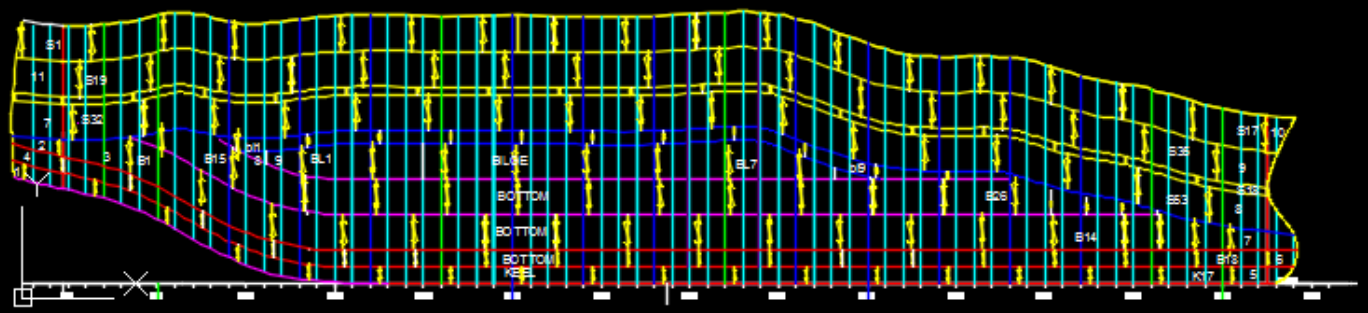


PLATE NO	AREA m2
1	.35
2	.645
3	1.92
4	.92
5	1.05
6	.51
7	1.42
8	2.94
9	2.3
10	.86
11	2.6

KEEL =1100 mm , BOTTOM= 2950mm ,BILGE= 1320 mm

side = 3870 mm

			NO OF PLATE
		2400X1200X8 2400X278X8	53 18
BOTTOM PLATE	B	2400X1200X8 2400X550X8	26 18
BILDGE	BL	2400X1200X8 2400X450X8	7 9
KEEL	K	2400X550X10	17

PLATE NAME	STRAKE	MAXIMUM PLATE SIZE
BULKHEAD		
SIDE SHELL PLATE	S	
WEB FRAME		
MAIN FRAME		

FISHING VESSEL
SHELL EXPANSION DRAWING
NAME- ARAFAT, ABDULLAH
STD ID-1212013,1212019
SCALE-1-100

LIGHTWEIGHT & DEADWEIGHT CALCULATIONS

UPDATED LIGHTWEIGHT

Weight of Plates:

ITEM	WEIGHT (tons)
Plate for main hull	40.34
Plate for deck house	7.87
Bulkhead plate	13.79
Main & upper deck plate	37.55
Bottom floor plate	89.77
Hatch cover plate	.3184
Total	**175.86**

UPDATED LIGHTWEIGHT

Weight of Structural Member:

For main hull: **146.014** tons

For upper deck &
Deck house : **5.21** tons

Weight of Engine Foundation:

ITEM	WEIGHT (tons)
Top plate	1.75
Longitudinal girder	1.06
Transverse web	.57
Inner bottom plate	5.73
Total	**9.11**

UPDATED LIGHTWEIGHT

Weight of Rudder:

ITEM	WEIGHT (tons)	LCG	MOMENT	VCG	MOMENT
Rudder stock	0.402	-20.27	-8.149	2.69	1.0814
Rudder plate	0.325	-20.27	-6.588	1.12	0.364
Vertical frame	0.016	-20.87	-0.334	1.12	0.0179
Horizontal frame	0.033	-20.77	-0.685	1.12	0.037
Pintle sole piece	0.185	-20.27	-3.75	0.05	0.0085
Coupling flange	0.041	-20.27	-0.831	2.29	0.0939
Others	0.1	-20.27	-2.027	2.5	0.25
Total	1.102		-22.36		1.8527

Total Rudder Weight = 1.102 tons

LCG = 19.99 m aft of amidship

VCG = 1.68 m from keel

UPDATED LIGHTWEIGHT

Weight of Steering Arrangement:

ITEM	WEIGHT (tons)	LCG	MOMENT	VCG	MOMENT	
Steering rod	0.022	-20.27	-0.4459	4.5	0.09988	
Tiller arm	0.034	-20.27	-0.6892	4.6	0.1547	
Hydraulic oil tank	0.15	-6.86	-1.029	4.6	0.69	
Pump	0.6	-20.11	-18.108	4.6	2.76	
Total	1.056		-20.272		3.70458	

weight of steering arrangement = **1.056** tons

LCG =19.19 m aft of amidship

VCG = **3.50** m from keel

UPDATED LIGHTWEIGHT

Weight of Propeller:

ITEM	WEIGHT (tons)
Propeller blade	1.044
Propeller boss	0.77
Total	**1.81**

Weight of Propeller Shaft:

ITEM	WEIGHT (tons)
Propeller shaft	0.311
Stern tube	0.110
Others	0.250
Total	**0.671**

UPDATED LIGHTWEIGHT

Weight of Machinery & Equipments:

ITEM	WEIGHT(tons)
Navigation equipment	0.75
Generator	**9.1**
Main engine	11
Auxiliary Engines	6
Gear box	4.2
Total	**31.05**

UPDATED LIGHTWEIGHT

Hull Outfit:

ITEM	WEIGHT, tons
Anchor	1.56
Winch and chain cable	3.19
Bollard and capstan	1.5
mooring ropes	0.75
Fender	1.5
Funnel	2.5
Mast	.5
Stairs and Railing	1.5
Total	**13**

UPDATED LIGHTWEIGHT

Furniture for Superstructure:

Main deck furniture	3.5 tons
Navigation bridge deck furniture	2.25 tons
Total	**5.75 tons**

