

KREŠIMIR ŠKOKIĆ

address: Zelinska 5, Zagreb, CROATIA

mobile tel. : 385989803367

email: kresimir.skokic@gmail.com

WATER LINE LTD., Zagreb Croatia

MY “Marco Polo 16” Powerboat

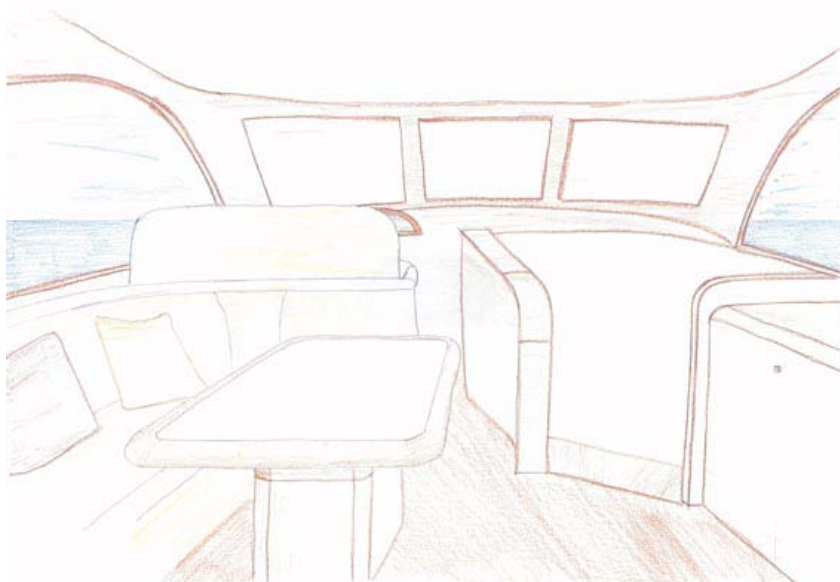
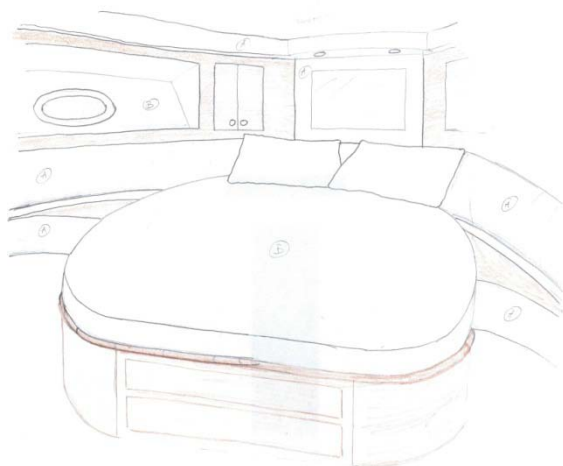
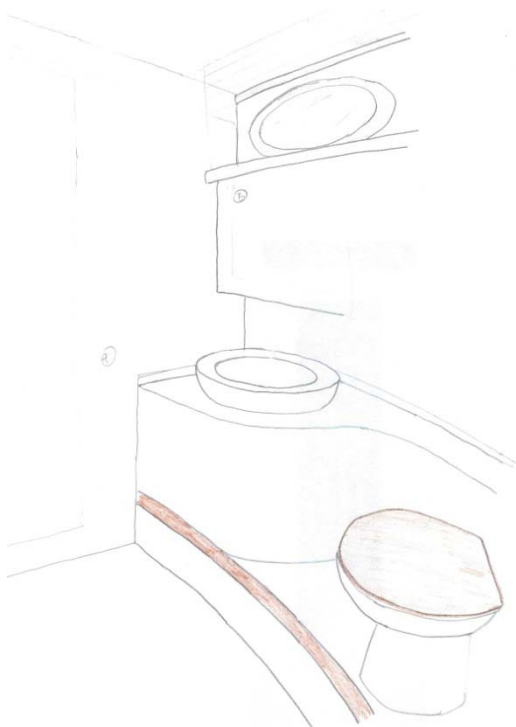


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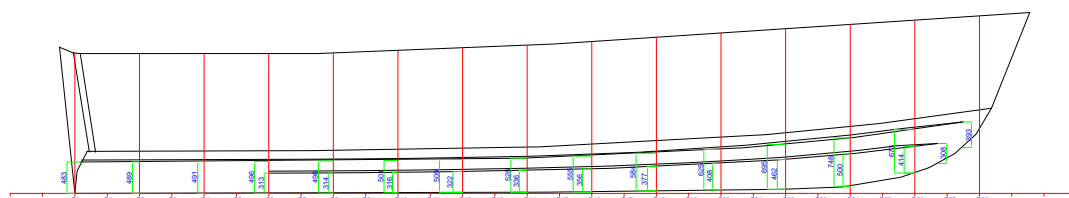
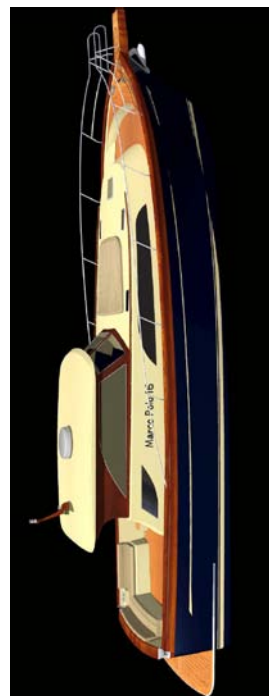
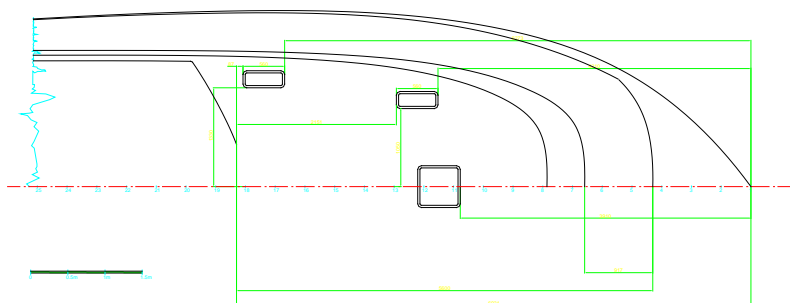
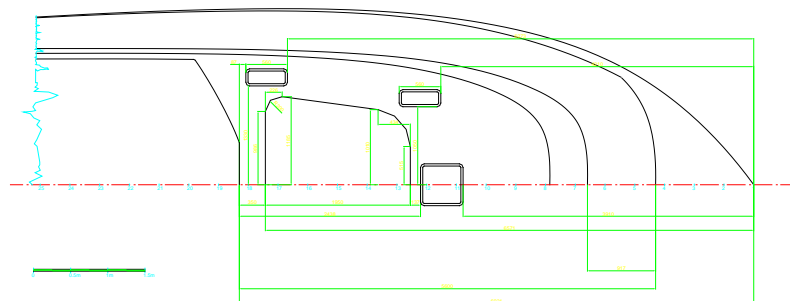


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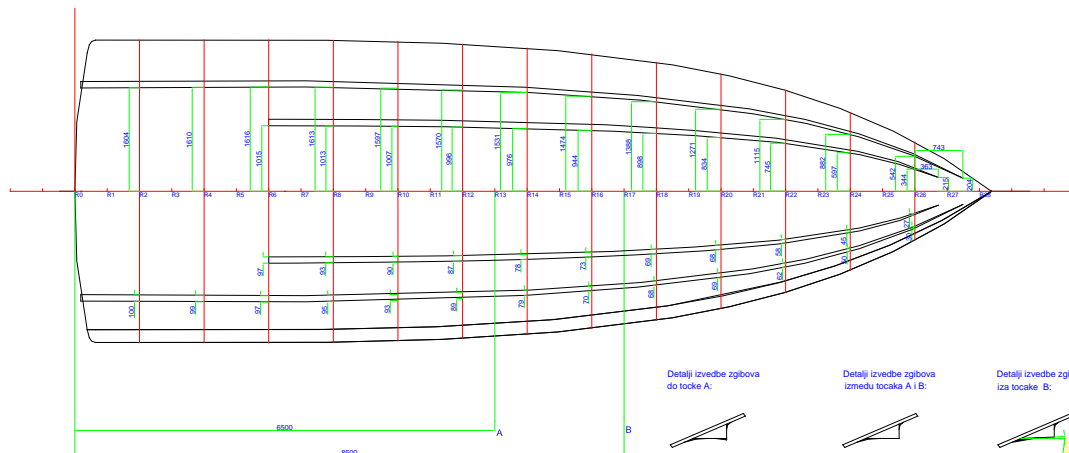
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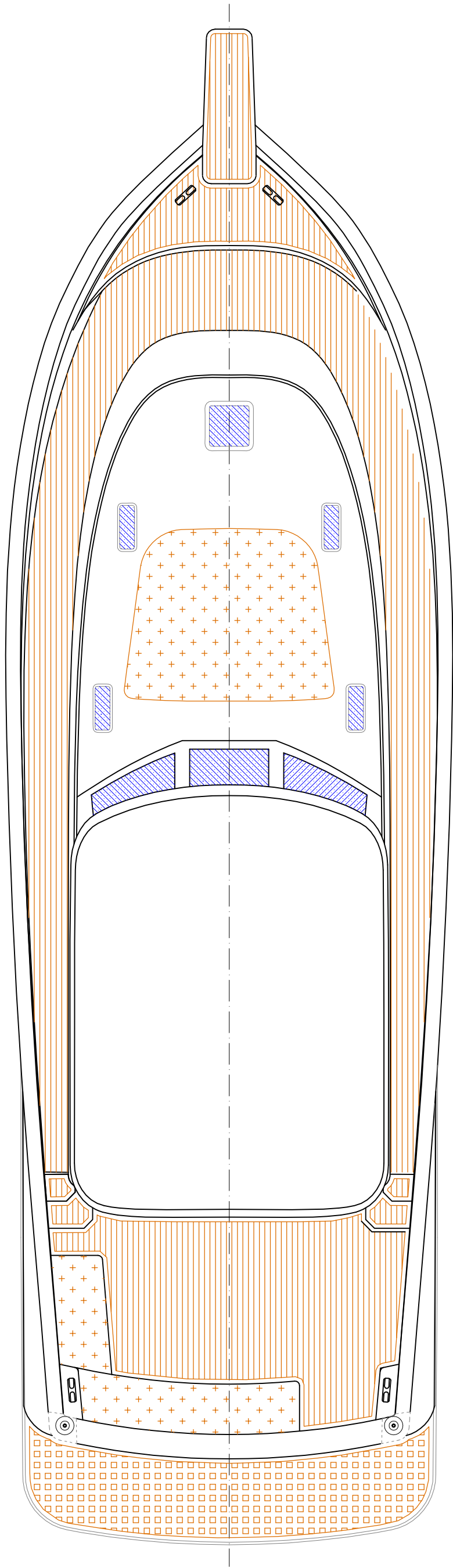
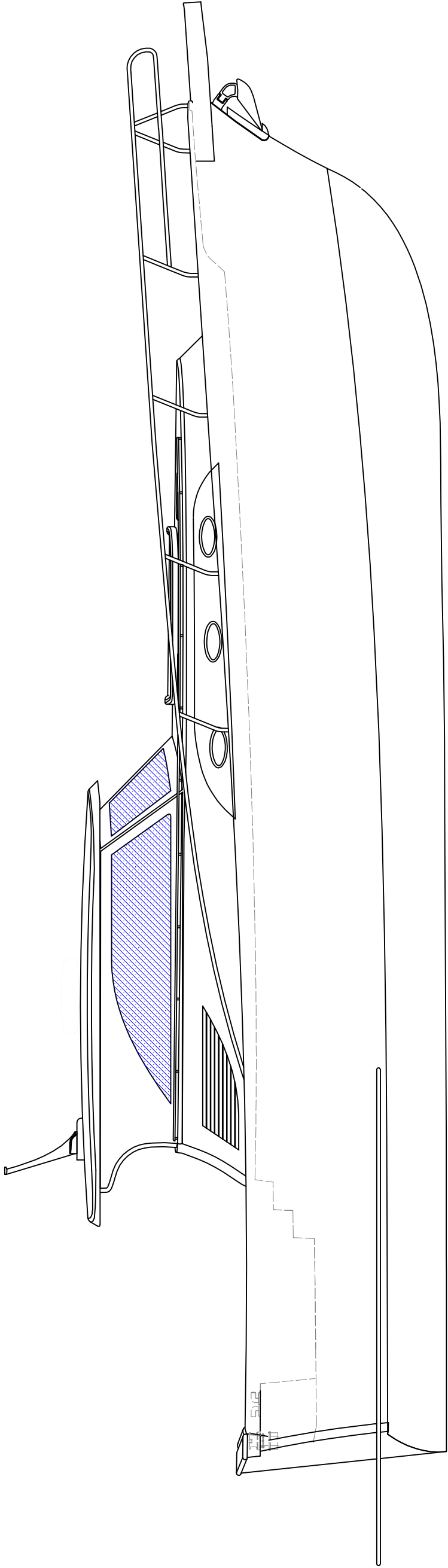
Razmak rebara 0.5m



Detalji izvedbe zgibova
do točke A:

Detalji izvedbe zgibova
izmedu tocaka A i B:

Detalji izvedbe zgibova
iza točke B:



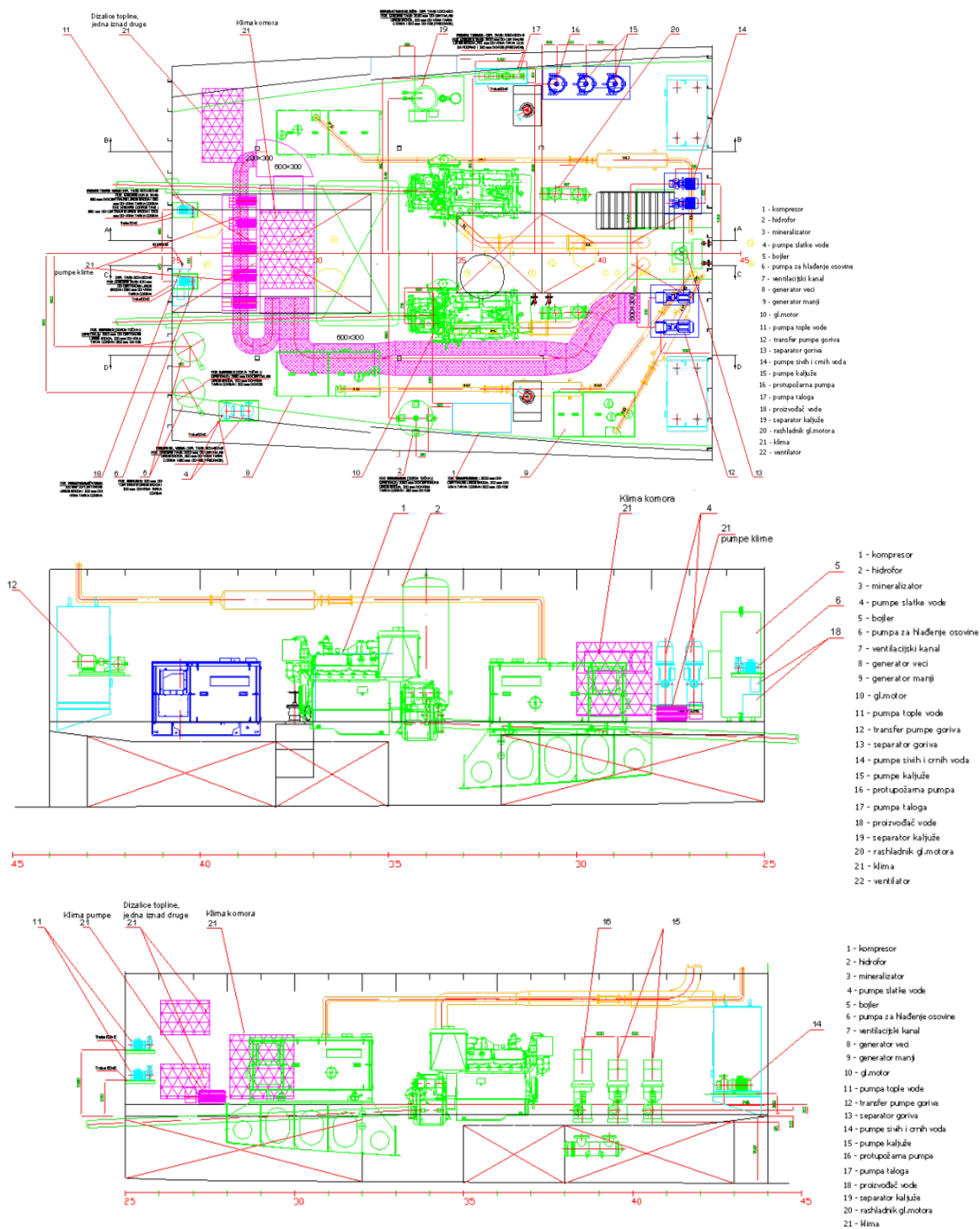
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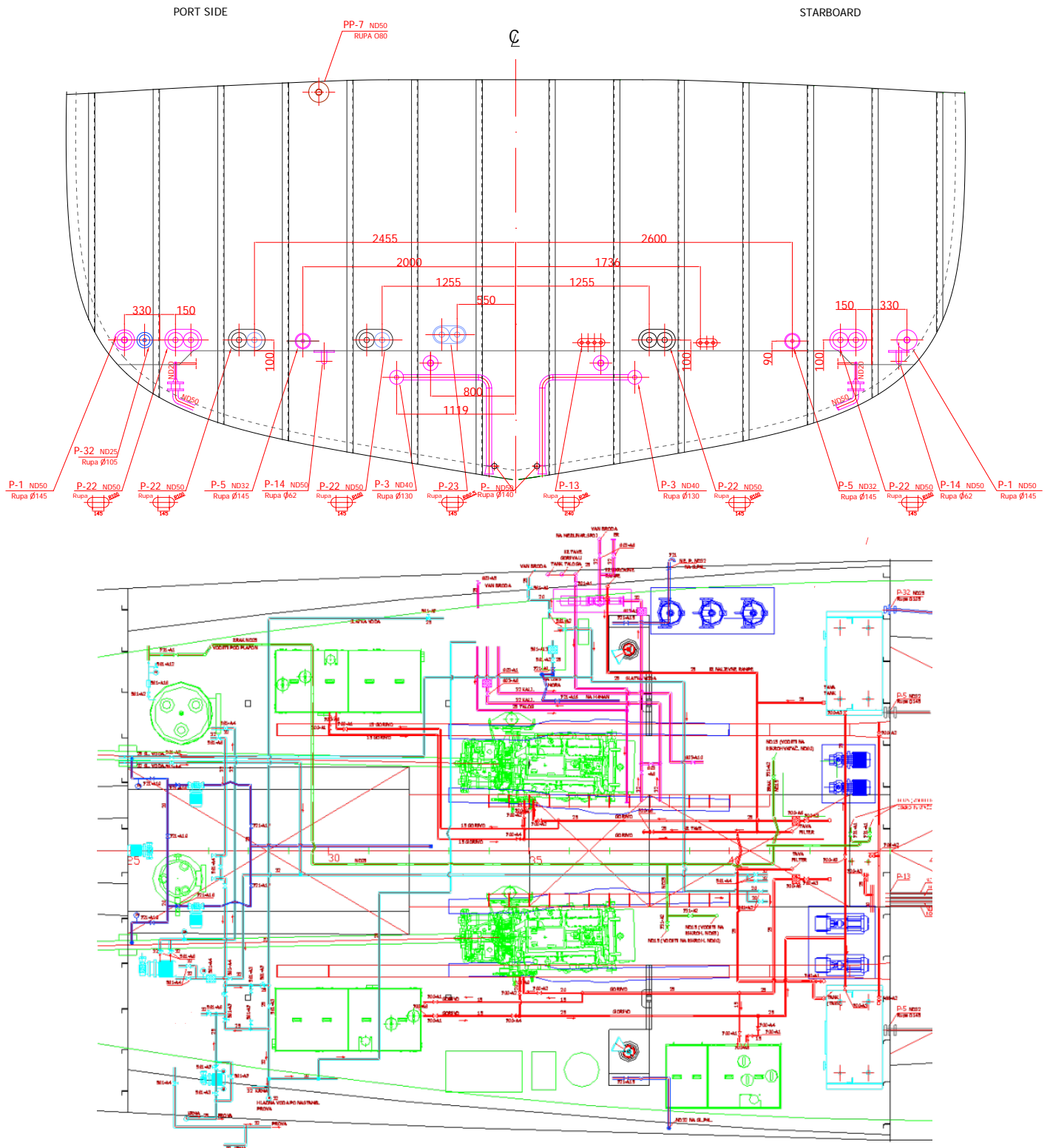
mobile tel. : 385989803367