Total Lightweight	333.82 tons
LCG	6.14 m aft
VCG	5.78m above keel

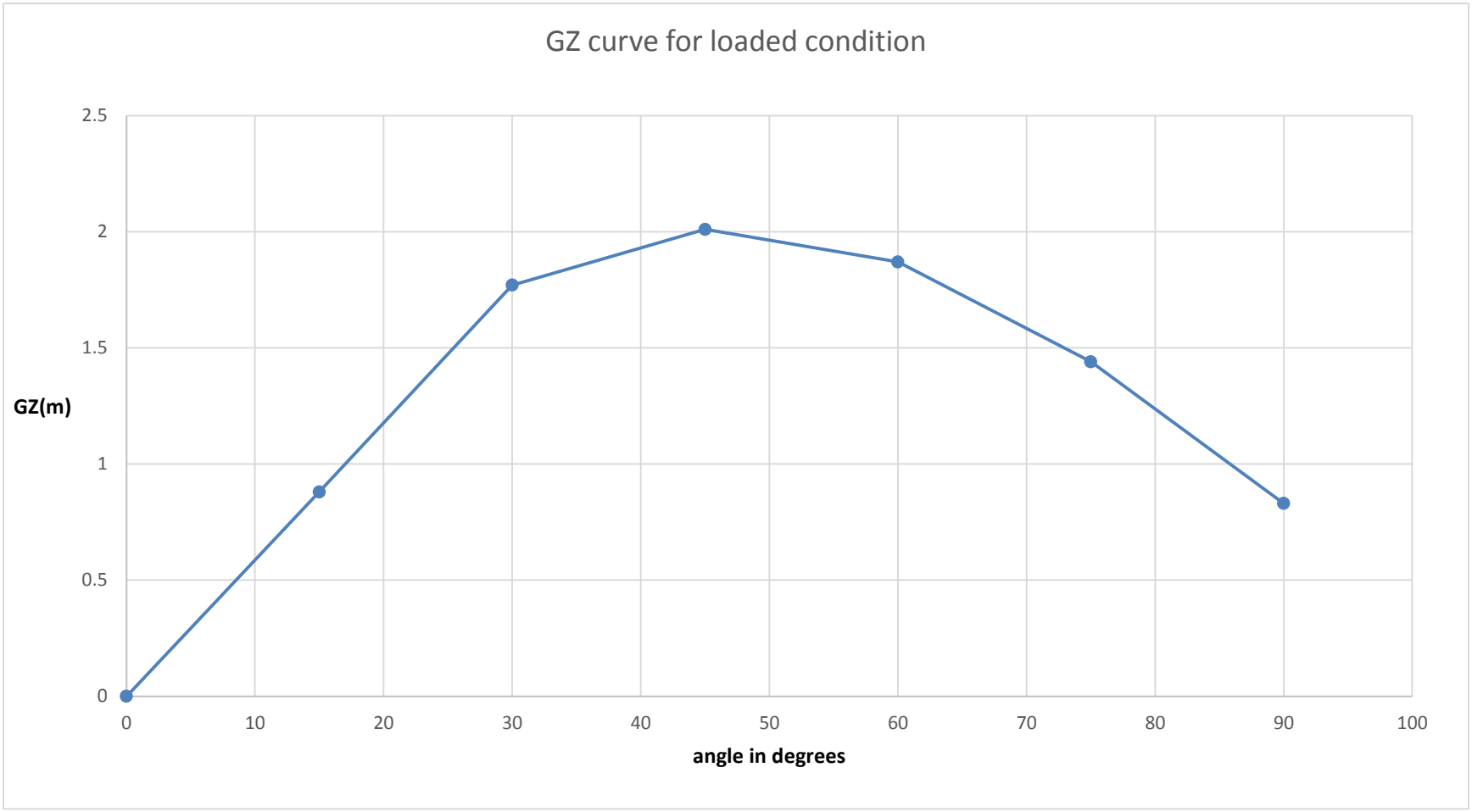
UPDATED DEADWEIGHT

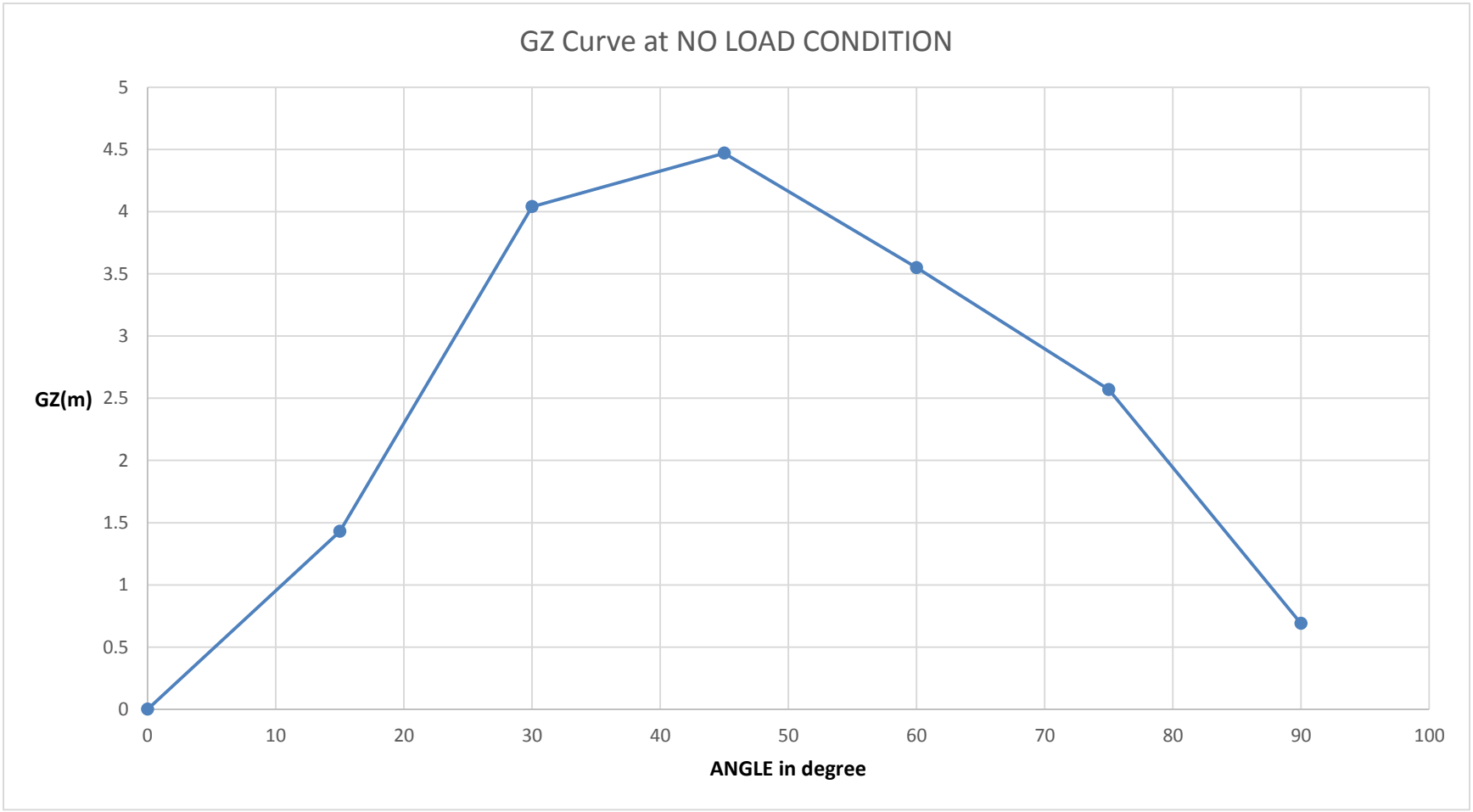
items	weght(tons)		LCG	VCG	moment for LCG	moment for VCG
FISHING HOLD1	73.14641886		9.956329216	1.807787067	728.2698271	132.23315
FISHING HOLD2	132.511436		6.738288784	1.716864476	892.9003249	227.5041776
FISHING HOLD3	118.423076		-1.54795069	1.70797	-183.313082	202.2630609
FUEL OIL TANK UNDER FH1	21.8318881		9.879235101	0.826374963	215.6823553	18.04132572
FUEL OIL TANK UNDER FH2	50.8716412		6.73	0.4	342.3661452	20.34865647
FUEL OIL TANK UNDER FH3	76.125		-1.54	0.4	-117.2325	30.45
FUEL OIL TANK 1 DIESEL	21.77821058		-7.613996207	1.778240926	-165.8192128	38.72690534
FUEL OIL TANK 2	25.36521		-7.613996207	1.778240926	-193.1306125	45.10545446
FRESH WATER TANK 1	13.13		-3.339469292	1.105715747	-43.8472318	14.51804776
FRESH WATER TANK 2	20.76		-4.309575205	1.223398514	-89.46678126	25.39775315
FRESH WATER TANK 3	26.22		-3.927579026	1.500936831	-102.9811221	39.3545637
FRESH WATER TANK 4	7.45342889		-2.400858658	0.616656197	-17.89462928	4.596203111
FRESH WATER TANK 5	13.9366354		3.560337064	3.381962859	49.61911974	47.13318347
LUBE OIL TANK	6.42		-2.475	0.7704	-15.8895	4.945968

Total Weight Displacement	**947.4**	tons
Final LCG	**0.79**	m aft
Final VCG	**2.93**	m

TRIM &STABILITY CALCULATION

FULL LOAD CONDITION		NO LOAD CONDITION		
Displacement,tonne	947.4	Displacement,tonne	333.82	
LBP,m	40.69	LBP,m	40.69	
Draft,m	3.65	Draft,m	1.55	
LCG aft amidship,m	0.7946	LCG aft amidship,m	5.08	
LCB aft amidship,m	0.045	LCB fwd amidship,m	1.3	
MCT 1m	10.15	MCT 1m	6.3	
LCF aft amidship	1.27	LCF fwd amidship	0.19	
Trim,m	0.7	Trim,m	2.14	
Aft Trim,m	0.35	Aft Trim,m	2.1	
Fore Trim,m	0.35	Fore Trim,m	0.045	
Aft Draft,m	3.299	Aft Draft,m	1.46	
Fore draft,m	4	Fore draft,m	3.61	
the ship is trimmed by stern		the ship is trimmed by stern		


GZ curve for loaded condition
GZ(m)
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
90
100
angle in degrees


GZ Curve at NO LOAD CONDITION
GZ(m)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
90
100
ANGLE in degree

RESISTANCE
&
APPROXIMATE POWER CALCULATION

APPROXIMATE CALCULATION OF SHIP'S RESISTANCE HOLTROP AND MENNEN'S METHOD

ITEM	VALUE
Frictional resistance, R_F	20.4053kN
Form factor describing the viscous Resistance 1+k_1	1.4635768
Wave-making and wave-breaking Resistance, R_w	75.510197kN
Appendage resistance, R_{APP}	2.7321308kN
Model-ship correlation resistance, R_A	7.2614074kN
Total	115.3638kN

POWER CALCULATION

ITEM	VALUES
Effective Power, P_E	712.14648KW
Quasi Propulsive Coefficient, QPC	0.544
Shaft Power, P_s	1248.8497KW
Brake Power , P_B (2% Gear loss)	1274.3364KW
P_B (15% sea margin)	1465.4869KW
Brake Horse Power	1963.7524HP

ENGINE & GEARBOX SELECTION

ENGINE SELECTION PARAMETER

1. Required horse power
2. Weight
3. Space
4. Capital cost
5. Running cost
6. Requirement for electrical power and heat , reliability and maintainability
7. Ease of installation
8. Vibration and noise availability