email: kresimir.skokic@gmail.com

MY "Sea Gull II" Motor yacht 54.2m



email: kresimir.skokic@gmail.com



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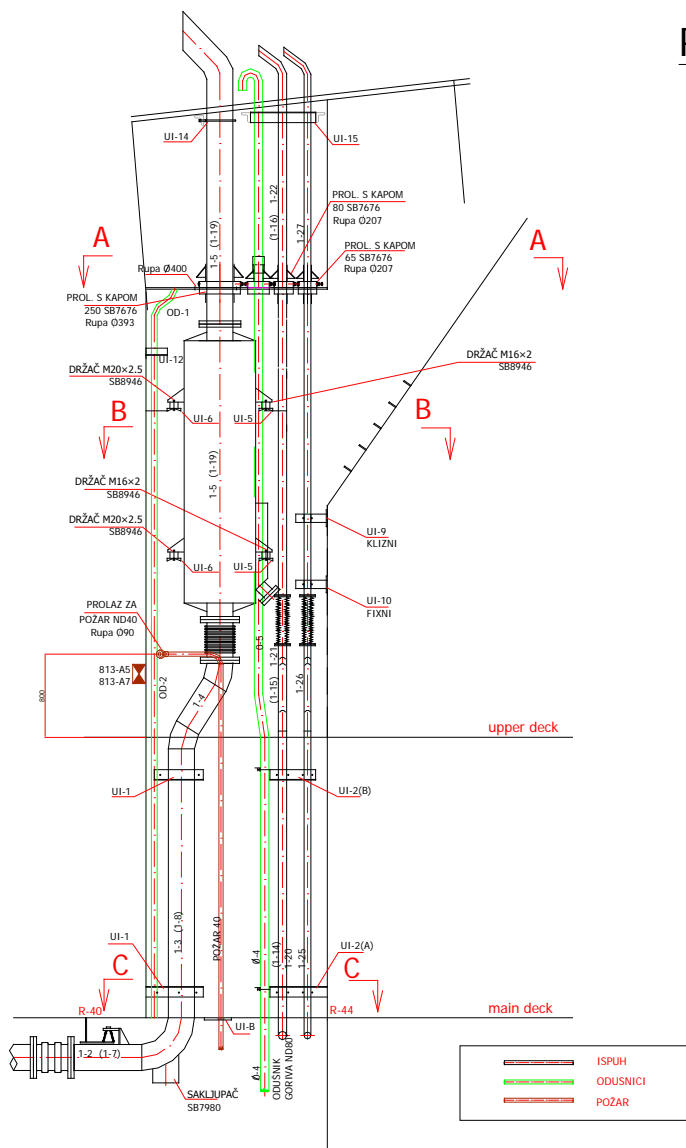
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RESJEK A-A

The drawing is a detailed cross-section of a ship's hull, labeled 'RESJEK A-A'. It shows the internal structure, including the deck, hull plating, and various openings. Key features include:

- PD-1:** POZAR ND40 NA UPPER DECK RUPA Ø90 (Fireproof bulkhead on upper deck, 90mm radius).
- PD-2:** PROLAZ S KAPOM 250 SB7676 RUPA Ø393 (Passage with hatch, 250mm thick, 393mm radius).
- PD-3:** PROLAZ S KAPOM 80 SB7979 RUPA Ø207 (Passage with hatch, 80mm thick, 207mm radius).
- PD-4:** PROLAZ S KAPOM 65 SB7676 RUPA Ø177 (Passage with hatch, 65mm thick, 177mm radius).
- PD-5:** RUPA Ø62 (Radius 62mm).
- R44:** A structural reinforcement or bulkhead.
- UI-15:** A structural element or bulkhead.
- UI-16:** A structural element or bulkhead.

Dimensions and other specifications are provided throughout the drawing, such as 1030, 780, 790, 400, 200, 250, 280, 80, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1050, 1100, 1150, 1200, 1250, 1300, 1350, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1750, 1800, 1850, 1900, 1950, 2000, 2050, 2100, 2150, 2200, 2250, 2300, 2350, 2400, 2450, 2500, 2550, 2600, 2650, 2700, 2750, 2800, 2850, 2900, 2950, 3000, 3050, 3100, 3150, 3200, 3250, 3300, 3350, 3400, 3450, 3500, 3550, 3600, 3650, 3700, 3750, 3800, 3850, 3900, 3950, 4000, 4050, 4100, 4150, 4200, 4250, 4300, 4350, 4400, 4450, 4500, 4550, 4600, 4650, 4700, 4750, 4800, 4850, 4900, 4950, 5000, 5050, 5100, 5150, 5200, 5250, 5300, 5350, 5400, 5450, 5500, 5550, 5600, 5650, 5700, 5750, 5800, 5850, 5900, 5950, 6000, 6050, 6100, 6150, 6200, 6250, 6300, 6350, 6400, 6450, 6500, 6550, 6600, 6650, 6700, 6750, 6800, 6850, 6900, 6950, 7000, 7050, 7100, 7150, 7200, 7250, 7300, 7350, 7400, 7450, 7500, 7550, 7600, 7650, 7700, 7750, 7800, 7850, 7900, 7950, 8000, 8050, 8100, 8150, 8200, 8250, 8300, 8350, 8400, 8450, 8500, 8550, 8600, 8650, 8700, 8750, 8800, 8850, 8900, 8950, 9000, 9050, 9100, 9150, 9200, 9250, 9300, 9350, 9400, 9450, 9500, 9550, 9600, 9650, 9700, 9750, 9800, 9850, 9900, 9950, 10000.



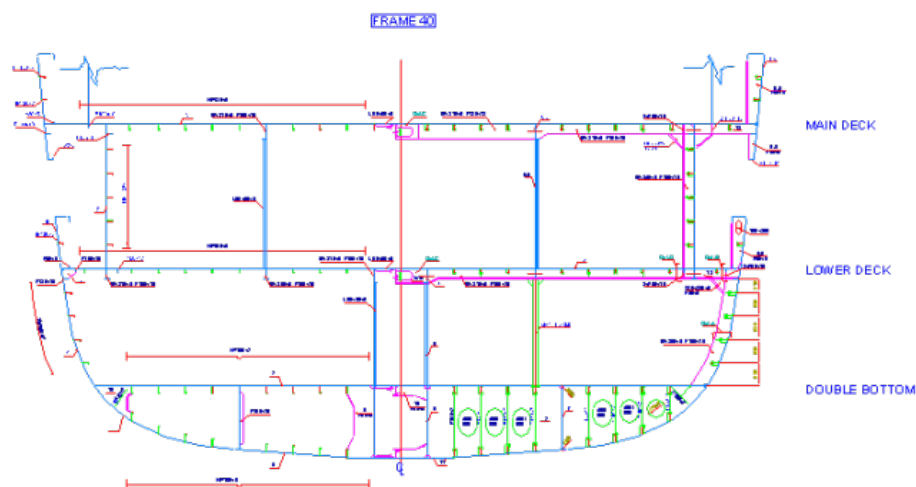
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MV "Perina" 73m , Project. No. 1022



MAIN DIMENSIONS:

LENGTH, OVER ALL	73.00 m
LENGTH, BETWEEN PP AT T-2.5	55.00 m
LENGTH, B.W.L.	55.40 m
BREADTH, MAX. MID LINES, B	16.46 m
BREADTH, MID LINES AT T-2.5	14.70 m
DEPTH, MID LINES, B	7.2 m
DRAUGHT, DEADEND	2.5 m
DRAUGHT, BOW	

DISPLACEMENT, CORN. 1.025 m³ AT T-2.5 APPROX.
BLOCK COEFFICIENT
DEPTH, MAIN DECK

7.2 m

SERVICE SPEED (DESIGN DRAUGHT)
DESIGN

CLASSE: G RM

NO.	DATE	REVISION	APPROVED
1	01.01.2017	1	
2	01.01.2017	2	
3	01.01.2017	3	
4	01.01.2017	4	
5	01.01.2017	5	
6	01.01.2017	6	
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100	01.01.2017	100	

MOTOR YACHT "PERINA"

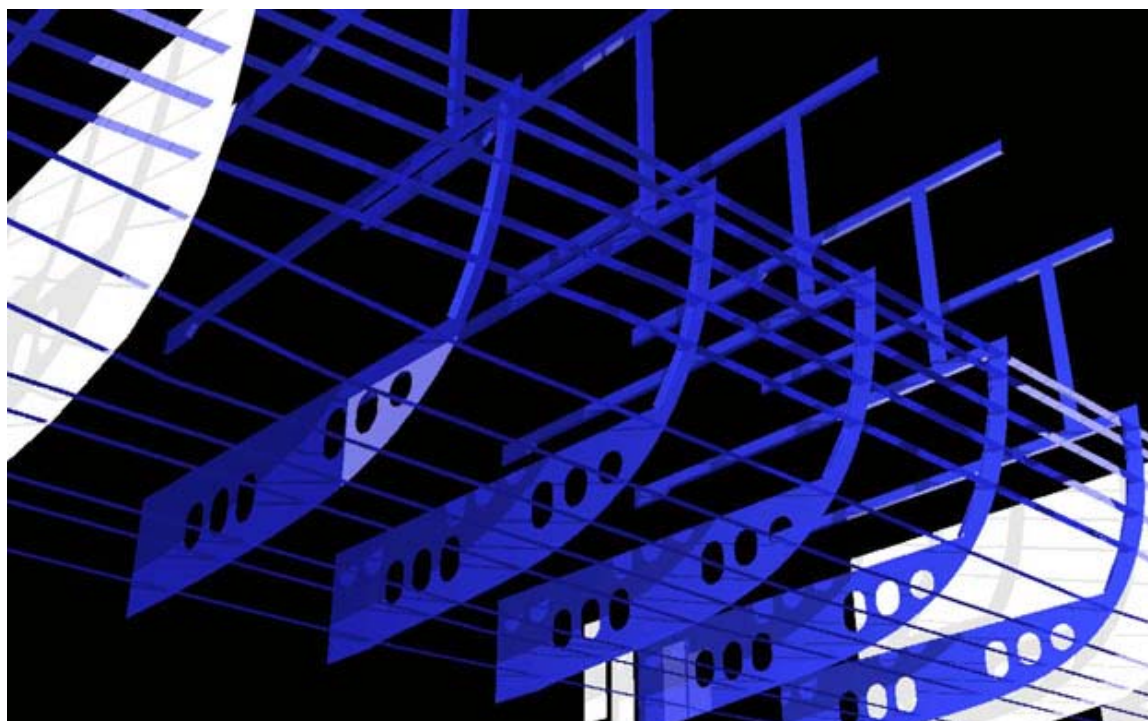
PRELIMINARY
MIDSHIP SECTION



DESIGNER: WL

SCALE: 1:100

DATE: 01.01.2017





WATERLINE L.T.D.

Bogišićeva 12

Zagreb

10000

CROATIA

Client:

Project:

MV "PERINA"

24PAX Cruise Vessel



DOCUMENT DESCRIPTION:

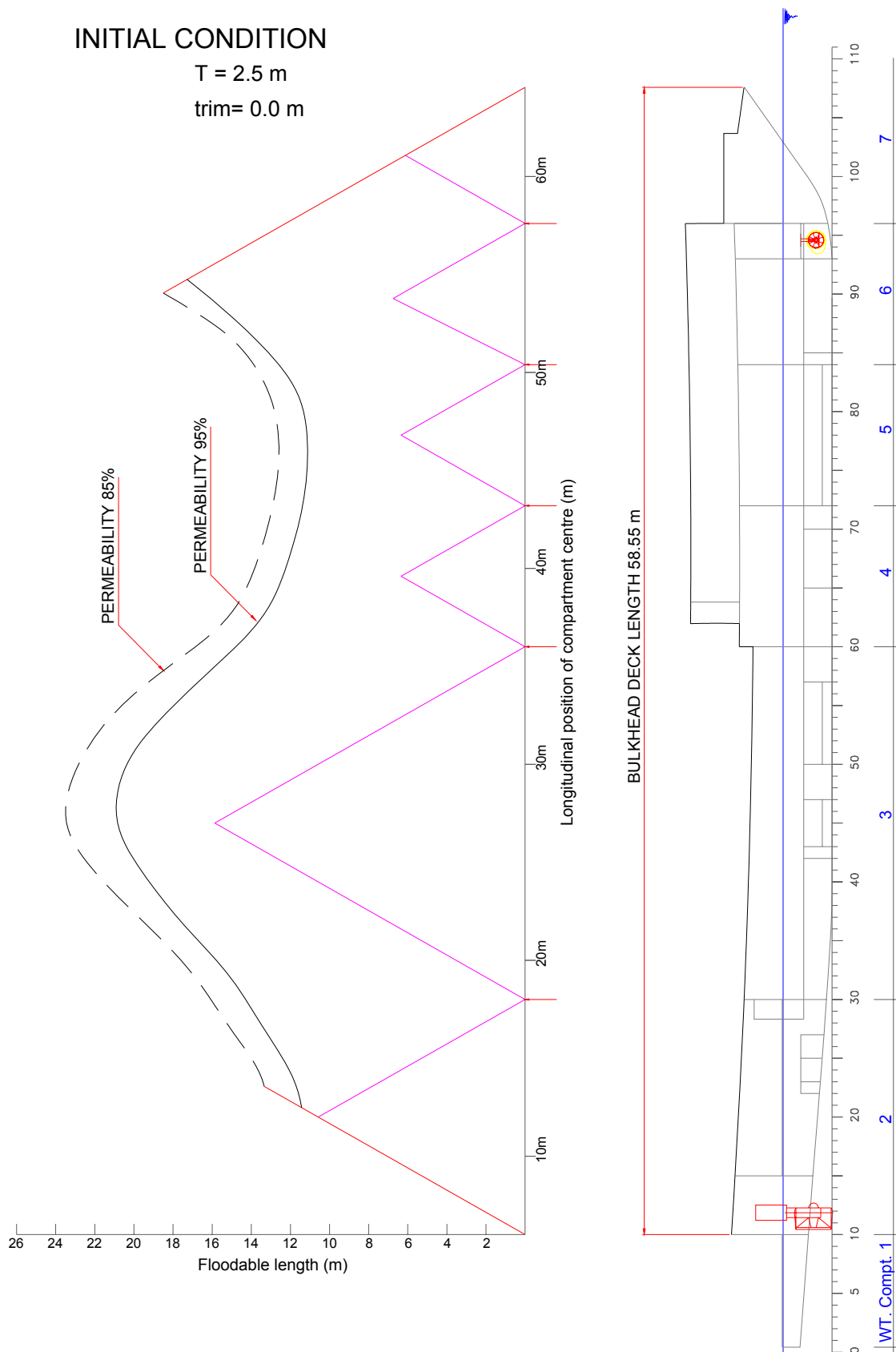
PRELIMINARY DAMAGE STABILITY PARTICULARS

DOCUMENT NUMBER:			101-1022-040		CONNECTION DRAWING:		
Status / Revision	Date	Number of Pages	Written by	Sign	Checked by	Sign	Reason for change
	Dec.'07.	94	Krešimir Škokić d.ing.		Ivo Miličić d.ing.		

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2.4 FLOODABLE LENGTH CURVE



3.4 DAMAGE ZONES

The following table shows the seven damage zones along the vessel for one-compartment damage.

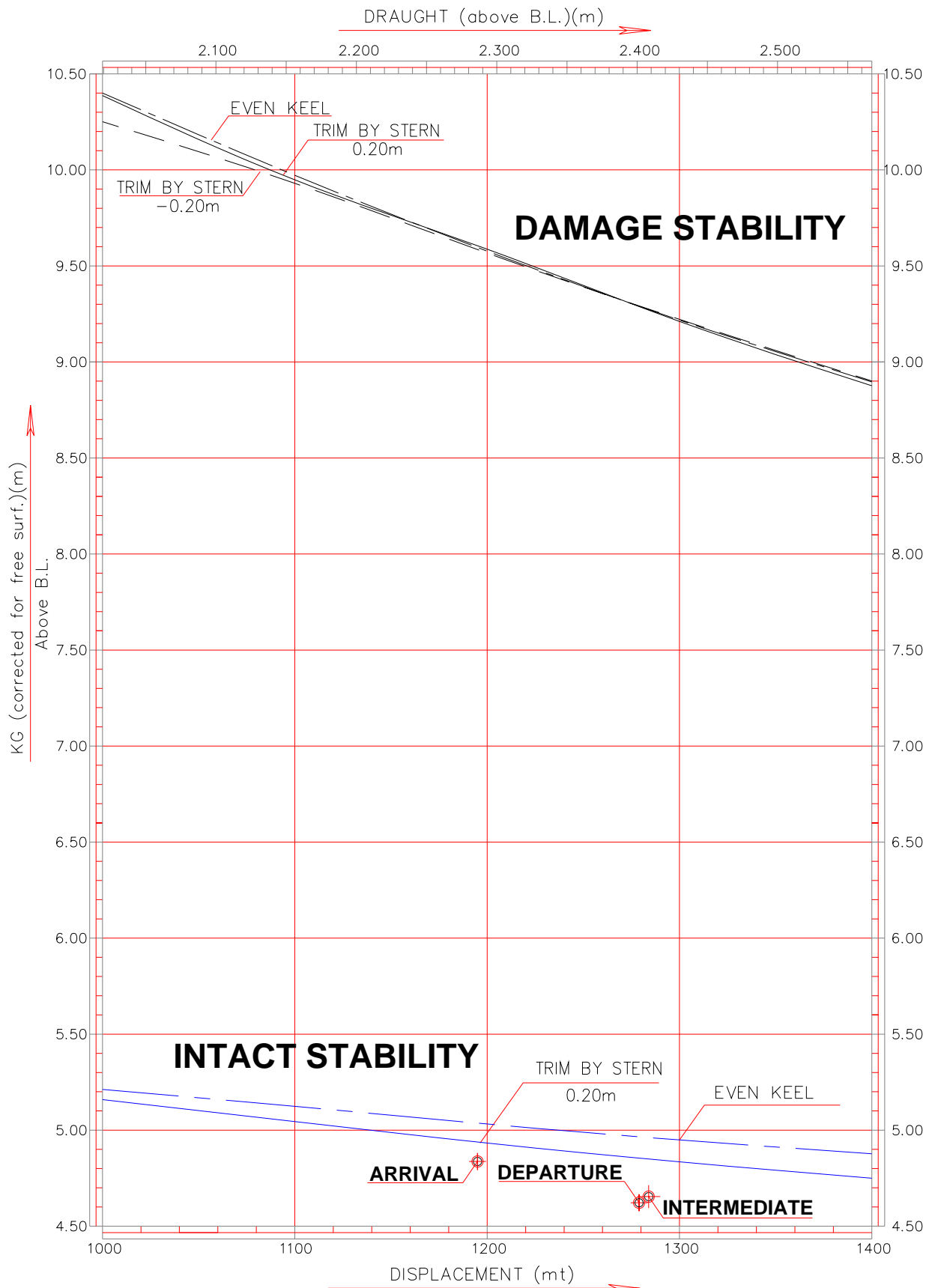
DAMAGE CASE	FLOODED COMPARTMENTS	FRAME	PERMEABILITY	NOTE
D1	BALLAST TANK No.1 (60)	0.5÷10	95	
D2	ENGINE ROOM CHAIN LOCKER BILGE (P) DIESEL OIL No.1 (P) (10) DIESEL OIL No.1 (S) (11) AUX. ENGINE ROOM TENDER STORAGE	10÷30 10÷15 15÷30 15÷30 15÷30 15÷30	85 85 95 95 85 95	MISC (20,21,22,23,24) and Diesel Oil service tanks (14,15) not flooded as outside B/5 TENDER STORAGE is connected with ENG.ROOM
D3	VOID (D.Bottom P,S) PAX ACCOMODATION	30÷60	95	Diesel Oil No.2 (P) & (S) (12,13), Sanitary Water No.1 (P) & (S) (30,31) not flooded as outside B/5
D4	VOID (D.Bottom P,S) CREW ACCOMODATION VOID (Upper tank P) LOUNGE BAR (main deck)	60÷72 62÷96	95	Gray water (P) & (S) (50,51), Black water (P) & (S) (52,53), Sanitary Water No.2 (32) not flooded as outside B/5 Comp.VOID (D.Bottom P,S) are connected
D5	BALLAST TANK No.2 P (61) CREW ACCOMODATION FRESH WATER No.3 (33) VOID (Upper tank P&S) LOUNGE BAR (main deck)	72÷84 62÷96	95	Pipe conn.space in double bottom not flooded as outside B/5
D6	BALLAST TANK No.3 (63) Pipe conn. space BOW THRUSTER SPACE TEHNICAL SPACE FRESH WATER No.4 (34) LOUNGE BAR (main deck)	84÷93 84÷93 93÷96 84÷96 84÷93 62÷96	95	
D7	BALLAST TANK No.4 (64)	96-109	95	

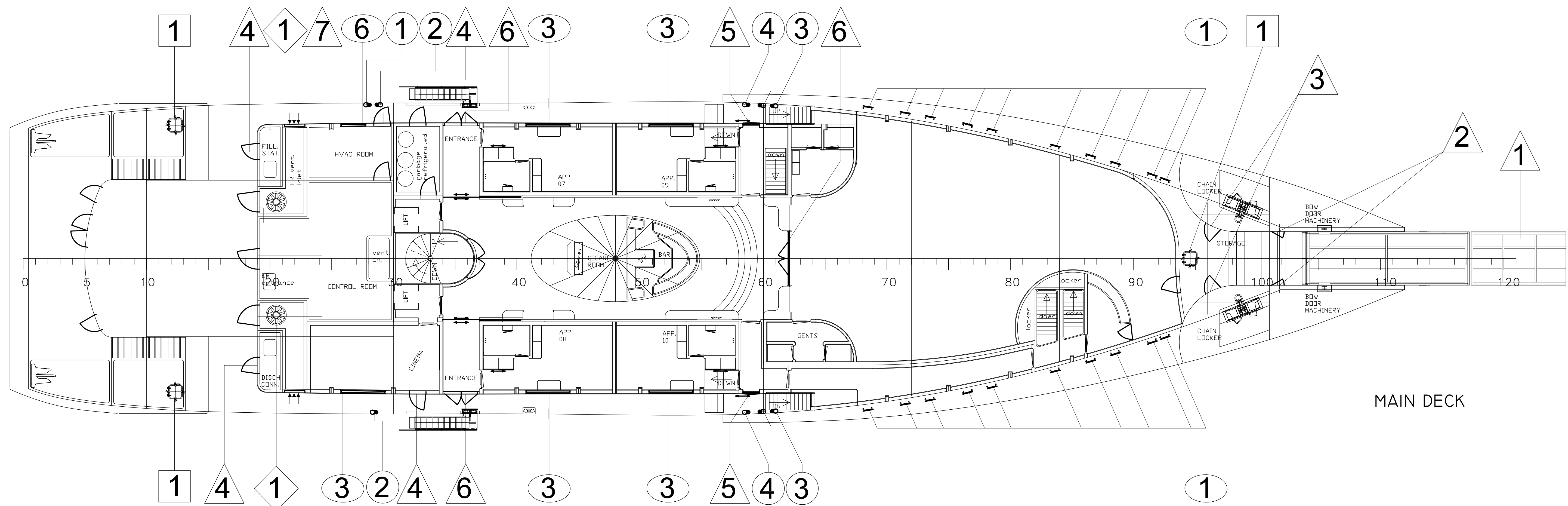
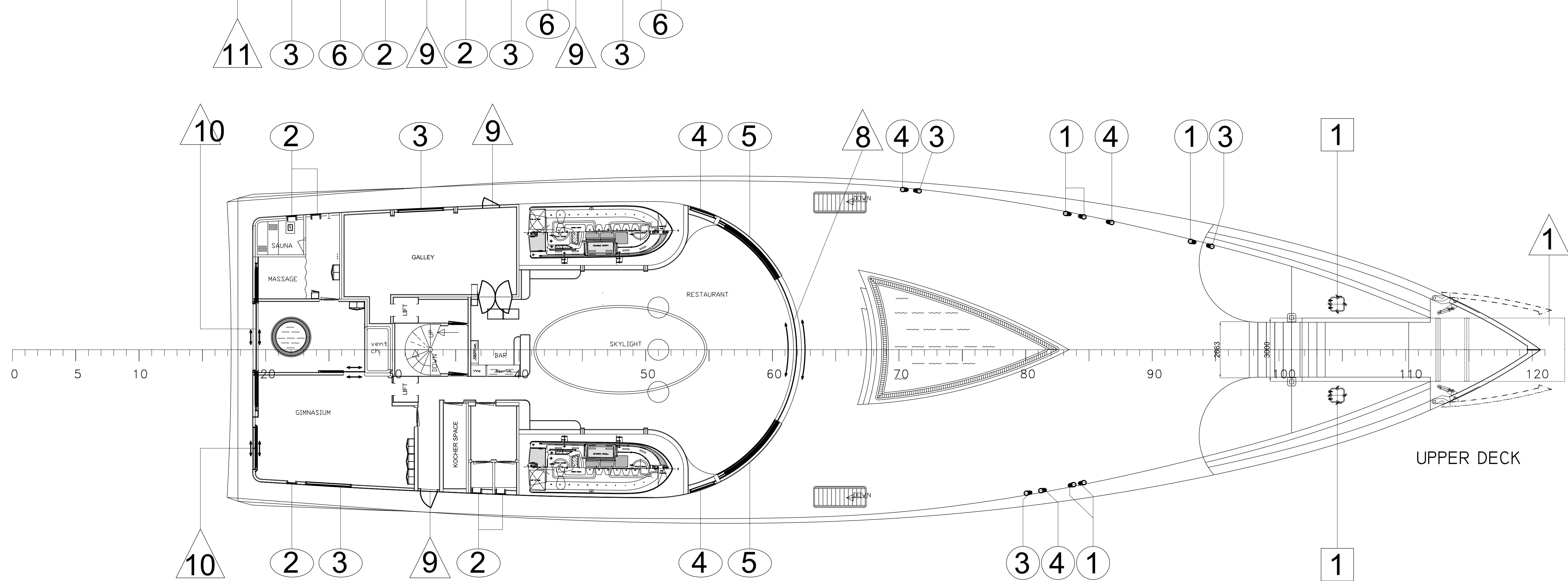
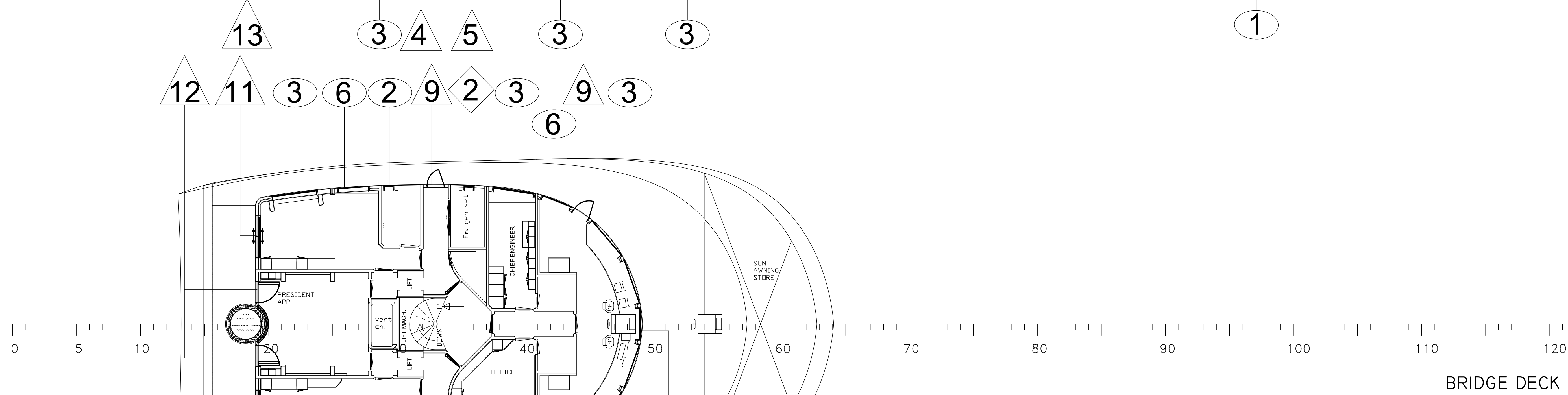
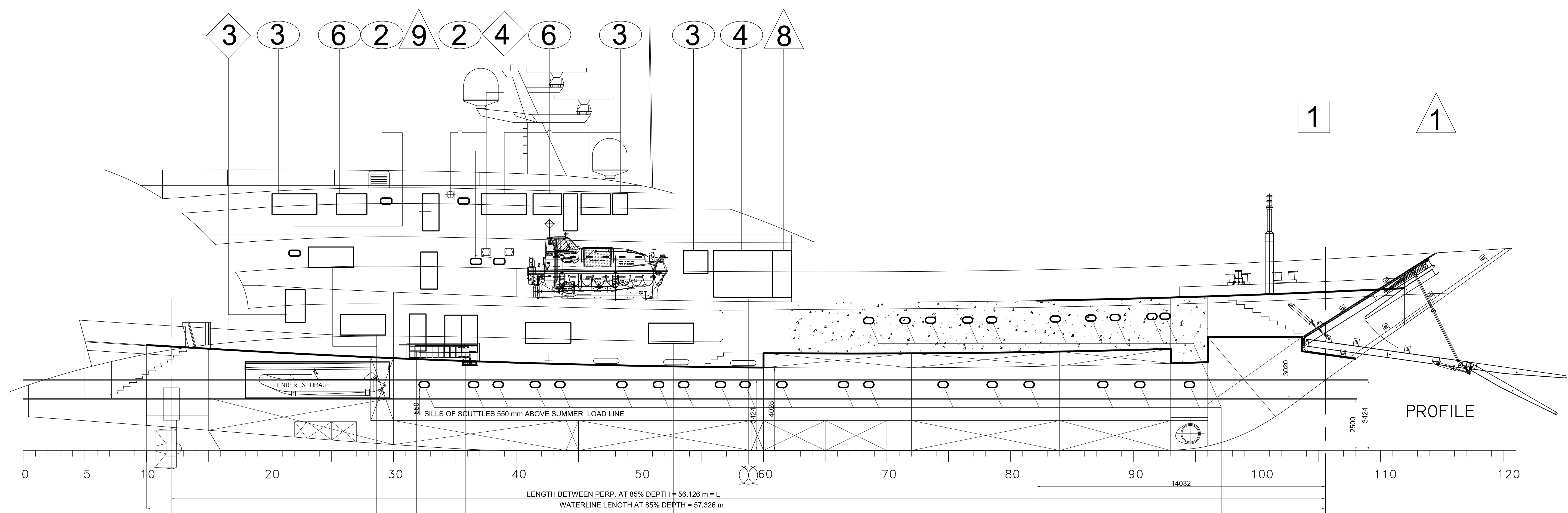
5. DAMAGE ANALYSIS**5.1 SUMMARY OF DAMAGE RESULTS****SOLAS, II-1/8**

CASE		damage case/ initial condition	
T	m	draught	
TR	m	trim	
RORPS	deg	range of residual positive stability	min 15,0
AURGZ	m.rad	area under residual GZ curve	min 0,015
MAXGZ	m	maximum residual GZ	min 0,100
RGM	m	residual GM	min 0,050
HEEL	deg	heeling angle to starboard	max 7
RESMRG	m	reserve to immersion of margin line	max 0.000