MAN
6L23/30A

WARTSILA 20 MARINE PROPULSION ENGINE

ENGINE TYPE- 8L20

4 STROKE DIESEL ENGINE

Engine Specific Information

Engine Name	WARTSILA 20 Marine Propulsion Engine ENGINE TYPE- 8L20
Power	1984 HP 1480 KW
Speed	900 rpm
Number of cylinder	6
Dimension (LxBxH)mm	3973X 1614 X 1756
Weight (tonnes)	11.0
Fuel consumption	186g/kWh
Bore X Stroke	200X 280 mm

GEARBOX SPECIFIC INFORMATION

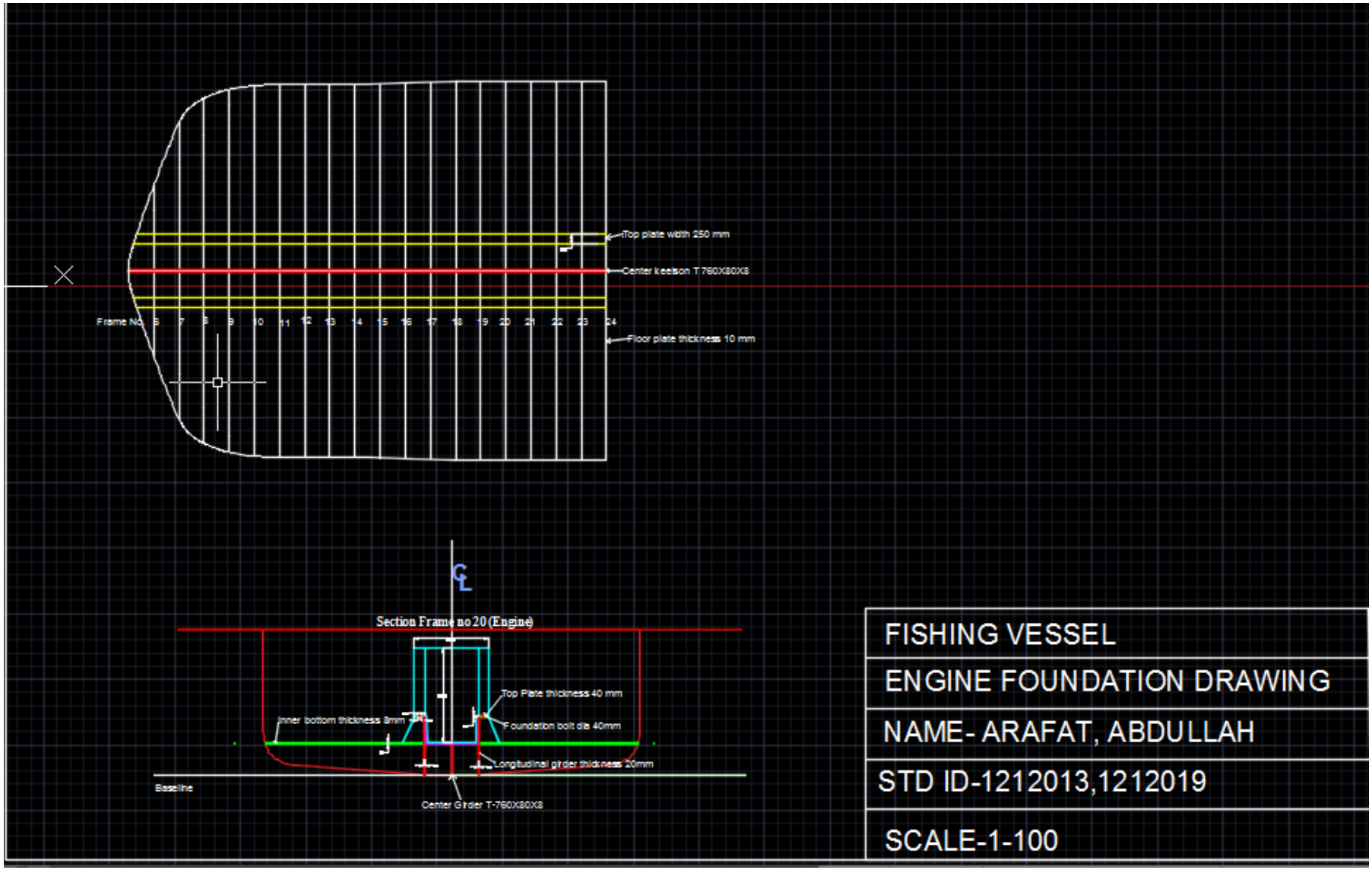
NAME	**WARTSILA SINGLE INPUT SCV-50**
GEAR RATIO	3.6 : 1
DIMENSION(mm)	1012X1340X1724
WEIGHT	4.2 TONNES

ENGINE FOUNDATION

Summary of Engine Foundation Scantling

ITEMS	DIMENSIONS
Floor plate	10 mm (Thickness)
Inner bottom plating	8 mm (Thickness)
Longitudinal girders	20 mm (Thickness)
Foundation bolts	40 mm (Diameter)
Rubber sheet	10 mm (Thickness)
Top plate dimension	250 mm (width) 40mm (Thickness)
Web frame	T-200×100 × 15

ENGINE ROOM FOUNDATION DRAWING



RUDDER
&
STEERING ARRANGEMENT

SUMMARY OF RUDDER CALCULATION

Items	Dimensions	Material
Rudder stock	Diameter 100mm	Forged Steel
Coupling bolts	Diameter 33 mm	Forged Steel
Coupling flanges	Thickness 33 mm	Forged Steel
Horizontal web	Spacing 480mm	Forged Steel
Vertical web	Spacing 720mm	Forged Steel
Web plate	Thickness 18 mm	Forged Steel
Rudder plate	Thickness 15mm	Forged Steel
Pintle	Diameter 70 mm	Forged Steel
Bush	Diameter 127 mm	Lignum Vitae
Tiller	Diameter 80 mm	Aluminum Brass (Cu+ Zn+ Al)