CASE	T m	TR m	RORPS deg	AURGZ m.rad	MAXGZ m	RGM m	HEEL deg	RESMRG M
D1/I1	2.432	0.739	44.0	0.342	1.502	5.398	0.2	1.560
D1/I2	2.440	0.705	43.8	0.332	1.467	5.346	0.4	1.528
D1/I3	2.315	0.578	50.3	0.334	1.492	5.581	0.5	1.623
D2/I1	2.706	2.391	28.0	0.297	1.237	4.272	-0.3	1.157
D2/I2	2.712	2.335	27.8	0.288	1.206	4.227	-0.1	1.194
D2/I3	2.537	1.859	31.9	0.291	1.312	4.384	-1.0	1.311
D3/I1	3.110	0.686	27.8	0.148	0.610	2.429	0.4	0.853
D3/I2	3.121	0.657	27.4	0.139	0.581	2.392	0.8	0.791
D3/I3	2.922	0.446	31.6	0.138	0.604	2.406	1.2	0.972
D4/I1	2.624	-0.472	46.2	0.287	1.237	4.977	0.2	1.264
D4/I2	2.635	-0.504	45.9	0.277	1.204	4.927	0.5	1.221
D4/I3	2.500	-0.488	52.1	0.276	1.219	5.000	0.6	1.342
D5/I1	2.610	-0.692	50.2	0.340	1.389	5.473	-0.4	1.238
D5/I2	2.622	-0.733	50.0	0.330	1.355	5.419	-0.2	1.247
D5/I3	2.489	-0.704	54.4	0.332	1.378	5.514	-0.1	1.399
D6/I1	2.516	-0.449	51.5	0.350	1.498	5.831	0.0	1.407
D6/I2	2.526	-0.944	50.5	0.304	1.269	5.199	0.2	1.329
D6/I3	2.521	-0.955	50.4	0.301	1.264	5.217	0.3	1.314
D7/I1	2.395	0.128	48.3	0.345	1.527	5.899	0.2	1.551
D7/I2	2.394	-0.305	54.5	0.302	1.305	5.309	0.4	1.493
D7/I3	2.390	-0.316	54.7	0.299	1.301	5.331	0.5	1.478

6. MAXIMUM KG CURVE





VOLUMES INCLUDED FOR RIGHTING LEVERS CALCULATION

POSITION 1

VENTILATOR OPENINGS

POS.	PCS.	COAMING		CLOSING APPLIANCES			REMARKS
		DIMENSIONS	THICKNESS	HEIGHT FROM DECK	PLATE THICKNESS	REMARKS	
1.	2	Ø490		760		E.ROOM AIR INLET	
2.	1	800x600		1000		ONLY OUTLET GRILLE. NO CLOSING APPLIANCE	EMERG. GENERATOR AIR INLET, SB8316
3.	2	1000x1500		870		ONLY OUTLET GRILLE. NO CLOSING APPLIANCE	E.ROOM AIR INLET
4.	2	VARIOUS		abt.1900		NO CLOSING APPLIANCE	E.ROOM AIR INLET

HATCHES

POS.	PCS.	COAMING		CLOSING APPLIANCES			REMARKS OR REF. TO STANDARD
		DIMENSION WxH	THICKNESS	HEIGHT FROM DECK	PLATE THICKNESS	REMARKS	
1	5	680x680	12	600	8	NEOPRENE	4xSCREWS/ NUTS SB 7458

SIDE SCUTTLES AND WINDOWS

POS.	PCS.	CLEAR GLASS SIZE		TYPE	MATERIAL		TYPE OR CATEGORY	THICK-NESS	STANDARD/ NOTE
		WxH	R		DEADLIGHT	FRAME			
1	29	513x310	155	FIXED WITH DEADLIGHT	ALMAG35	ALMAG35	HEAVY-DUTY TEMPERED GL.	15	FREEMAN 4152
2	3 P 5 S	558x302	100	FIXED WITHOUT DEADLIGHT	ALMAG35	ALMAG35	HEAVY-DUTY TEMPERED GL.	15	FREEMAN 4152
3	15	2200x1000		FIXED	STEEL	STEEL	CLEAR / TEMPERED	15	MODIFIED SB 8598
4	2	1250x1000		FIXED	STEEL	STEEL	CLEAR / TEMPERED	12	MODIFIED SB 8598
5	2	3800x1800		FIXED	STEEL	STEEL	CLEAR / TEMPERED	10	MODIFIED SB 8598
6	6	1100x1000		FIXED	STEEL	STEEL	CLEAR / TEMPERED	8	MODIFIED SB 8598

AIR-PIPES

POS.	PCS.	HEIGHT ABOVE DECK	SIZE ABOVE DECK	MATERIAL	FROM	TO/OVER	TYPE OF CLOSING APPLIANCE	STANDARD
1	6	760	DN80	GALVANIZED STEEL	BALLAST	FREEBOARD D.	WITH BALL	SB4184
2	2	760	DN32	GALVANIZED STEEL		FREEBOARD D.		SB7873
3	7	760	DN40	GALVANIZED STEEL	VOID	FREEBOARD D.	WITH BALL	SB4184
4	4	760	DN65	GALVANIZED STEEL	FRESH WATER	FREEBOARD D.	WITH BALL	SB4184


DOORS

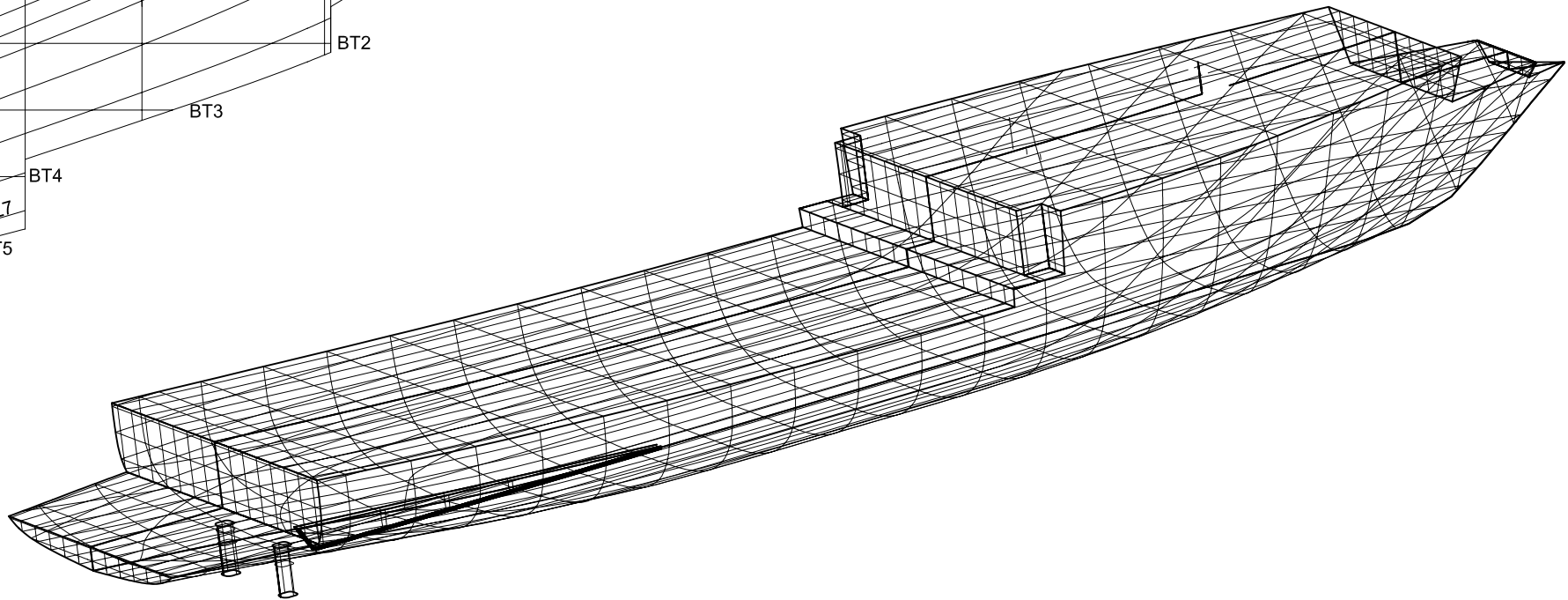
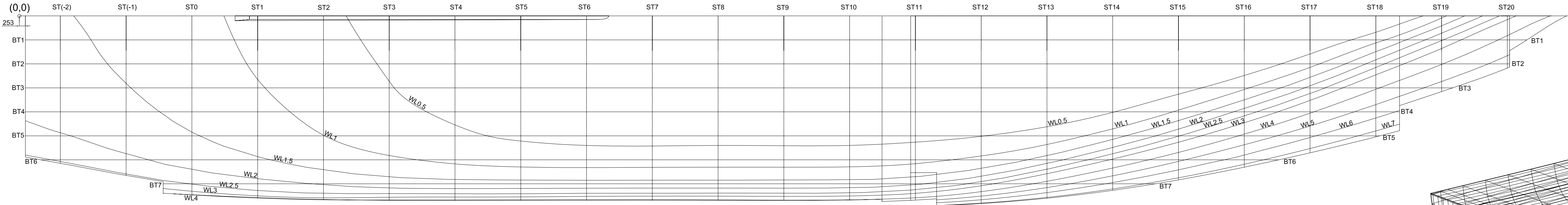
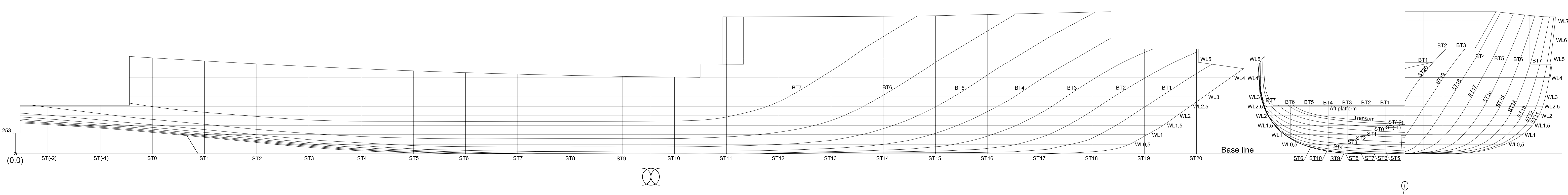
POS.	PCS.	DECK	HEIGHT OF SILL (mm)	CLOSING APPLIANCES		CLEAR SIZE OF OPENING H x W (mm x mm)	REMARKS
				STANDARD	MAT.		
1	1	BOW DOOR			STEEL	9380x7417	WATERTIGHT
2	2	MAIN DECK	380	SB 9650 FREEMAN 104	STEEL	1800x600	WATERTIGHT Wheel Operated
3	2	MAIN DECK	380	SB 9650 FREEMAN 104	STEEL	1800x800	WATERTIGHT Wheel Operated
4	7	MAIN DECK	200	SB 9510	STEEL	1800x800	WEATHERTIGHT 3 HINGES, 1 HANDLE
5	2	MAIN DECK	380	FREEMAN 1430	STEEL /AL/GRP	1800x800	WATERTIGHT Pantograph Hinge
6	3	MAIN DECK	380	FREEMAN 1620	STEEL /AL/GRP	1800x1600	WEATHERTIGHT FRENCH, HEAVY DUTY
7	3	MAIN DECK	380	SB 9510	STEEL	1800x1000	WEATHERTIGHT 3 HINGES, 1 HANDLE
8	1	UPPER DECK	200	FREEMAN 1730	STEEL /AL/GRP	1800x7100	DOUBLE SLIDING GLASS (*)
9	6	UPPER DECK	200	SB 9437 FREEMAN 1100	STEEL /AL/GRP	1800x800	NON-WEATHERTIGHT 3 HINGES, 1 HANDLE
10	1	UPPER DECK	200	FREEMAN 1720	STEEL /AL/GRP	1800x3350	DOUBLE SLIDING GLASS (*)
11	3	UPPER DECK	200	FREEMAN 1720	STEEL /AL/GRP	1800x2000	DOUBLE SLIDING GLASS (*)
12	2	BRIDGE DECK	200	SB 9437 FREEMAN 1100	STEEL	1800x1000	NON-WEATHERTIGHT 3 HINGES, 1 HANDLE
13	2	SHELL DOOR		AYEHOLLAND OR GREEN	STEEL	6995x1750	WATERTIGHT

(*) - DETAILS TO BE SUBMITTED FOR APPROVAL

PRELIMINARY

LENGTH OVERALL abt.73.30 m
LENGTH BETWEEN PP 54.90 m
BREADTH, MOULDED 15.38 m
DEPTH, MOULDED 4.03 m
DRAUGHT TO SUMMER L.L.(above b.l.) 2.40 m

C		B		A		INDEX	
DATE	NAME	CHANGES	SRGN	WATERLINE LTD.	PROJECT	DATE	NAME
DESIGNED 01.2007	KRESIMIR SKOKIC, DIPL.ING. NAV.ARCH.			BOULEVARD 12, 10000 ZAGREB, CROATIA	MV "PERINA"		
APPROVED 01.2007	IVO MILICIC, DIPL.ING. NAV.ARCH.			WWW.WATERLINE.CRO			
DRAWING TITLE				PRELIMINARY			
FREEBOARD DATA							
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OFFSETS TABLE

LENGTH OVERALL	abt.73.30 m
LENGTH BETWEEN PP	54.90 m
BREADTH, MOULDED	15.38 m
DEPTH, MOULDED	4.03 m
DRAUGHT TO SUMMER L.L.(above b.l.)	2.40 m

PRELIMINARY

FRAME		transom	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Height from base L [m]	X - distance [m]	0.253	1.71	4.455	7.2	9.945	12.69	15.435	18.18	20.925	23.67	26.415	29.16	31.905	34.65	37.395	40.14	42.885	45.63	48.375	51.12	53.865	56.61	59.355	62.1	
	Butt. 0	1.625	1.531	1.345	1.122	0.865	0.592	0.336	0.150	0.049	0	0	0	0	0	0	0	0	0	0	0	0	0.328	0.843		
	Butt. 1	1.680	1.586	1.395	1.168	0.905	0.640	0.396	0.196	0.087	0.023	0.001	0	0	0	0	0.008	0.031	0.045	0.057	0.070	0.188	0.809	2.448	4.231	
	Butt. 2	1.744	1.632	1.447	1.224	0.955	0.696	0.455	0.244	0.123	0.048	0.004	0.002	0	0	0	0	0.015	0.060	0.091	0.139	0.268	0.826	2.262	3.966	
	Butt. 3	1.827	1.709	1.513	1.298	1.027	0.765	0.513	0.323	0.171	0.086	0.027	0.021	0.028	0.028	0.022	0.046	0.111	0.186	0.365	0.929	2.108	3.904	---	---	
	Butt. 4	1.941	1.834	1.607	1.389	1.127	0.860	0.589	0.430	0.249	0.178	0.125	0.123	0.133	0.132	0.137	0.179	0.276	0.485	1.063	2.223	3.894	---	---	---	
	Butt. 5	2.142	2.032	1.781	1.527	1.271	1.001	0.739	0.575	0.421	0.371	0.347	0.365	0.354	0.355	0.396	0.486	0.702	1.315	2.468	4.159	---	---	---		
	Butt. 6	2.455	2.455	2.115	1.811	1.547	1.285	1.067	0.905	0.819	0.783	0.789	0.798	0.793	0.796	0.884	1.124	1.742	3.082	---	---	---	---	---	---	
	Butt. 7	---	---	---	---	2.487	2.176	1.958	1.771	1.708	1.709	1.694	1.698	1.699	1.708	1.719	1.927	2.729	4.351	---	---	---	---	---	---	
Offsets [m]	WL 0.5	---	---	---	---	---	---	2.778	4.536	5.260	5.409	5.433	5.404	5.420	5.414	5.273	5.032	4.637	4.031	3.276	2.494	1.629	0.730	---	---	
	WL 1	---	---	---	---	2.657	4.997	5.843	6.180	6.305	6.327	6.313	6.309	6.307	6.302	6.169	5.853	5.375	4.714	3.938	3.068	2.165	1.148	0.103	---	
	WL 1.5	---	---	---	2.815	4.832	5.879	6.429	6.719	6.825	6.845	6.857	6.852	6.842	6.838	6.712	6.363	5.830	5.150	4.371	3.499	2.576	1.501	0.418	---	
	WL 2	4.378	4.882	5.736	6.401	6.787	7.041	7.178	7.201	7.192	7.184	7.179	7.179	7.181	7.169	7.039	6.694	6.155	5.488	4.726	3.858	2.929	1.833	0.723	---	
	WL 2.5	5.805	6.070	6.588	7.011	7.284	7.403	7.422	7.425	7.418	7.394	7.377	7.382	7.395	7.379	7.249	6.919	6.394	5.751	5.018	4.168	3.243	2.148	1.033	---	
	WL 3	---	---	---	7.310	7.508	7.588	7.559	7.554	7.548	7.524	7.514	7.514	7.525	7.509	7.392	7.084	6.560	5.968	5.269	4.450	3.525	2.453	1.354	0.142	
	WL 4	---	---	---	7.463	7.595	7.667	7.674	7.671	7.664	7.659	7.660	7.669	7.681	7.669	7.583	7.328	6.896	6.342	5.691	4.930	4.056	3.059	2.023	0.826	
	WL 5	---	---	---	7.460	---	---	---	---	---	---	---	---	---	---	---	6.534	7.513	7.156	6.667	6.066	5.372	4.592	3.698	2.741	1.660
	WL 6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6.534	7.664	7.366	6.947	6.417	5.790	5.068	4.257	---	---
WL 7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6.534	7.805	7.566	7.213	6.750	6.184	5.530	4.796	---	---	
DECK EDGE	X - Long.position [m]	0.253	1.71	4.455	6.003	6.003	7.200	9.945	12.690	15.435	18.180	20.925	23.670	26.415	29.160	31.905	34.650	36.003	36.003	37.200						
	Y - Offsets [m]	5.883	6.146	6.649	6.909	7.394	7.455	7.572	7.652	7.698	7.696	7.692	7.689	7.684	7.687	7.691	7.674	7.643	7.735	7.690						
	Z - Height [m]	2.550	2.550	2.550	2.550	5.127	5.054	4.887	4.735	4.600	4.477	4.368	4.274	4.195	4.129	4.078	4.041	4.028	4.728	4.719						
	X - Long.position [m]	37.200	37.200	38.280	38.280	40.140	42.885	45.630	48.375	51.120	53.865	56.610	57.602	57.606	59.355	62.100	62.194	62.194	64.550							
	Y - Offsets [m]	6.534	6.534	6.533	7.916	7.822	7.604	7.272	6.834	6.308	5.708	5.043	4.786	3.680	3.134	2.173	2.134	1.449	0.000							
	Z - Height [m]	4.720	7.219	7.212	7.212	7.207	7.208	7.230	7.264	7.315	7.378	7.455	7.486	5.520	5.512	5.520	5.520	4.820	4.488							