RUDDER CALCULATION

A=c1.c2.c3.c4 $\frac{1.75xLxT}{100}$ from GL rulebook

=2.3736 m^2

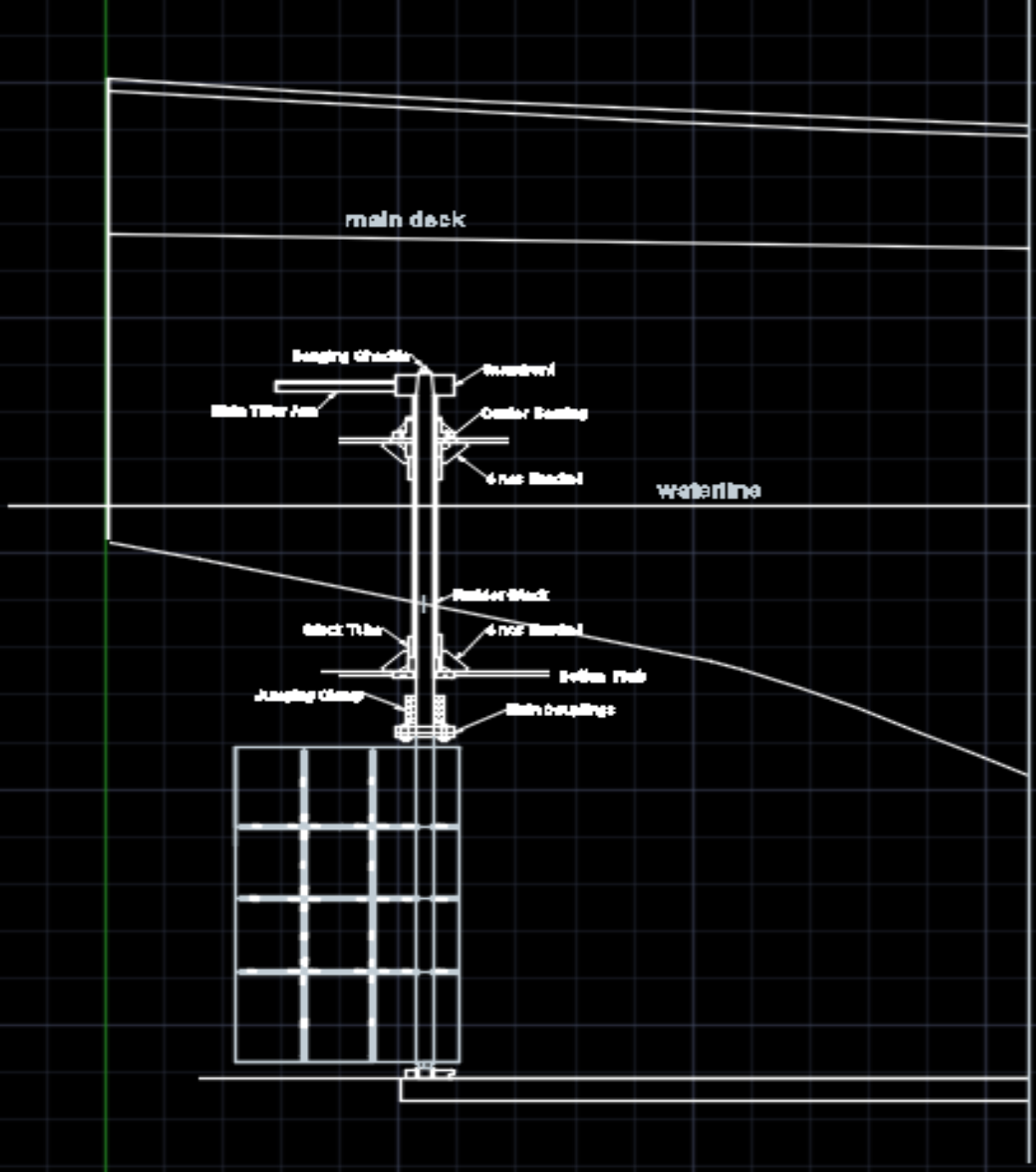
ASPECT RATIO= 1.75

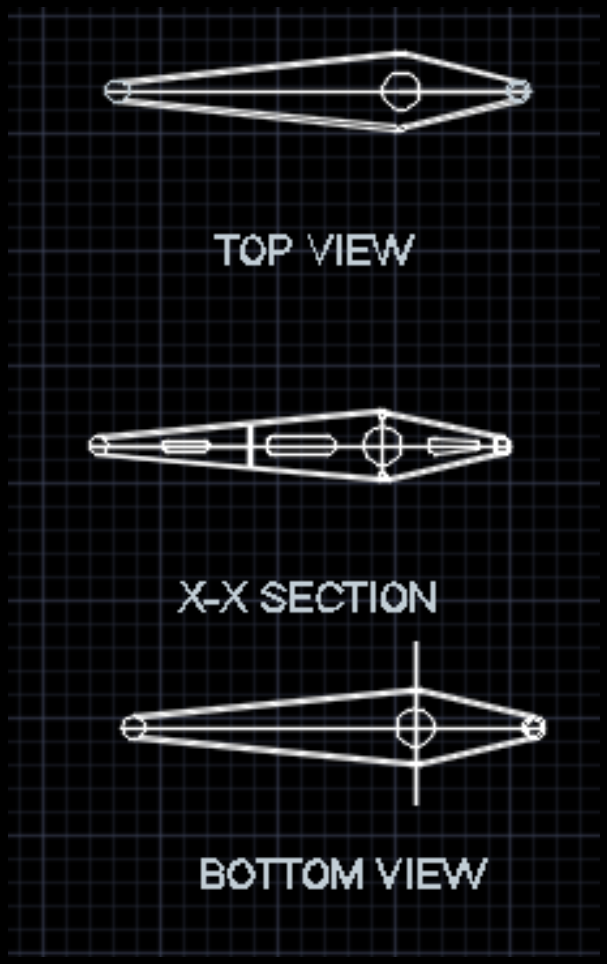
h=2.088 m

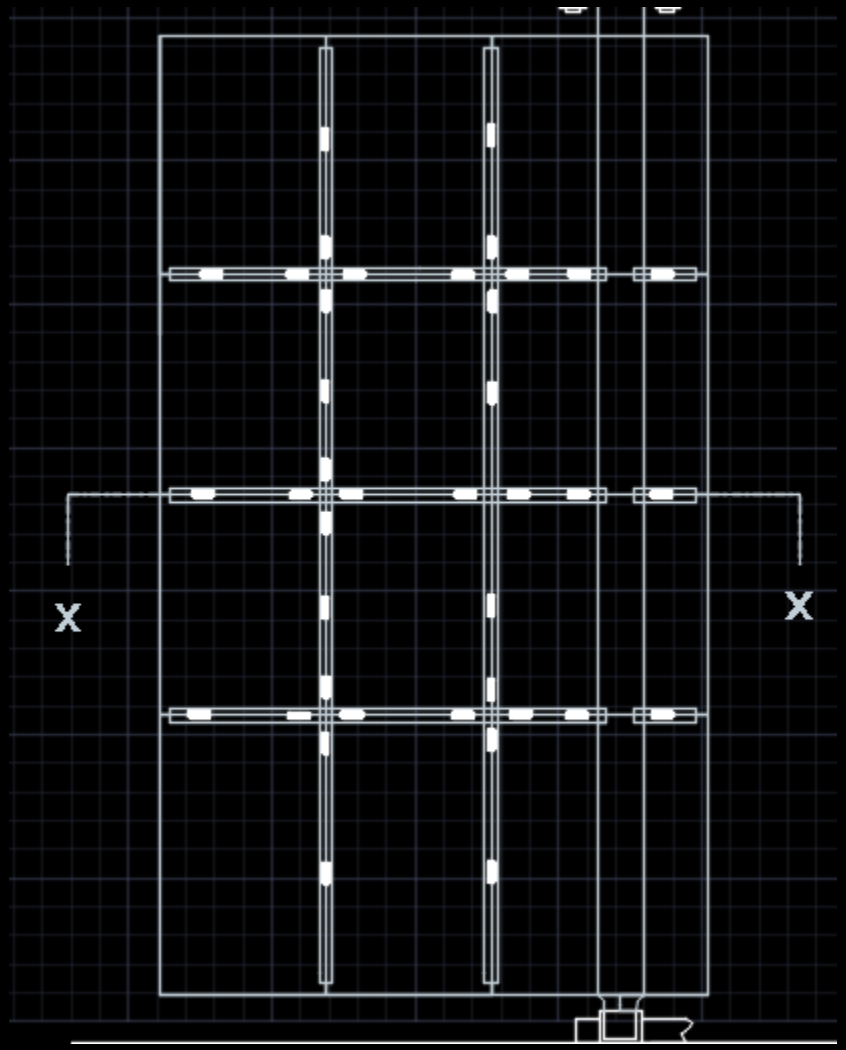
b=1.193 m

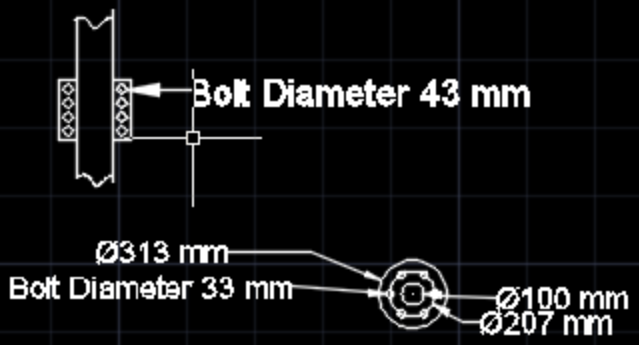
Shape of the rudder= Rectangular

Rudder Torque=13.026 KNm


main deck
waterline

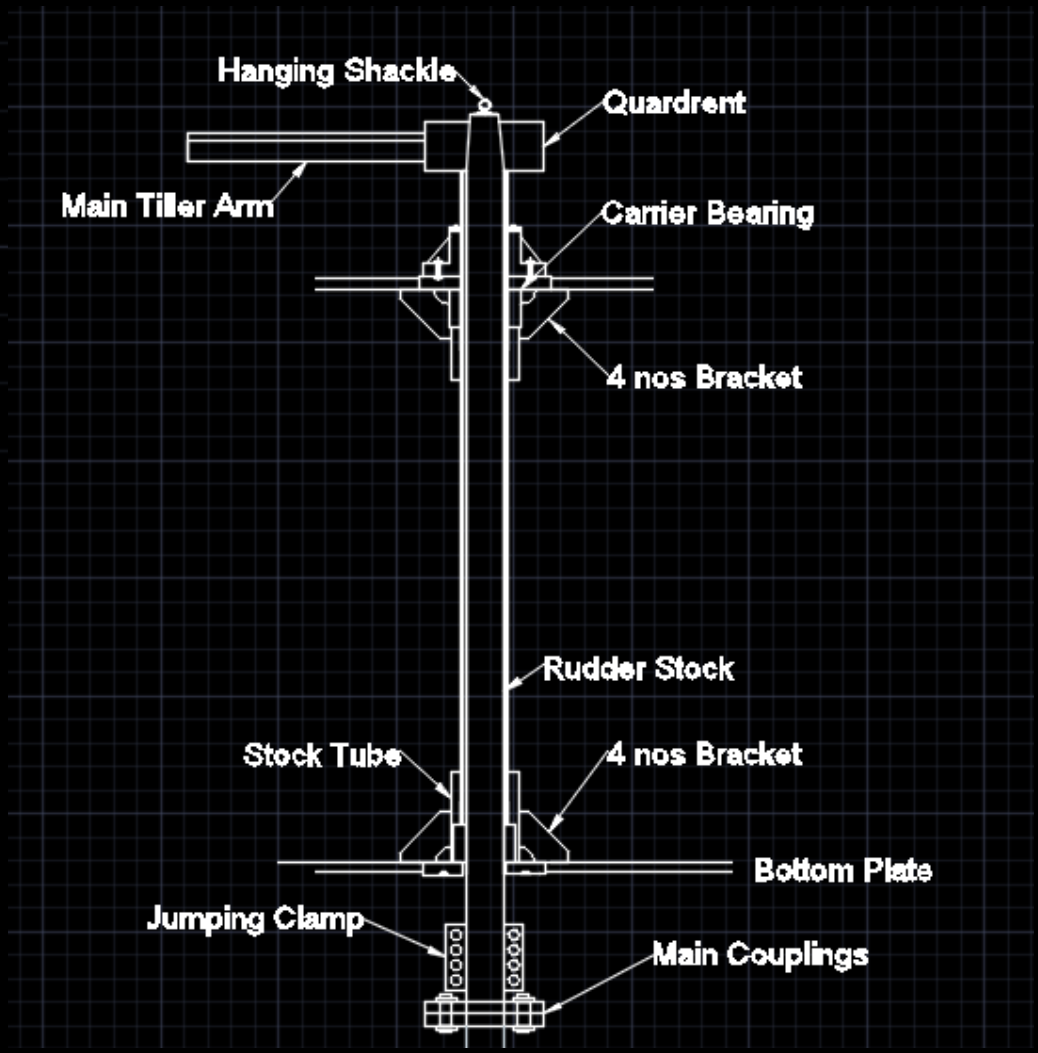

TOP VIEW
X-X SECTION
BOTTOM VIEW

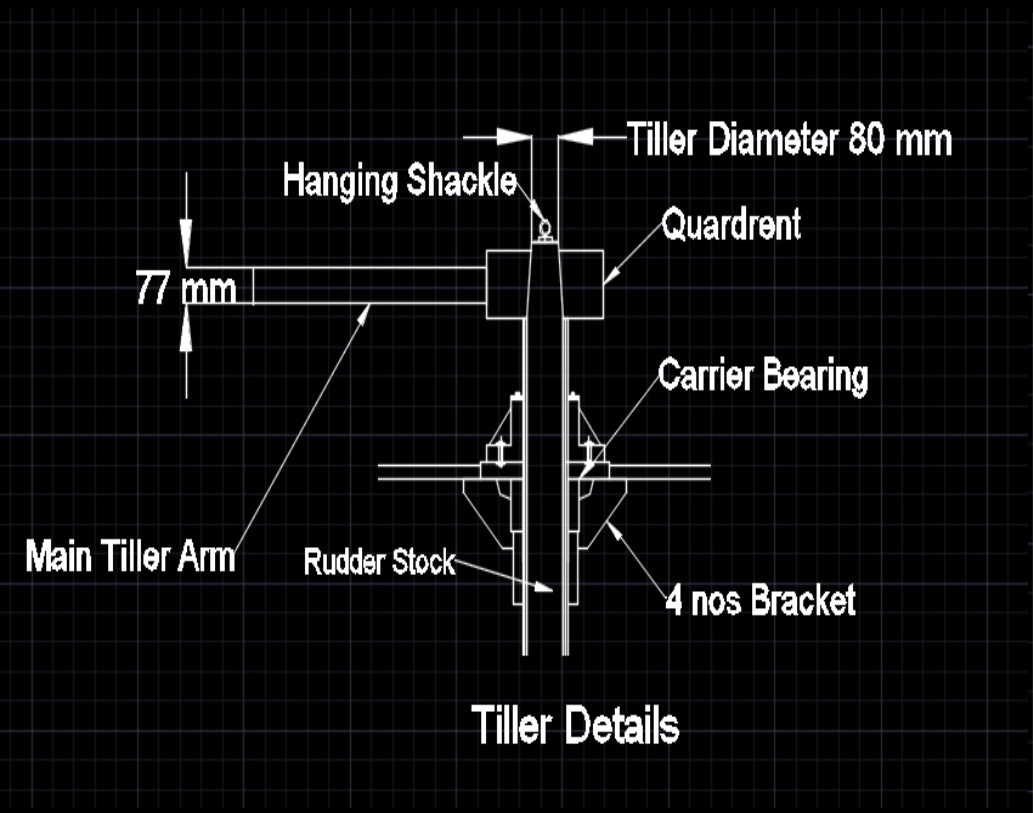

X
X



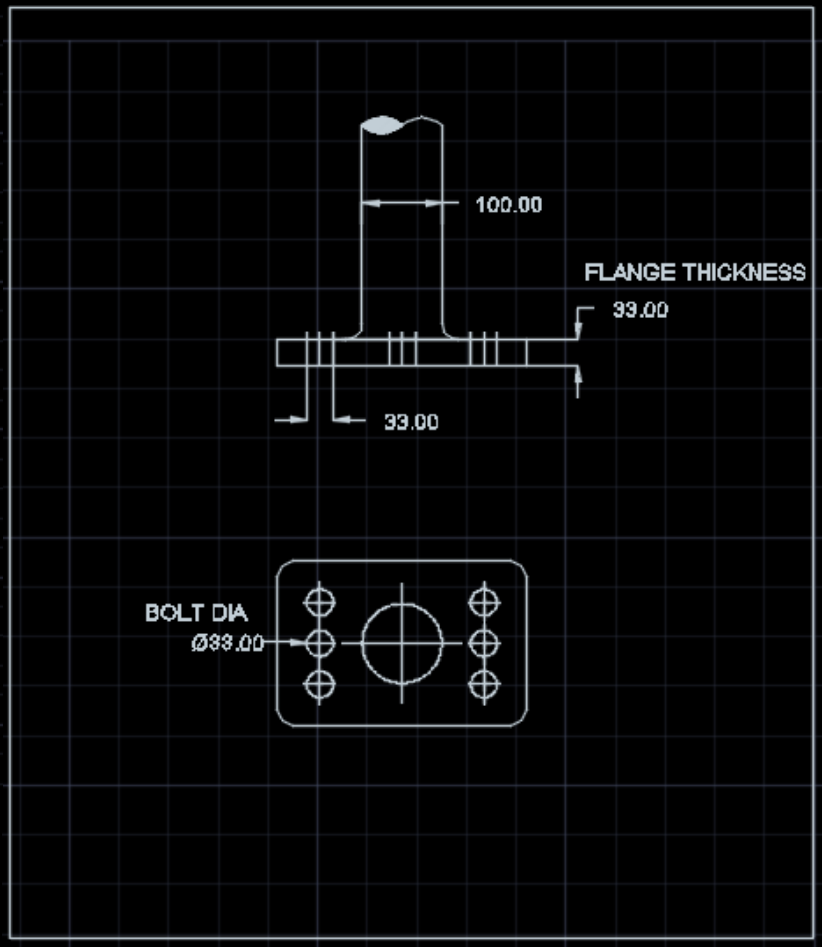
Jumping Clamp

Pintle Details





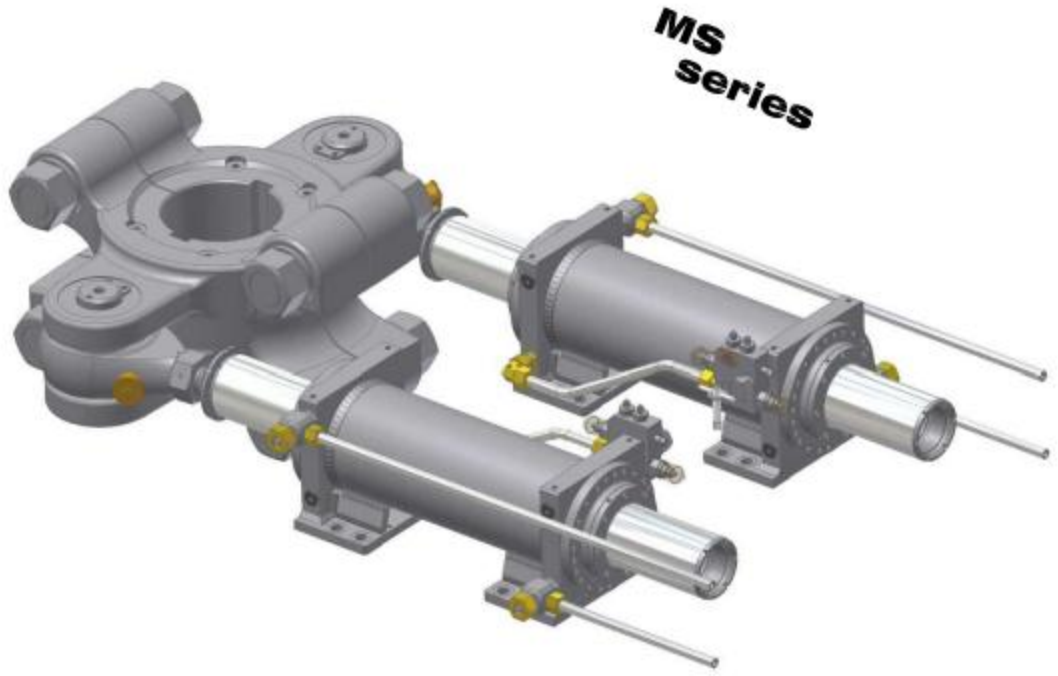
Tiller Details



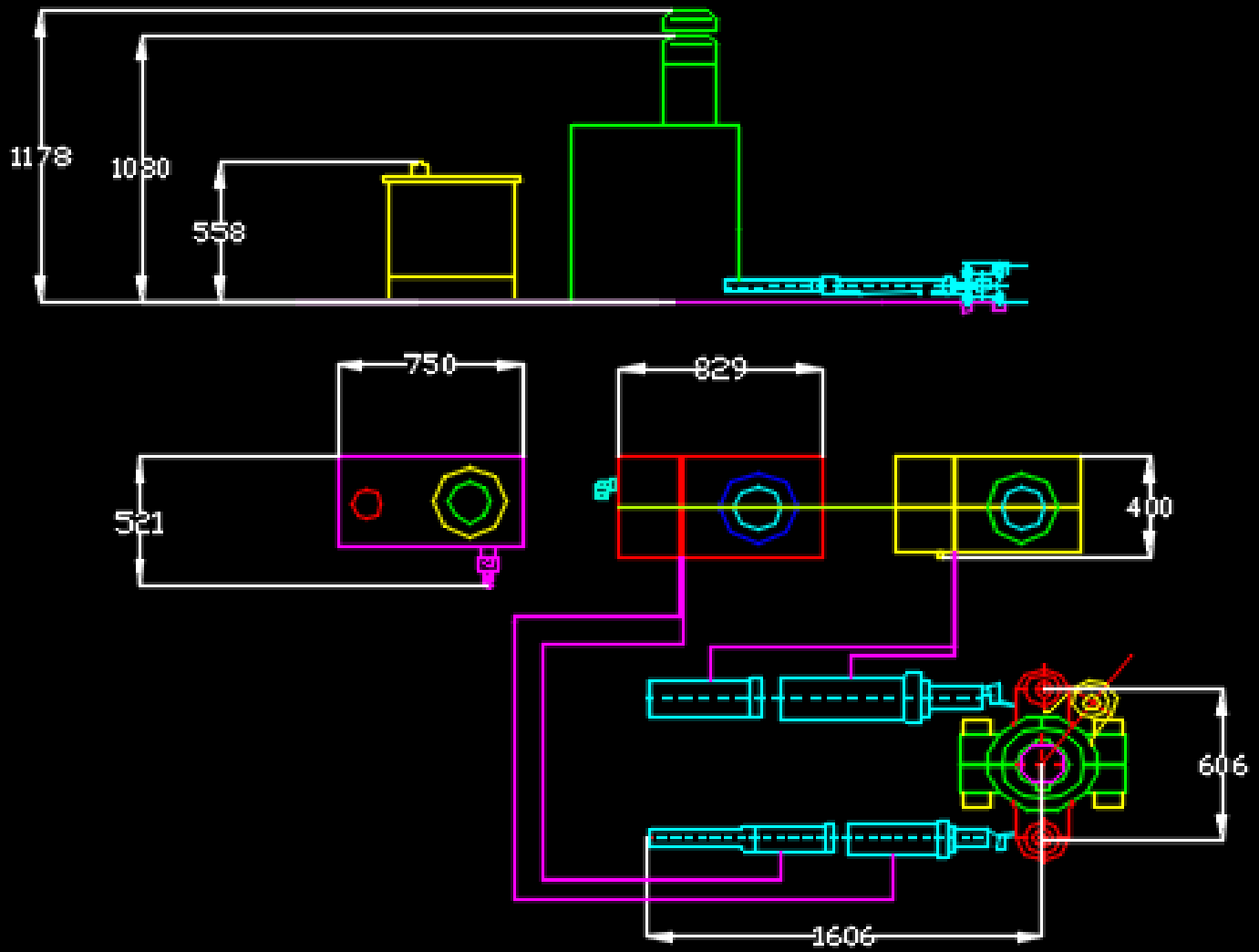
main coupling

STEERING GEAR

Model-HYDROSTAR MS25-35
(Hydraulic Piston type)



STEERING GEAR



PROPELLER DESIGN USING WAGENINGEN B SERIES

- LBP(m)=40.69
- B(m)=9
- T(m)=3.65
- BLOCK COEFFCIENT,C_B= .719
- VESSEL SPEED,V_S=12 KNOTS
- PROPELLER BLADE NO.,Z=4

MAXIMUM PERMISSIBLE PROPELLER DIAMETER=0.7T

=3.65*.7=2.55m

RELATIVE ROTATIVE EFFICIENCY η_R=1

SHAFT TRANSMISSION EFFICIENCY η_s=.97

PROPELLER DIAMETER BEHIND HULL $D_{MAX}=D_B$=2.55m

w=.2081

t=.1515

OPEN WATER DIAMETER $D_0=D_B/.95$=2.68m

$\frac{AE}{\mathrm{Ao}} = \frac{(1.3+.3Z)T}{(Po-Pv)D^2} + K = \frac{(1.3+.3*4)137.69}{124980.1138*2.55^2} + .2 = .63$ KELLER'S FORMULA

R_T=115.35KN

$T=R_T/(1-t)$=135.94 KN

HEIGHT OF SHAFT CENTRE LINE ABOVE BASE LINE h=D/2+.2=1.47m

VAPOUR PRESSURE OF WATER AT 15 DEGREE, Pv=1646 N/m^2

ATMOSPHERIC PRESSURE, P_{atm}= 101300 N/m^2

H=T-h=3.65-1.475=2.175m

$P_o = P_{atm} + \rho g H = 101300 + 1025 * 9.81 * 2.175 = 124980.113$ N

K=.2 for SINGLE SCREW

WAGENINGEN B-4.70 PROPELLER CHOSEN

WE KNOW,

$$Bp = 1.158 \left(N \times \frac{{P_D}^{.5}}{{V_A}^{2.5}} \right)$$

$$\delta = 3.2808 \left(N \times \frac{D_0}{V_A} \right)$$

HERE, P_E=712.146 KN

P_D=1266.412 KN

V_A=9.50 m/s

ASSUMED η_D=.60

N(rpm)	Bp	δ	η_o
150	21.64	137.38	.525
200	28.863	183.178	.545
250	36.079	228.97	.535
300	43.29	274.767	.495