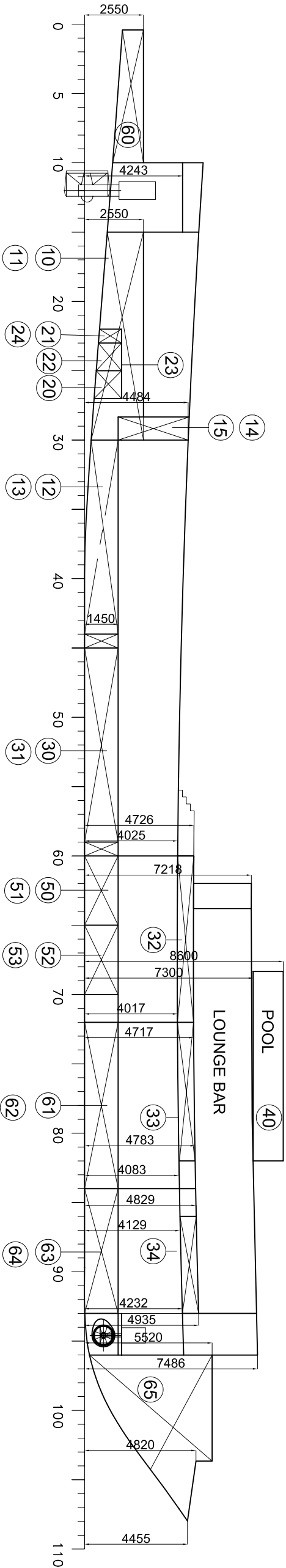
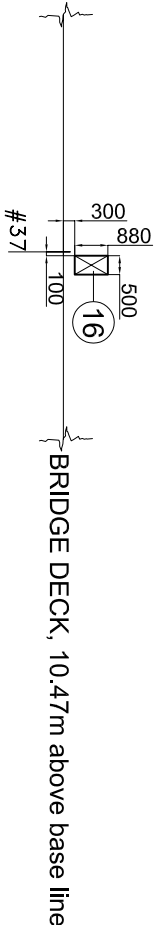
PRELIMINARY
HULL LINES &
OFFSETS TABLE



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ρ _{STEEL} 7,85		ITEM	pcs	AREA [m ²]	t [mm]	WEIGHT [t]	XCG [m]	YCG [m]	ZCG [m]	DESCRIPTION
HULL - PLATE	PLANTING	Keel	2,00	73,6	11	12,7	36,110	0,000	0,950	Rhino
		Bottom	2,00	277,5	9	39,2	28,440	0,000	0,644	Rhino,-5.2m ² windows
		Side 1	2,00	211,0	9	29,1	29,950	0,000	2,990	Rhino
		Bulwark 1	2,00	78,2	6	7,4	33,150	0,000	5,000	Rhino
		Side 2	2,00	185,9	7	16,9	29,390	0,000	6,090	Rhino
		Bulwark 2	2,00	241,8	6	22,8	44,340	1,000	7,800	Rhino
		Bow1	2,00	90,0	7	11,2	60,300	0,000	7,370	Rhino+stiffeners
	WEBS	Web #34				1,7	20,400	0,000	3,777	Tab: WEBS
		Web #40				1,8	24,000	0,000	3,859	Tab: WEBS
		Web #45				1,9	27,000	0,000	3,680	Tab: WEBS
		Web #50				1,9	30,000	0,000	3,250	#45÷#55
		Web #55				1,9	33,000	0,000	3,250	#45÷#56
		Web #60				0,7	36,000	0,000	6,840	#45...na D3 isto
		Web #64				1,9	38,400	0,000	3,679	Tab: WEBS
		Web #68				1,7	40,800	0,000	3,703	Tab: WEBS
		Web #72				0,6	43,200	0,000	6,736	#60...na D3 isto
		Web #76				1,4	45,600	0,000	4,133	Tab: WEBS
		Web #80				1,4	48,000	0,000	3,464	#76÷#80
		Web #84				0,6	50,4	0,0	6,8	#76...na D3 isto
		Web #88				1,3	52,800	0,000	4,891	Tab: WEBS
	SCANTLINGS	Bottom				11,8	27,9	0,0	0,7	Tab: Scantlings
		Side 1				7,9	33,9	0,0	3,3	Tab: Scantlings
		Bulwark 1				0,6	32,7	0,0	4,8	Tab: Scantlings
		Side 2				5,3	34,2	0,0	5,5	Tab: Scantlings
		Bulwark 2				5,2	42,1	0,0	7,4	Tab: Scantlings
DECKS	PLAT.	Deck 1_(Inner bottom)	2,00	315,8	7	34,7	28,200	0,000	1,600	Rhino
		Deck 2_(Lower Deck)	2,00	398,3	8	50,0	28,090	0,000	4,300	Rhino
		Deck 3_(Main Deck)	2,00	372,5	8	46,8	35,350	0,000	7,460	Rhino
	GIRD.	Deck 1_(Inner bottom)				19,4	20,400	0,000	0,888	Tab: Girders
		Deck 2_(Lower Deck)				5,9	20,400	0,000	4,062	Tab: Girders
		Deck 3_(Main Deck)				2,9	36,9	0,0	7,3	Tab: Girders
	SCANTL.	Deck 1_(Inner bottom)				9,2	27,796	0,000	1,500	Tab: Scantlings
		Deck 2_(Lower Deck)				6,5	31,673	0,000	4,193	Tab: Scantlings
		Deck 3_(Main Deck)				8,7	34,657	0,000	1,500	Tab: Scantlings

ρSTEEL 7,85		ITEM	pcs	AREA	t	WEIGHT	XCG	YCG	ZCG	DESCRIPTION
				[m ²]	[mm]	[t]	[m]	[m]	[m]	
BULKH.		#0				0,55	0,250	0,000	2,160	Tab: Bulkheads
		#10				3,0	6,000	0,000	3,080	Tab: Bulkheads
		#15				3,5	9,000	0,000	3,116	Tab: Bulkheads
		#30				3,8	18,000	0,000	2,564	Tab: Bulkheads
		#60				3,1	36,000	0,000	2,182	Tab: Bulkheads
		#72				2,6	43,200	0,000	2,225	Tab: Bulkheads
		#84				1,9	50,400	0,000	2,350	Tab: Bulkheads
		#95				0,9	56,860	0,000	3,090	Tab: Bulkheads
		#15÷#30				4,1	13,400	0,000	3,500	Tab: Bulkheads
CORRID.	D1-D2	Plating		294,0	5	11,5	23,200	0,950	3,060	Rhino
		Stiffeners		0,0067		2,0	23,200	0,950	3,060	0,007 t/m ² Površ.m. ukre
	D2-D3	Plating		445,0	5	17,5	28,600	-0,600	5,920	Rhino
		Stiffeners		0,0067		3,0	28,600	-0,600	5,920	0,007 t/m ² Površ.m. ukre
TANK		Plating	1,00	50,0	7	2,7	38,770	0,000	1,170	Rhino
		Stiffeners	1,00	0,011		0,610	38,770	0,000	1,170	0,011 t/m ² Površinska m
E.R.		Girders				4,706	12,294	0,000	1,190	
		Floors				12,048	13,561	0,000	1,190	
		Webs				2,051	13,500	0,000	5,600	
PILL.		D2				1,5	31,330	0,000	2,830	
		D3				1,2	40,725	0,000	5,700	
SUPERST.		Decks				14,2	20,502	0,000	11,476	
		Girders				5,3	22,562	0,000	9,983	
		Stiffeners				5,6	21,478	0,000	11,747	
		Total				480,41	32,093	0,049	4,397	



COMP1

COMP2

COMP3

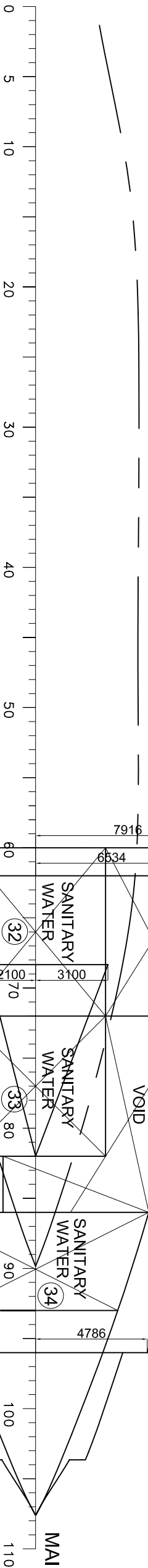
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COMP5

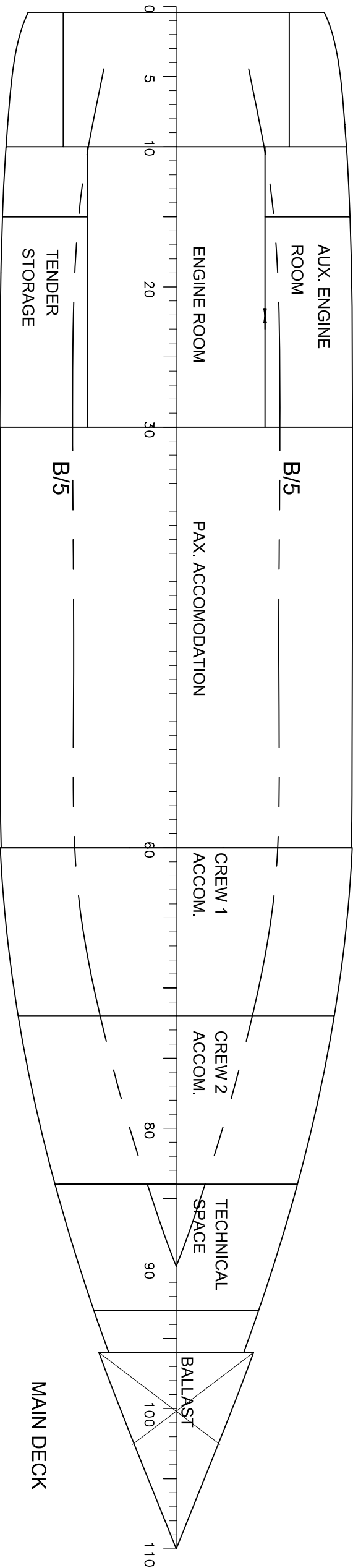
COMP6

COMP7

Watertight Compartments



MAIN DECK TANKS



MAIN DECK

COMP1

COMP2

COMP3

COMP4

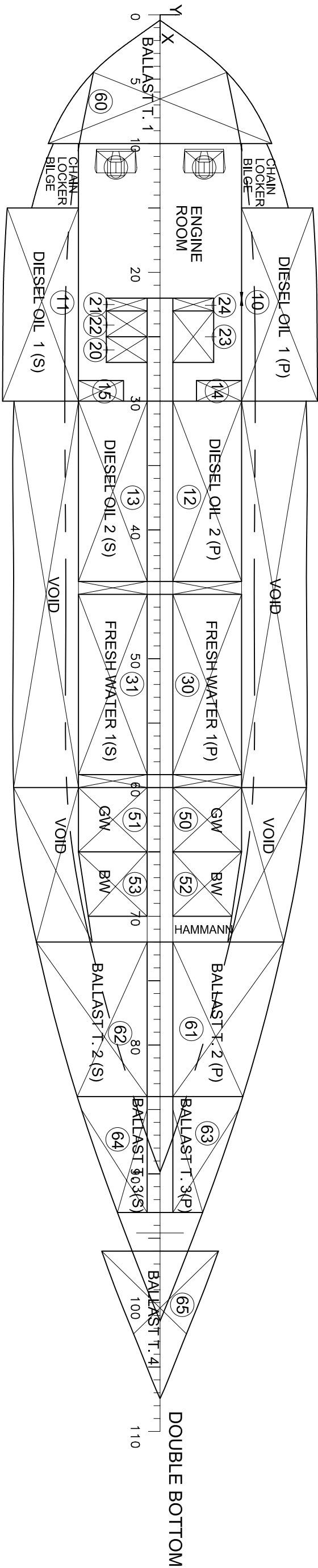
COMP5

COMP6

COMP7

Watertight Compartments

Watertight Compartments



FUEL TANKS							
TANK No.	DESCRIPTION	X ₁ [m]	X ₂ [m]	Y ₁ [m]	Y ₂ [m]	Z ₁ [m]	Z ₂ [m]
10	DIESEL OIL No.1 (P)	9.0	18.0	3.8	-	-	2.55
11	DIESEL OIL No.1 (S)	9.0	18.0	-3.8	-	-	2.55
12	DIESEL OIL No.2 (P)	18.0	26.4	0.6	3.8	-	1.45
13	DIESEL OIL No.2 (S)	18.0	26.4	-0.6	-3.8	-	1.45
14	DIESEL OIL SERVICE (P)	16.9	18.0	1.7	3.8	1.45	4.5
15	DIESEL OIL SERVICE (S)	16.9	18.0	-1.7	-3.8	1.45	4.5
16	D.O. EMERGENCY GENER.	22.3	22.8	1.23	3.5	10.77	11.56

MISCELLANEOUS TANKS							
TANK No.	DESCRIPTION	X ₁ [m]	X ₂ [m]	Y ₁ [m]	Y ₂ [m]	Z ₁ [m]	Z ₂ [m]
20	CLEAN BUDGE (S)	15.0	16.2	-0.6	-2.5	0.5	1.6
21	FUEL DRAIN T. (S)	13.2	13.8	-0.6	-2.5	0.5	1.6
22	LUB. OIL (S)	13.8	15.0	-0.6	-2.5	0.5	1.6
23	BUDGE WATER COLL. (P)	13.8	16.2	0.6	2.5	0.5	1.6
24	SLUDGE (P)	13.2	13.8	0.6	2.5	0.5	1.6
SANITARY WATER TANKS							
TANK No.	DESCRIPTION	X ₁ [m]	X ₂ [m]	Y ₁ [m]	Y ₂ [m]	Z ₁ [m]	Z ₂ [m]
30	SANITARY WATER No.1 (P)	27.0	35.4	0.6	3.8	0.0	1.45
31	SANITARY WATER No.1 (S)	27.0	35.4	-0.6	-3.8	0.0	1.45
32	SANITARY WATER No.2	36.0	43.2	-3.0	3.0	4.02	4.72
33	SANITARY WATER No.3	43.2	49.2	-3.0	3.0	4.09	4.75
34	SANITARY WATER No.4	51.6	55.8	-	-	4.18	4.88

No.	DESCRIPTION	X ₁ [m]	X ₂ [m]	Y ₁ [m]	Y ₂ [m]	Z ₁ [m]	Z ₂ [m]
40	POOL	41.0	49.2	3.1 -2.1	0.0	7.3	8.6

COMP. No.	FLOODED COMPARTMENT	X ₁ [m]	X ₂ [m]	Y ₁ [m]	Y ₂ [m]	Z ₁ [m]	Z ₂ [m]	TANKS NOT FLOODED AS OUTSIDE B/S
COMP.1	BALLAST TANK No.1 (60)	0.253	6.0	-	-	-	2.55	MISCELLANEOUS (20,21,22,23,24)AND DIESEL OIL SERVICE TANKS (14,15)
COMP.2	ENGINE ROOM	9.0	18.0	-3.8	3.8	-	4.714	
	CHAIN LOCKER BILGE (P)	6.0	9.0	3.8	-	-	4.243	
	DIESEL OIL No.1 (P) (10)	9.0	18.0	3.8	-	-	2.55	
COMP.3	AUX.ENGINE ROOM	9.0	18.0	3.8	-	2.55	4.714	DIESEL OIL No.2 (P) & (S) (12,13) FRESH WATER No.1 (P) & (S) (30,31)
	VOID (D,Bottom P)	18.0	36.0	-	-	0.0	1.45	
	PAX ACCOMMODATION	18.0	36.0	-	-	1.45	4.255	
COMP.4	VOID (D,Bottom P)	36.0	39.0	3.8	-	0.0	1.45	GRAY WATER (P) & (S) (50,51) BLACK WATER (P) & (S) (52,53) FRESH WATER No.2 (32)
	VOID (D,Bottom P)	39.0	42.0	3.572	-	0.0	1.45	
	CREW ACCOMMODATION	36.0	43.2	-	-	1.45	4.021	
COMP.5	VOID (Upper tank P)	36.0	43.2	3.0	-	4.023	4.723	PIPE CONN.SPACE IN DOUBLE BOTTOM
	LOUNGE BAR	37.19	57.6	6.53 7.92	4.786	7.218	7.486	
	BALLAST TANK No.2 (61)	43.2	50.4	0.6	-	0.0	1.45	
COMP.6	FRESH ACCOMMODATION	43.2	50.4	-	-	1.45	4.061	FRESH WATER No.3 (33)
	FRESH WATER No.3 (33)	43.2	50.4	-3.0	3.0	4.061	4.761	
	VOID (Upper tank P&S)	43.2	50.4	3.0	-	4.061	4.761	
COMP.7	LOUNGE BAR	37.19	57.6	6.53 7.92	4.786	7.218	7.486	PIPE CONN.SPACE
	BALLAST TANK No.3 (63)	50.4	55.8	0.6	-	0.0	1.45	
	PIPE CONN.SPACE	50.4	55.8	-0.6	0.6	0.0	1.45	
COMP.8	BOW THRUST. TECH.SPACE	50.4	57.6	-	-	0.0	4.198	FRESH WATER No.4 (34)
	FRESH WATER No.4 (34)	50.4	55.8	-	-	4.169	4.87	
	LOUNGE BAR	37.19	57.6	6.53 7.92	4.786	7.218	7.486	
COMP.9	BALLAST TANK No.4 (65)	57.6	70.0	-	-	0.0	1.45	PIPE CONN.SPACE



WATERLINE L.T.D.