OPTIMUM N(rpm)=200

MAXIMUM ηo=.545

B 4.70 BP-δ CHART

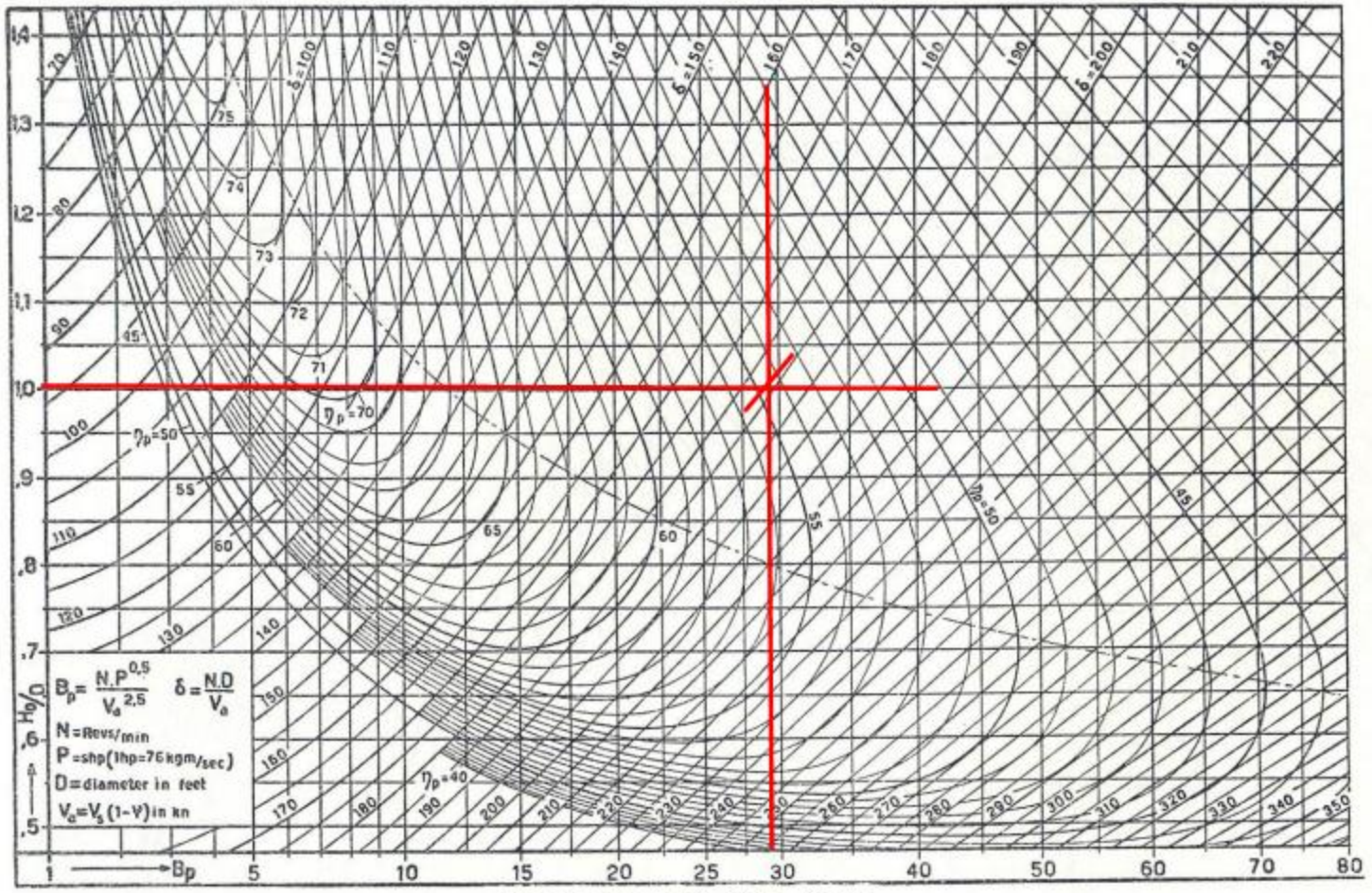


Fig. 3.17 Troost B.4 – 70 *Bp* – δ Chart

$\eta_D=\eta_h\eta_R\eta_0=(1-t/1-w)\eta_R\eta_0$

$=.59$

SO, η_D is CONVERGED.

BRAKE POWER= $P_B=(P_E/\eta_D\ \eta_S)$

$=1240$ KN

INSTALLED MAX. CONTINUOUS POWER=

$P_B/.85=1459.8$ KN

DELIVERED POWER $P_D=P_B*\ \eta_S=1278.35$KN

THEREFORE Bp=28.863

$\delta= 183.178$

FROM DIAGRAM WE GET, P/D=1

Parameters of selected Propeller:

No. of Blade, Z	4
Blade Area Ratio (BAR)	0.7
Diameter, D	2.5m
Revolution per minute (rpm)	200
Efficiency , η	55%
Pitch, P	2.5m

Burril Cavitation Number at 0.7R

$$\sigma_{0.7R} = \frac{P_A + \rho g h - p_v}{.5\rho(V_A{}^2 + 4.836\, n^2 D^2)}$$

$$= \frac{121524.16}{.5 \times 1025 \times (9.5^2 + 4.836 \times (\frac{200}{60})^2 \times 2.5^2)}$$

$$= .57$$

Thrust loading coefficient

$$\tau_c = \frac{T/A_P}{1/2\,\rho V_{0.7R}{}^2} = 0.21$$

$$(from\ chart, 2.5\%\ back\ cavitation)$$

$$\Rightarrow \frac{135.94/A_P}{214.94} = 0.21$$

Solving *the above equation, we get*

$$A_P = \mathbf{2.96 m^2}$$

Assuming $A_D \approx A_E$

$$A_E = \frac{A_P}{1.067 - 0.229\ {}^{P}/_{D}}$$

$$= \frac{2.96}{1.067 - 0.229 \times 1}$$

$$\mathbf{= 3.53 m^2}$$

Blade Area Ratio for avoiding Cavitation:

BAR(For avoiding cavitation)