Bogišićeva 12

Zagreb

10000

CROATIA

Client:

Project:

MV "PERINA"

24PAX Cruise Vessel



DOCUMENT DESCRIPTION:

PRELIMINARY STABILITY BOOKLET

DOCUMENT NUMBER:			101-1022-040	CONNECTION DRAWING:			
Status / Revision	Date	Number of Pages	Written by	Sign	Checked by	Sign	Reason for change
	Oct.'07.	84	Krešimir Škokić d.ing.		Ivo Miličić d.ing.		

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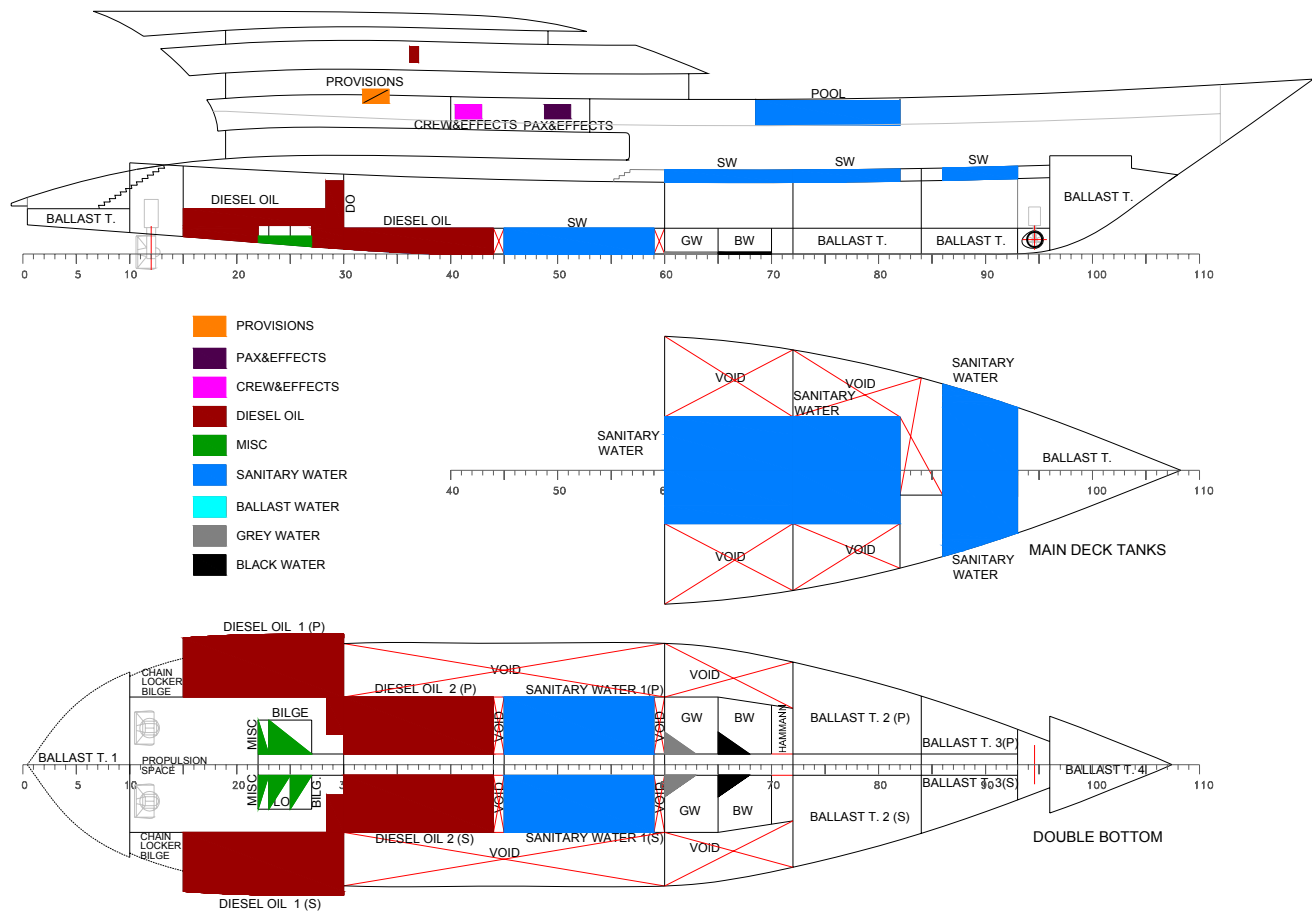
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It is quite sufficient to work out only three representative loading conditions:

- I1** - DEP_PAX 100% - Departure with 100% stores and 24 passengers
- I2** - INT_PAX_50% - Intermediate with 50% stores and 24 passengers
- I3** - ARR_PAX_10% - Arrival with 10% stores and 24 passengers

Loading condition without passengers is not calculated regarding minor influence of passengers weight, also there is no cargo loading condition whereas motor vessel 'Perina' will not carry any cargo.

4.1 I1 - DEPARTURE WITH 100% STORES AND 24 PASSENGERS



SUMMARY OF LOADS – I1

Loadcase - I1

Damage Case - Intact

Free to Trim

Relative Density (specific gravity) = 1,025; (Density = 1,0252 tonne/m³)

Fluid analysis method: Use corrected VCG

Item Name	Quantity	Weight tonne	Long.Arm m	Vert.Arm m	Trans.Arm m	FS Mom. tonne.m
Lightship	1	950,0	28,840	5,095	0,069	0,000
Water in Whirpool2	1	2,000	32,200	13,500	0,000	0,000
Water in Whirpool	1	2,000	25,000	9,300	-0,300	0,000
Pax+effects	1	3,120	30,000	8,000	0,000	0,000
Crew+effects	1	3,380	25,000	8,000	-2,000	0,000
Provisions (100%)	1	10,00	19,800	8,860	-4,350	0,000
11_DO_No1 (S)	97,99%	33,49	13,928	1,791	5,259	28,274
10_DO_No1 (P)	97,99%	33,49	13,928	1,791	-5,259	28,274
13_DO_No2 (S)	97,99%	28,51	22,336	0,767	2,171	18,816
12_DO_No2 (P)	97,99%	28,51	22,336	0,767	-2,171	18,816
15_DO_No3 (S)	50%	2,863	17,450	2,213	2,750	0,696
14_DO_No3 (P)	50%	2,863	17,450	2,213	-2,750	0,696
20_MISC Clean Bilg.	50%	1,336	15,617	0,710	-1,520	0,000
21_MISC Fuel Drain	50%	0,5654	13,506	0,847	-1,516	0,000
22_MISC Lub.oil	50%	1,123	14,419	0,787	-1,518	0,000
23_MISC Bilge wat.	50%	2,621	15,073	0,746	1,519	0,000
24_MISC Sludge	50%	0,5796	13,506	0,847	1,516	0,000
30_Sanitary W_No1 (P)	100%	38,15	31,197	0,733	-2,187	0,000
31_Sanitary W_No1 (S)	100%	38,15	31,197	0,733	2,187	0,000
32_Sanitary W_No2	100%	23,71	39,636	4,372	0,000	0,000
33_Sanitary W_No3	100%	19,96	46,200	4,411	0,000	0,000
34_Sanitary W_No4 (P)	100%	12,76	53,593	4,524	-2,206	0,000
40_Pool on upper deck	90%	24,34	43,803	7,884	0,358	23,012
50_Gray W. (P)	5%	0,6768	37,489	0,048	-1,918	8,192
51_Gray W. (S)	5%	0,6768	37,489	0,048	1,918	8,192
52_Black W. (P)	5%	0,6212	40,343	0,064	-1,805	6,639
53_Black W. (S)	5%	0,6212	40,343	0,064	1,805	6,639
60_Ballast No1	0%	0,0000	3,361	2,054	0,000	0,000
61_Ballast No2 (P)	0%	0,0000	46,449	0,839	-2,367	0,000
62_Ballast No2 (S)	0%	0,0000	46,449	0,839	2,367	0,000
63_Ballast No3 (P)	0%	0,0000	52,562	0,899	-1,512	0,000
64_Ballast No3 (S)	0%	0,0000	52,562	0,899	1,512	0,000
65_Ballast No4	0%	0,0000	59,448	4,087	0,000	0,000
35_Sanitary W_No4 (S)	100%	12,77	53,593	4,524	2,206	0,000
	Total Weight=	1279	LCG=28,982	VCG=4,506	TCG=0,019	148,246
				FS corr.=0,116		
				VCG fluid=4,622		

FLOATING POSITION / calculation method: free trim – I1

Draft Amidsh. m	2,384
Displacement tonne	1279
Heel to Starboard degrees	0,2
Draft at FP m	2,288
Draft at AP m	2,479
Draft at LCF m	2,397
Trim (+ve by stern) m	0,190
WL Length m	61,222
WL Beam m	14,791
Wetted Area m ²	846,293
Waterpl. Area m ²	738,617
Prismatic Coeff.	0,681
Block Coeff.	0,561
Midship Area Coeff.	0,842
Waterpl. Area Coeff.	0,816
LCB from zero pt. m	28,973
LCF from zero pt. m	26,692
KB m	1,415
KG fluid m	4,622
BMt m	9,104
BML m	138,309
GMt corrected m	5,897
GML corrected m	135,102
KMt m	10,519
KML m	139,724
Immersion (TPc) tonne/cm	7,572
MTc tonne.m	28,148
RM at 1deg = GMt.Disp.sin(1) tonne.m	131,617
Max deck inclination deg	0,3
Trim angle (+ve by stern) deg	0,2

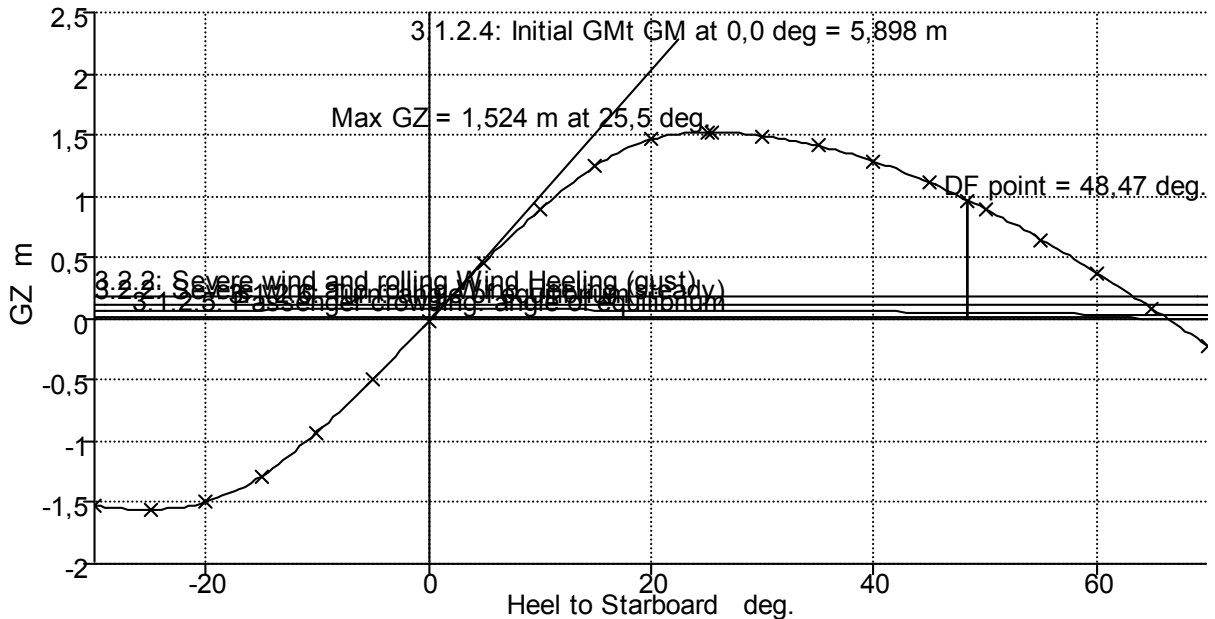
DOWNFLOODING AND DECK IMMERSION ANGLES – I1

Key point	Type	DF angle deg	Freeboard m
Margin Line (immersion pos = 36 m; freeboard pos = 36 m)		12,27	1,565
Deck Edge (immersion pos = 36 m; freeboard pos = 36 m)		12,87	1,641
DF point	Downflooding point	48,43	2,946

Key point	Type	Freeboard m
Margin Line (freeboard pos = 36 m)		1,568
Deck Edge (freeboard pos = 36 m)		1,644
DF point	Downflooding point	2,946

Key point	Type	DF angle deg
Margin Line (immersion pos = 36 m)		12,28
Deck Edge (immersion pos = 36 m)		12,87
DF point	Downflooding point	48,47

GZ DIAGRAM



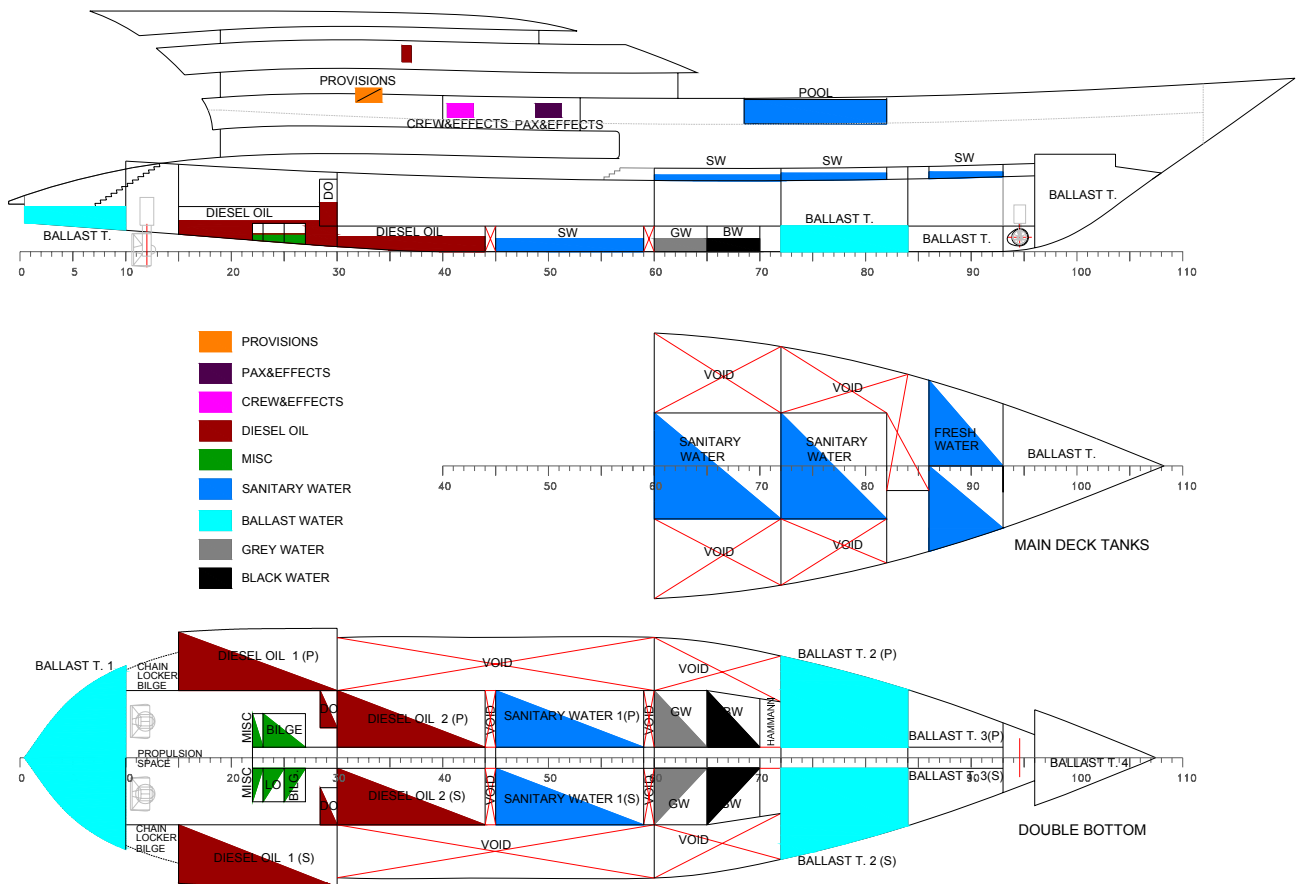
STABILITY CRITERIA LIST – I1

Code	Criteria	Value	Units	Actual	Status
A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.1: Area 0 to 30				Pass
	<i>from the greater of</i>				
	spec. heel angle	0,0	deg	0,0	
	<i>to the lesser of</i>				
	spec. heel angle	30,0	deg	30,0	
	angle of vanishing stability	66,4	deg		
	shall not be less than (>=)	0,055	m.rad	0,556	Pass
A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.1: Area 0 to 40				Pass
	<i>from the greater of</i>				
	spec. heel angle	0,0	deg	0,0	
	<i>to the lesser of</i>				
	spec. heel angle	40,0	deg	40,0	
	first downflooding angle	48,5	deg		
	angle of vanishing stability	66,4	deg		
	shall not be less than (>=)	0,090	m.rad	0,801	Pass
A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ				Pass
	shall not be less than (>=)	25,0	deg	25,5	Pass
A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.4: Initial GMt				Pass
	spec. heel angle	0,0	deg		
	shall not be less than (>=)	0,350	m	5,898	Pass