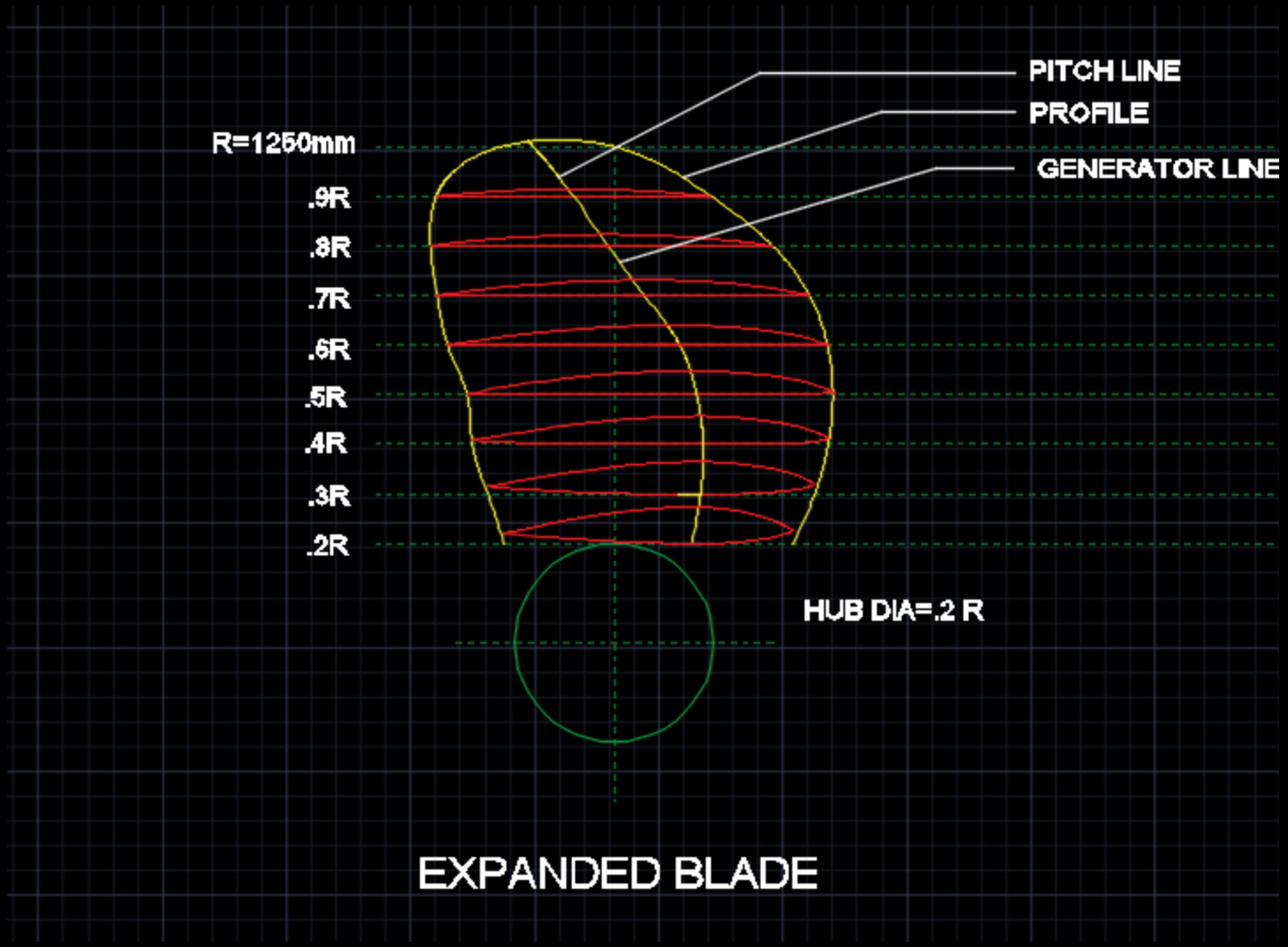
$$= \frac{A_E \times 4}{\pi D^2}$$

$$= \frac{3.53 \times 4}{\pi \times 2.5^2}$$

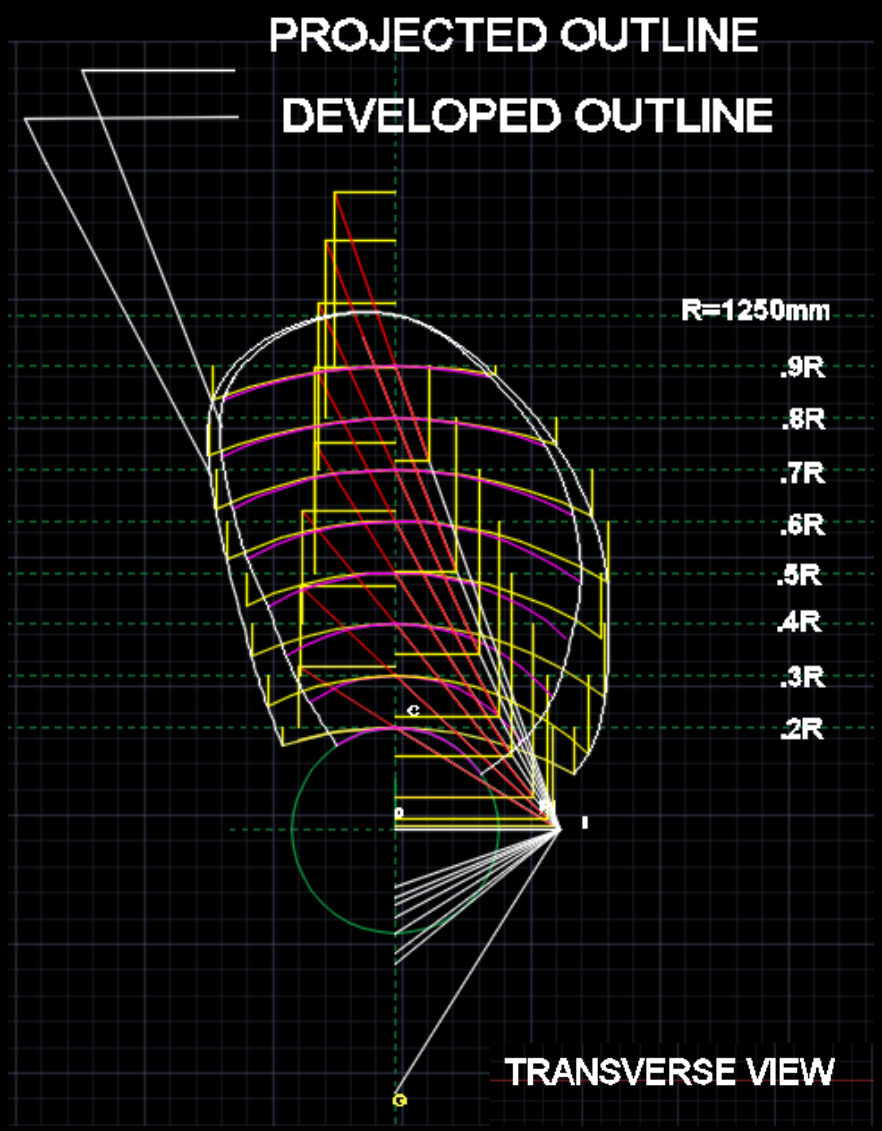
$$= \mathbf{0.69}$$

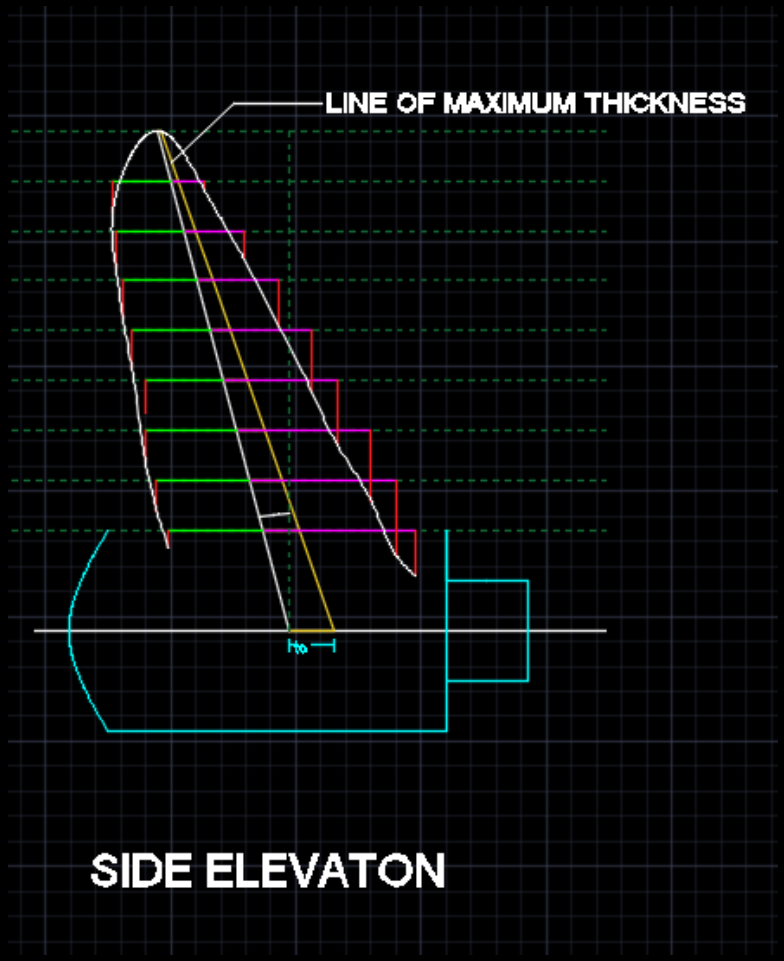
Taken BAR = 0.70

Capable of avoiding Cavitation.



EXPANDED BLADE


PROJECTED OUTLINE
DEVELOPED OUTLINE
R=1250mm
.9R
.8R
.7R
.6R
.5R
.4R
.3R
.2R
TRANSVERSE VIEW


LINE OF MAXIMUM THICKNESS
SIDE ELEVATON

PROPELLER SHAFT ARRANGEMENT

SHAFT CALCULATION RESULT

- SHAFT DIAMETER-200mm
- MINIMUM WALL THICKNESS-16mm
- THICKNESS OF COUPLING FLANGE-40mm
- lmax=maximum permissible distance between bearing(mm)-3.96m
- LENGTH OF AFT STERN TUBE BEARING-0.3m
- LENGTH OF FORWARD STERN TUBE BEARING-0.8m

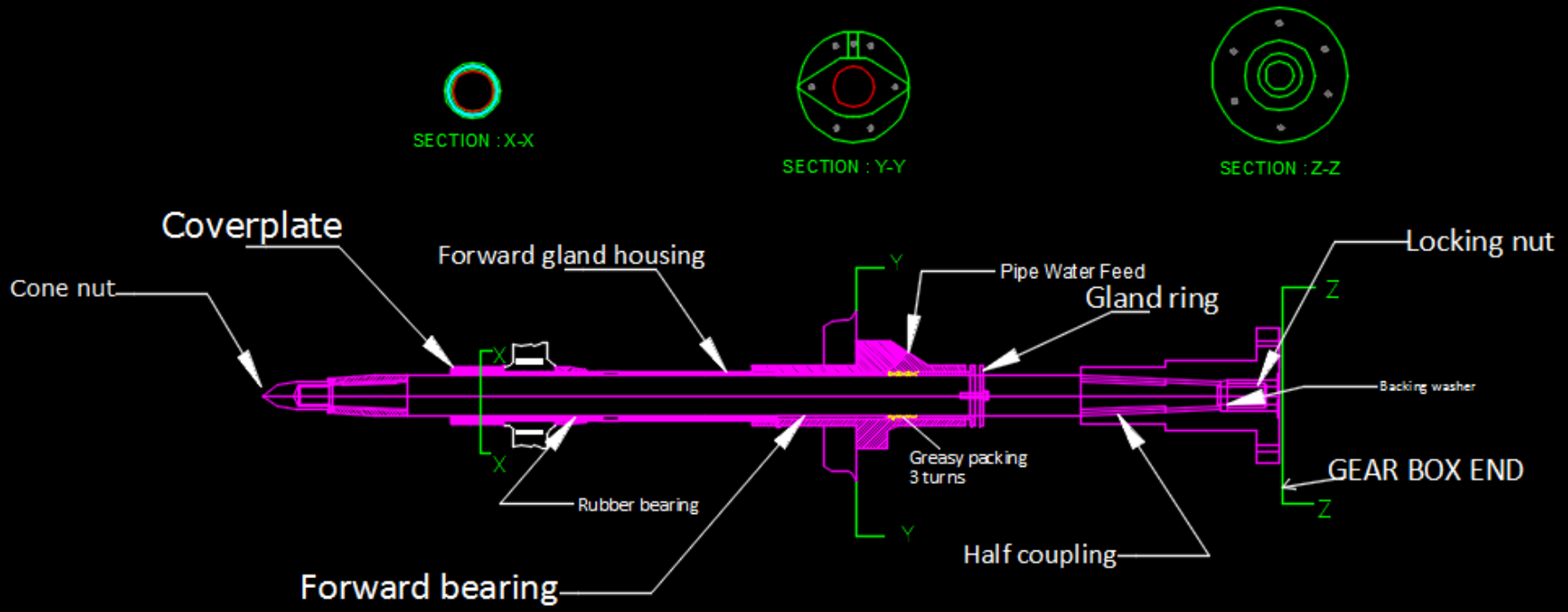


FIG: DETAILS OF PROPELLER SHAFT

THANK YOU