A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.5: Passenger crowding: angle of equilibrium				Pass
	<i>Pass. crowding arm = $nPass M / disp. D \cos^n(\phi)$</i>				
	number of passengers: $nPass =$	24			
	passenger mass: $M =$	0,075	tonne		
	distance from centre line: $D =$	7,400	m		
	cosine power: $n =$	1			
	shall not be greater than (\leq)	10,0	deg	0,3	Pass
	<i>Intermediate values</i>				
	Heel arm amplitude		m	0,010	
A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.6: Turn: angle of equilibrium				Pass
	<i>Turn arm: $a v^2 / (R g) h \cos^n(\phi)$</i>				
	constant: $a =$	0,9996			
	vessel speed: $v =$	16,000	kts		
	turn radius, R , as percentage of Lwl	500,00	%		
	$h = KG - \text{mean draught} / 2$	3,314	m		
	cosine power: $n =$	1			
	shall not be greater than (\leq)	10,0	deg	1,0	Pass
	<i>Intermediate values</i>				
	Heel arm amplitude		m	0,075	
A.749(18) Ch3 - Design criteria applicable to all ships	3.2.2: Severe wind and rolling				Pass
	<i>Wind arm: $a P A (h - H) / (g disp.) \cos^n(\phi)$</i>				
	constant: $a =$	0,99966			
	wind pressure: $P =$	504,0	Pa		
	area centroid height: $h =$	6,924	m		
	total area: $A =$	505,000	m ²		
	$H = \text{mean draught} / 2$	1,192	m		
	cosine power: $n =$	0			
	gust ratio	1,5			
	<i>Area2 integrated to the lesser of</i>				
	roll back angle from equilibrium (with steady heel arm)	28,9 (-27,5)	deg	-27,5	
	<i>Area 1 upper integration range, to the lesser of:</i>				
	spec. heel angle	50,0	deg		
	first downflooding angle	48,5	deg	48,5	
	angle of vanishing stability (with gust heel arm)	63,4	deg		
	<i>Angle for GZ(max) in GZ ratio, the lesser of:</i>				
	first downflooding angle	48,5	deg	48,5	
	Select required angle for angle of steady heel ratio:	Marginline Immersion Angle			
	Criteria:				Pass
	Angle of steady heel shall not be greater than (\leq)	16,0	deg	1,4	Pass
	Area1 / Area2 shall not be less than (\geq)	100,000	%	138,697	Pass
	<i>Intermediate values</i>				
	Heel arm amplitude		m	0,116	
	Equilibrium angle with steady heel arm		deg	1,4	
	Equilibrium angle with gust heel arm		deg	2,0	
	Area1 (under GZ), from 2,0 to 48,5 deg.		m.rad	0,966	
	Area1 (under HA), from 2,0 to 48,5 deg.		m.rad	0,142	
	Area1, from 2,0 to 48,5 deg.		m.rad	0,825	
	Area2 (under GZ), from -27,5 to 2,0 deg.		m.rad	-0,505	
	Area2 (under HA), from -27,5 to 2,0 deg.		m.rad	0,090	
	Area2, from -27,5 to 2,0 deg.		m.rad	0,595	

A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.1: Area 30 to 40				Pass
	<i>from the greater of</i>				
	spec. heel angle	30,0	deg	30,0	
	<i>to the lesser of</i>				
	spec. heel angle	40,0	deg	40,0	
	first downflooding angle	48,5	deg		
	angle of vanishing stability	66,4	deg		
	shall not be less than (>=)	0,030	m.rad	0,245	Pass

4.2 I2 - INTERMEDIATE WITH 50% STORES AND 24 PASSANGERS



SUMMARY OF LOADS – I2

Loadcase - I2

Damage Case - Intact

Free to Trim

Relative Density (specific gravity) = 1,025; (Density = 1,0252 tonne/m³)

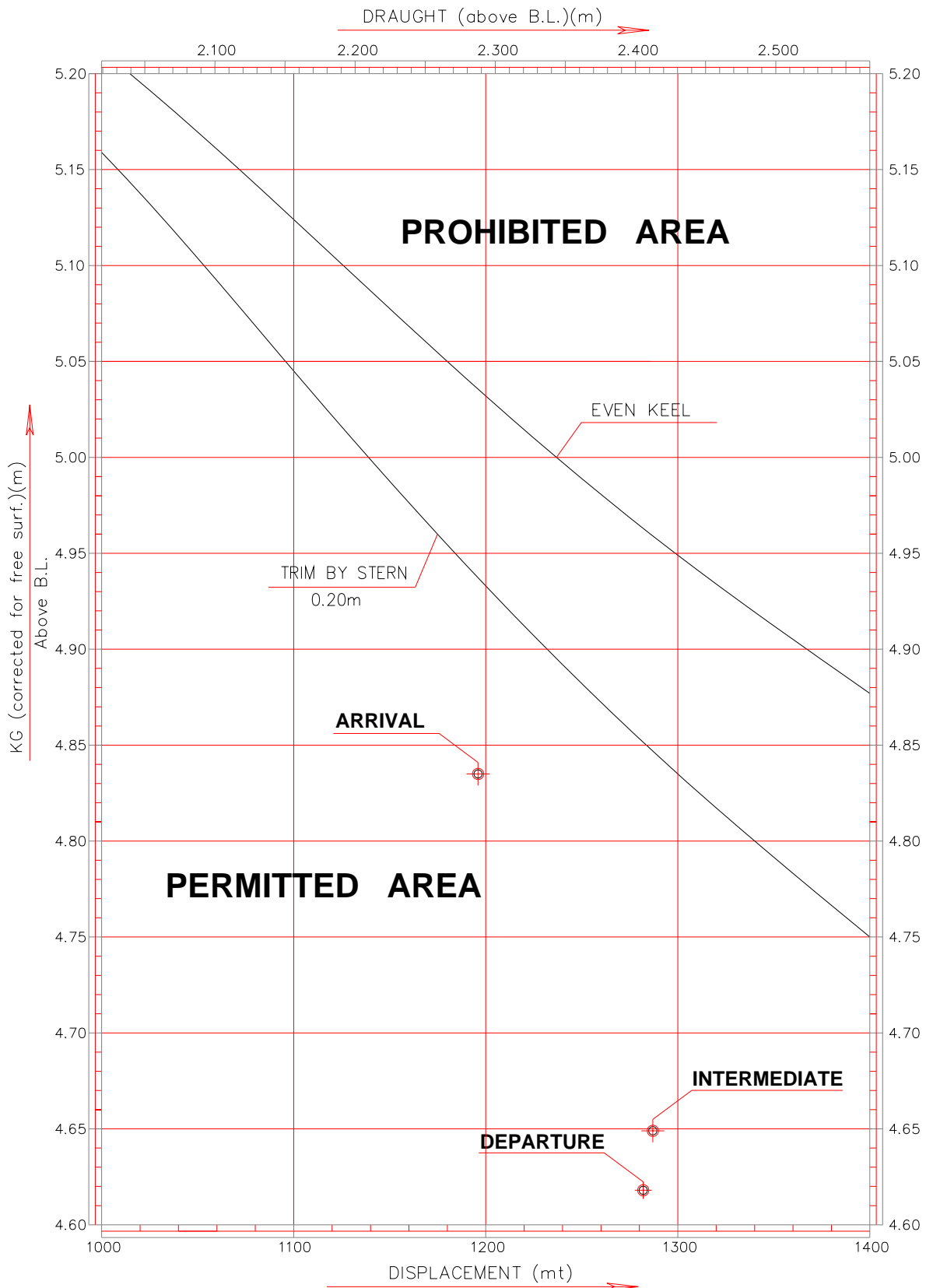
Fluid analysis method: Use corrected VCG

	Equilibrium angle with gust heel arm		deg	2,4	
	Area1 (under GZ), from 2,4 to 50,0 deg.		m.rad	0,961	
	Area1 (under HA), from 2,4 to 50,0 deg.		m.rad	0,157	
	Area1, from 2,4 to 50,0 deg.		m.rad	0,805	
	Area2 (under GZ), from -27,1 to 2,4 deg.		m.rad	-0,516	
	Area2 (under HA), from -27,1 to 2,4 deg.		m.rad	0,097	
	Area2, from -27,1 to 2,4 deg.		m.rad	0,613	
A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.1: Area 30 to 40				Pass
	<i>from the greater of</i>				
	spec. heel angle	30,0	deg	30,0	
	<i>to the lesser of</i>				
	spec. heel angle	40,0	deg	40,0	
	first downflooding angle	55,0	deg		
	angle of vanishing stability	64,5	deg		
	shall not be less than (>=)	0,030	m.rad	0,238	Pass

4.4 SUMMARY OF INTACT STABILITY

		Units	I1 DEPARTURE 100%	I2 INTERMED. 50%	I3 ARRIVAL 10%	
Displacement		tonne	1279	1284	1196	
Heel to Starboard		deg	0.2	0.3	0.51	
Draft at FP		m	2.288	2.312	2.215	
Draft at AP		m	2.479	2.473	2.34	
Trim (+ve by stern)		m	0.119	0.161	0.125	
LCG		m	28.982	29.038	29.289	
KG _{CORR.}		m	4.622	4.654	4.835	
TCG		m	0.019	0.035	0.053	
Criteria	Required Value Accor. IMO A.749(18)	Units	I1 DEP_PAX 100%	I2 INT_PAX 50%	I3 ARR_PAX 10%	Status
Area 0 to 30	0,055	m.rad	0.556	0.541	0,545	Pass
Area 0 to 40	0,090	m.rad	0.8	0.778	0,783	Pass
Angle of maximum GZ	25,0	deg	25.5	25.5	25.5	Pass
Initial GMt	0,350	m	5.898	5.843	5.976	Pass
Passenger crowding: angle of equilibrium	16,0	deg	0.3	0.5	0.6	Pass
Turn: angle of equilibrium	10,0	deg	1.0	1.1	1.3	Pass
Severe wind and rolling						
Angle of steady heel shall not be greater than (<=)	16,0	deg	1.4	1.6	1.8	Pass
Area1 / Area2 shall not be less than (>=)	100,0	%	139	135	132	Pass
Area 30 to 40	0,030	m.rad	0.245	0.239	0,238	Pass
Downflooding immersion angle		deg	48.47	48.44	55.03	

4.5 KG LIMIT CURVE



Initial Trim = 0 m (+ve by stern)

Relative Density = 1,025

Displacement tonne	Limit KG m	Criteria	Type
900	5,286	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1000	5,212	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1100	5,124	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1200	5,032	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1300	4,949	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1400	4,877	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ

Initial Trim = 0,2 m (+ve by stern)

Relative Density = 1,025

Displacement tonne	Limit KG m	Criteria	Type
900	5,253	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1000	5,159	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1100	5,045	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1200	4,933	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1300	4,835	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ
1400	4,750	A.749(18) Ch3 - Design criteria applicable to all ships	3.1.2.3: Angle of maximum GZ

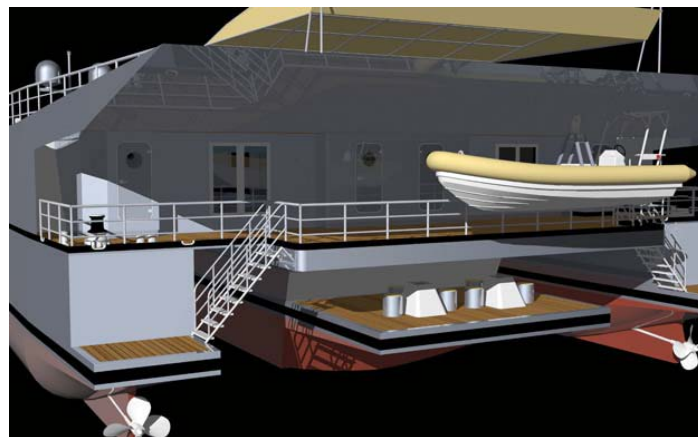
KREŠIMIR ŠKOKIĆ

address: Zelinska 5, Zagreb, CROATIA

mobile tel. : 385989803367

email: kresimir.skokic@gmail.com

Trimaran 50m , Conversion, Project. No. 1024

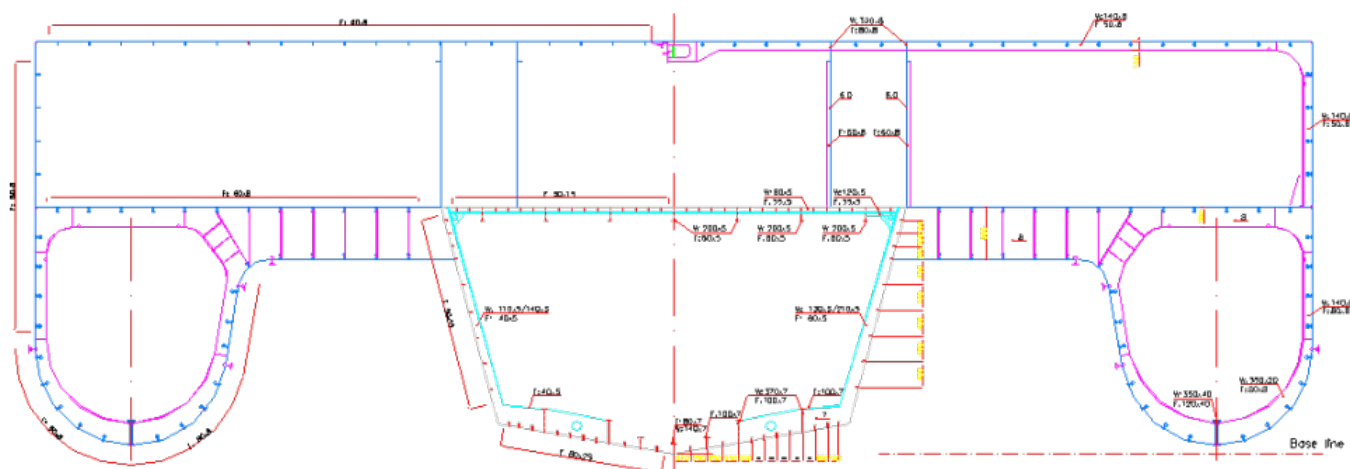


KREŠIMIR ŠKOKIĆ

address: Zelinska 5, Zagreb, CROATIA

mobile tel. : 385989803367

email: kresimir.skokic@gmail.com



MAIN DIMENSIONS:

LENGTH, OVER ALL	55.60 m
LENGTH, BETWEEN PP AT T=2.5	48.50 m
LENGTH, RULE, L	44.30 m
BREADTH, MAX, MOULDED, B	20.00 m
BREADTH, MOULDED AT T=2.5	20.00 m
DEPTH, MOULDED, D	6.45 m
DRAUGHT, SCANTLING	2.5 m
DRAUGHT, DESIGN	

DISPLACEMENT MLD. (SW. 1.025 t/m ³) AT T=2.5	APPROX. 855t.
BLOCK COEFFICIENT.	Cb... 0.69
DEPTH, MAIN DECK	...3.84 m
SERVICE SPEED (DESIGN DRAUGHT)	...14.0 kn
85 % MCR	
CLASS: CRS	

BOGIŠIÆEVA 12,
10000 ZAGREB
CROATIA

Client:**Project:**

1024

32 Pax Cruise Vessel

DOCUMENT DESCRIPTION:



MIDSHIP SECTION CALCULATION

[illegible]

2. BOTTOM STRUCTURE

2.1. Bottom shell plating

Minimum thickness requirements

Pt.3, Ch. 4, 2.1. → Table 4.2.1

$$\omega \sqrt{k_{ms}} (0,4 \sqrt{L_R} + 2,0) \geq 3,5 \omega$$

Table 3.2.2 Service type correction factor (ω)

Service type notation	ω
Cargo	1,1
Passenger	1,0
Patrol	1,0
Pilot	1,1
Yacht	1,0
Workboat MFV	1,2

Service type notation

ω

Passenger

1,0

Workboat

1,2

Pt.6, Ch. 2, 2.4.1.

σ_s 235

N/mm²

σ_u 450

N/mm²

E 200000

N/mm²

σ_s = specified minimum yield strength

σ_u = specified minimum ultimate tensile strength

modulus of elasticity

$$k_{ms} = 635 / (\sigma_s + \sigma_u)$$

$$k_{ms} = 0,927$$

min. thickness 5.4 mm

Pt.6, Ch.4, 3.2.

Keel plates

$$b_k = 5,0 L_R + 250 \text{ mm}$$

Pt.6, Ch. 4,3.2.1.

$$t_k = \sqrt{k_s} 1,35 L_R^{0,45} \text{ mm}$$

b_k 471,5

mm

The breadth

k_s 1

for mild steel

t_k 7,4

mm

The thickness

adopted value 8 mm

Pt.6, Ch. 4,3.2.2.

In no case is the thickness of the keel to be less than that of the adjacent .
bottom shell plating

PRELIMINARY

β = panel aspect ratio correction factor

Pt.6, Ch.3, 1.15.1.

1.15.1. The thickness of plating as determined by the Rules may be reduced when the panel aspect ratio is taken into consideration. In such cases a panel aspect ratio correction factor may be applied:

β = aspect ratio correction factor

$= A_R(1 - 0,25A_R)$ for $A_R \leq 2$

$= 1$ for $A_R > 2$

A_R = panel aspect ratio

= panel length/panel breadth

p = design pressure, in kN/m²

Pt.5, Ch.4, 3.1. Table 4.3.1.

Multi-hull craft							
Bottom shell	Partially submerged hulls	P_{BP}	Greater of $H_f S_f P_s$ $H_f S_f G_f P_{dh}$ $H_f S_f G_f P_f$		P_{BF}	Greater of $\delta_f H_f S_f P_s$ $\delta_f H_f S_f G_f P_{dh}$ $\delta_f H_f S_f G_f P_f$	
	Fully submerged hulls	P_{BP}	Greater of $H_f S_f P_s$ $H_f S_f G_f P_f$		P_{BF}	Greater of $\delta_f H_f S_f P_s$ $\delta_f H_f S_f G_f P_f$	

H_f 1,05

G_f Service area restriction notation factor

Service area restriction notation	Factor
G1	0,6
G2	0,75
G3	0,85
G4	1,0
G5	1,2
G6	1,25

Pt.1, Ch.2, 3.5.5.

G_f G2 0,75

. **G2 Service Group 2** covers craft intended for service in reasonable weather, in waters where the range to refuge is 20 nautical miles or less. This group will usually cover craft intended for service in coastal waters, for which geographical limits are to be identified by the Builder and agreed with LR.

PRELIMINARY

P_h Hydrostatic pressure on the shell plating

4.3.1. The pressure, P_h , acting on the shell plating up to the operating waterline due to hydrostatic pressure

$$P_h = 10(T_x - (z - z_k)) \text{ kN/m}^2$$

P_h 20 kN/m²

P_w Hydrodynamic wave pressure

4.4.1. The hydrodynamic wave pressure distribution due to relative motion, P_w , around the shell envelope up to the operating waterline, i.e. $z \leq T$ is to be taken as the greater of the following:

P_m kN/m² The distribution of hydrodynamic pressure up to the operating waterline

P_p kN/m² The distribution of hydrodynamic pressure up to the operating waterline

f_z = the vertical distribution factor

$$P_m = 10 f_z H_{rm} \text{ kN/m}^2$$

$$= k_z + (1 - k_z) \left(\frac{z - z_k}{T_x} \right)$$

$$k_z = e^{-u}$$

$$u = \left(\frac{2\pi T_x}{L_{WL}} \right)$$

T_x	u	k_z	z	z_k	f_z	P_m
2,0	0,273	0,761	0,0	0,0	0,761	20,98

$$P_p = 10 H_{pm} \text{ kN/m}^2$$

$$H_{pm} = 1,1 \left(\frac{2x_{wl}}{L_{WL}} - 1 \right) \sqrt{L_{WL}}$$

but not less than $f_L \sqrt{L_{WL}}$

$$f_L = 0,6 \text{ for } L_{WL} < 60$$

$$= 1,5 - 0,015 L_{WL} \text{ for } 60 > L_{WL} > 80$$

$$= 0,3 \text{ for } L_{WL} > 80$$

f_L	x_{wl}	H_{pm}	P_p
0,600	22,15	4,069	40,69

Shell

s	h	γ	a_{panel}	b_{panel}	A_R	β	Area	f_σ	σ_s
500	18	0,964	5000	2000	2,5	1	2	0,75	235

H_f	S_f	G_f	z	z_k	T_x	k_r	F_n	x_m	C_w
1,05	1,25	0,75	0	0	2	2,55	0,226	0,314	2,805

k_m	$C_{w,min}$	x_{wl}	H_{rm}	H_w	P_h	u	k_z	f_z	P_m
1,098	2,555	22,150	2,758	5,515	20	0,273	0,761	0,761	20,984

f_L	H_{pm}	P_p	P_w	P_s	P_f	P	t_{bottom}	t_{bottom} adopted value	
0,600	4,069	40,694	40,694	60,694	0	79,7	7,3	8	mm

PRELIMINARY

P_{wh} Pressure on weather and interior decks

4.5.2. The pressure acting on weather and interior decks, P_{wh} , in the displacement mode is to be taken as:

$$P_{wh} = f_L(6 + 0,01 L_{WL})(1 + 0,05 \Gamma) + E \text{ kN/m}^2$$

f_L = the location factor for weather decks

= 1,0 from aft end to $0,88L_R$

= 1,25 from $0,88L_R$ to $0,925L_R$

= 1,50 from $0,925L_R$ to forward end

f_L = 1,0 for interior decks

$E = \frac{0,7 + 0,08 L_{WL}}{D - T} \text{ kN/m}^2$ for exposed decks but need not be taken greater than 3 kN/m^2

$E = 0,0$ for sheltered decks

Γ = Taylor Quotient as defined in 2.1.17, and

Δ = the displacement as defined in 2.2

f_L	Γ	E	P_{wh} kN/m ²
1	2,06	0,0051	7

Shell

s	h	γ	a_{panel}	b_{panel}	A_R	β	Area	f_g	σ_s
520	0	1,000	5000	2000	2,5	1	2	0,75	235

H_f	S_f	G_f	z	z_k	T_x	k_r	F_n	x_m	C_w
1,05	1,25	0,75	0	0	2	2,55	0,226	0,314	2,805

k_m	$C_{w,min}$	x_{wl}	H_{rm}	H_w	P_h	u	k_z	f_z	P_m
1,098	2,555	22,150	2,758	5,515	20,000	0,273	0,761	0,761	20,984

f_L	H_{pm}	P_p	P_w	P_s	P_f	P	t_{bottom}	t_{bottom} adopted value
0,600	4,069	40,694	40,694	60,694	0	79,7	7,8	8 mm

PRELIMINARY

P_{wh} Pressure on weather and interior decks

4.5.2. The pressure acting on weather and interior decks, P_{wh} , in the displacement mode is to be taken as:

$$P_{wh} = f_L(6 + 0,01 L_{WL})(1 + 0,05 \Gamma) + E \text{ kN/m}^2$$

f_L = the location factor for weather decks

= 1,0 from aft end to $0,88L_R$

= 1,25 from $0,88L_R$ to $0,925L_R$

= 1,50 from $0,925L_R$ to forward end

$f_L = 1,0$ for interior decks

$E = \frac{0,7 + 0,08 L_{WL}}{D - T} \text{ kN/m}^2$ for exposed decks but need not be taken greater than 3 kN/m^2

$E = 0,0$ for sheltered decks

Γ = Taylor Quotient as defined in 2.1.17, and

Δ = the displacement as defined in 2.2

f_L	Γ	E kN/m ²	P_{wh} kN/m ²
1	2,06	0,0051	7,1

$$t_p = 22,4 s \gamma \beta \sqrt{\frac{P}{f_s \sigma_s}} \times 10^{-3} \text{ mm}$$

s	h	γ	a_{panel}	b_{panel}	A_R	β	f_s	σ_s	H_f
500	0	1,000	5000	2000	2,5	1	0,75	235	1,05

S_f	P_{wh}	P_{cd}	P_{IDP}	t_{bottom}	t_{bottom} adopted value
1,25	7,132	2,000	9,361	2,6	4,3 5 mm

4.2.2. Cross-deck stiffening-secondary

Pt.6, Ch.3,8.2.1.

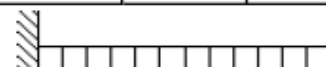
8.4.2. The Rule requirements for section modulus, inertia and web area of the strength/weather deck secondary stiffening are to be determined from the general equations given in Ch 3.1.17, using the design pressures from Pt 5, Ch 3.3.1 or Pt 5, Ch 4.3.1 for non-displacement or displacement craft as appropriate, and the coefficients Φ_Z , Φ_I , and Φ_A as detailed in Table 3.1.1 for the load model (b). Special consideration will be given to the application of other load models subject to the structural arrangement and degree of end fixity provided.

Pt.6, Ch.4,1.17.

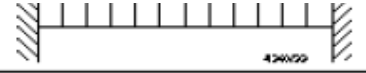

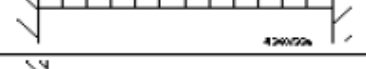

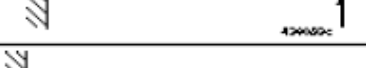
(a). Section modulus:

$$Z = \Phi_Z \frac{P s l_e^2}{f_s \sigma_s} \text{ cm}^3$$

Φ_Z = section modulus coefficient dependent on the loading model assumption taken from

Load model	Position			Position	Web area coefficient Φ_A	Section modulus coefficient Φ_Z	Inertia coefficient Φ_I	Application
	1	2	3					
(a)				1	1/2	1/12	-	Primary and other members where the end

PRELIMINARY

(a)		1 2 3	1/2 - 1/2	1/12 1/10 1/10	- 1/288 -	fixity is considered encastre
(b)		1 2 3	1/2 - 1/2	1/10 1/10 1/10	- 1/288 -	Local, secondary and other members where the end fixity is considered to be partial
(c)		1 2 3	5/8 - 3/8	1/8 9/128 -	- 1/185 -	Various
(d)		1 2 3	1 - -	1/2 - -	- - 1/8	Various
(e)		1 2 3	1/2 - 1/2	- 1/8 -	- 5/384 -	Hatch covers, glazing and other members where the ends are simply supported

f_σ = limiting bending stress coefficient for the plating element under consideration

Item	Limiting stress coefficient		
	Bending f_σ	Shear f_τ	Equivalent f_e
Main/strength deck plating and stiffeners:			
(a) Plating	0,75	-	-
(b) Secondary stiffening	0,65	0,65	-
(c) Primary girders and web frame	0,65	0,65	0,75
(d) Hatch covers	0,55	0,55	0,64

(a). Section modulus:

(b). Inertia:

(c). Web area:

$$Z = \Phi_z \frac{psl_e^2}{f_\sigma \sigma_s} \quad \text{cm}^3$$

$$I = \Phi_I f_\delta \frac{psl_e^3}{E} \times 100 \quad \text{cm}^4$$

$$A_w = \Phi_A \frac{psl_e}{100 f_\tau \tau_s} \quad \text{cm}^2$$

Shell

s	Φ_z	Φ_I	Φ_A	l_e	Area	f_σ	f_δ	f_τ	σ_s	τ_s
500	0,1	0,003	0,5	1,6	2	0,65	800	0,65	235	136
H _f	S _f	σ_f	P _{wh}	P _{cd}	P _{IDP}	Z _{bottom}	I	A		
1,05	1,25	0,8	7,132	2,000	9,361	8	27	0,4	cm ³	cm ⁴

Adopted HP profil_Bottom outboard longitudinal stiffeners

1

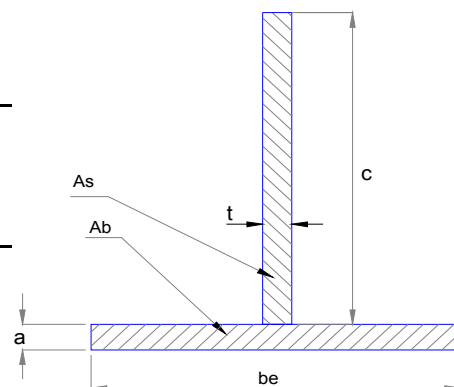
HP 80×5

W = 6,91 cm³

Pt.6, Ch.3,1.10.

1.10.3. The effective width of attached plating to secondary members b_e is to be taken as $2t_p \sqrt{E/\sigma_s}$ but not greater than s . σ_s is not to be taken as greater than 235 N/mm² for mild steel or 340 N/mm² for higher tensile steel. E , s and σ_s are as defined in 1.5.1.

t_p [mm]	E [N/mm ²]	σ_s [N/mm ²]	b_e [mm]			
5	200000	235	292			
c [mm]	t [mm]	t check	a [mm]	b_e [cm]	d [mm]	e [mm]
60	8	PASS	5	29,2	0	0
A_s [cm ²]	A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	$y_1 \times A_b$ [cm ³]	A_w [cm ²]	A [cm ²]
4,8	0,00	14,59	0,3039	9,44499	19,39	19
I_{As} [cm ⁴]	$y_2 \times A_s$ [cm ³]	I_{Ap} [cm ⁴]	$y_3 \times I_{Ap}$ [cm ³]	η [cm]	I [cm ⁴]	Z [cm ³]
14,4	28,70194	0	0	1,05468	53	10



Adopted I profil_Bottom outboard longitudinal stiffeners

Longitudinal Strainers			
I profile	60	×	8
	Z	I	A
	[cm ³]	[cm ⁴]	[cm ²]
adopted	10	53	19
required	8	27	0,4
	PASS	PASS	PASS

4.2.3. Cross-deck/Lower deck stiffening - primary webs

8.4.1. The Rule requirements for section modulus, inertia and web area for the cross-deck primary stiffeners are to be determined from the general equations given in Ch 3.1.17, using the design pressures from Pt 5, Ch 3.3.1 or Pt 5, Ch 4.3.1 for non-displacement or displacement craft as appropriate, and the coefficients Φ_Z , Φ_I , and Φ_A as detailed in Table 3.1.1 for the load model (a).

Pt.6, Ch.4,1.17.

(a). Section modulus:

(b). Inertia:

(c). Web area:

$$Z = \Phi_Z \frac{p s l_e^2}{f_\sigma \sigma_s} \quad \text{cm}^3 \quad I = \Phi_I f_\delta \frac{p s l_e^3}{E} \times 100 \quad \text{cm}^4 \quad A_w = \Phi_A \frac{p s l_e}{100 f_\tau \tau_s} \quad \text{cm}^2$$

Shell

s	Φ_Z	Φ_I	Φ_A	I_e	Area	f_σ	f_δ	f_τ	σ_s	τ_s
500	0,083	0,003	0,5	3	2	0,65	1000	0,65	235	136
H_f	S_f	σ_f	P_{wh}	P_{cd}	P_{IDP}	Z_{bottom}	I	A		
1,05	1,25	0,5	7,132	2,000	9,361	23	165	0,8	cm ³	cm ⁴

Pt.7, Ch.3,1.10.

1.10.4. The effective breadth of attached plating to primary support members (girders, transverses, webs, etc.) b_e is to be taken as bf , where b and f are as defined in Pt 3, Ch 2.3.2.1.

b = the actual width, in metres, of the load-bearing plating, i.e. one-half of the sum of spacings between parallel adjacent members or equivalent supports

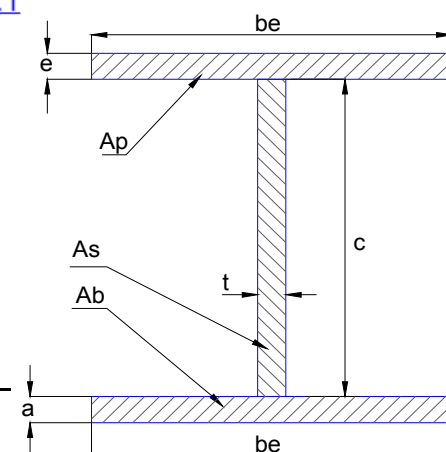
l = the overall length, in metres, of the primary support member, as indicated in Fig. 3.1.2 in Pt 6, Ch 3 and Pt 7, Ch 3, respectively, for steel and aluminium alloy construction and Fig. 3.1.4 of Pt 8, Ch 3 for composite construction

$$f = 0,3 \left(\frac{l}{b} \right)^{\frac{2}{3}}$$

but is not to exceed 1,0. Values of this factor are given in Table 2.3.1

Cross-deck stiffening - primary webs

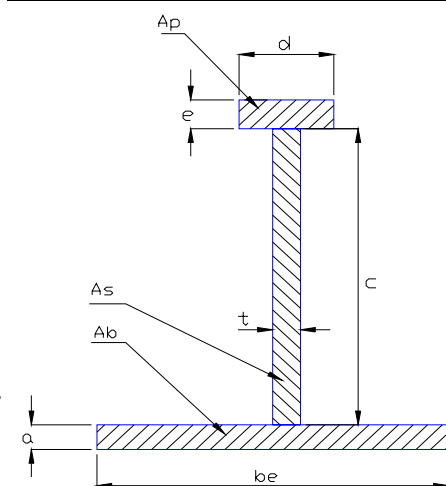
b	0,8	[m]				
l	3	[m]				
f	0,724					
c [mm]	t [mm]	t check	a [mm]	b_e [cm]	d [mm]	e [mm]
600	8	NOT PASS	5	57,9	579	5
A_p check	A_s [cm ²]	A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	y₁×A_b [cm ³]	A [cm ²]
FALSE	48	28,96	28,96	0,60343	26504,5	106
I_{As} [cm ⁴]	y₂×A_s [cm ³]	I_{Ap} [cm ⁴]	y₃×I_{Ap} [cm ³]	η [cm]	I [cm ⁴]	Z [cm ³]
14400	0	0.603	26504	30.50	67410	2210



ADOPTED 'T' profile:			
W	600	x	8
F	579	x	5
	Z [cm ³]	I [cm ⁴]	A [cm ²]
adopted	2210	67410	106
required	23	165	1
	PASS	PASS	PASS

Lower deck stiffening - primary webs

b	0,8	[m]				
l	3	[m]				
f	0,724					
c [mm]	t [mm]	t check	a [mm]	b_e [cm]	d [mm]	e [mm]
140	8	PASS	5	57,9	50	6
A_p check	A_s [cm ²]	A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	y₁×A_b [cm ³]	A [cm ²]
TRUE	11,2	3,00	28,96	0,60343	242,32	43
I_{As} [cm ⁴]	y₂×A_s [cm ³]	I_{Ap} [cm ⁴]	y₃×I_{Ap} [cm ³]	η [cm]	I [cm ⁴]	Z [cm ³]
183	213	0.090	407.7	3.14	1046	88



ADOPTED 'T' profile:			
W	140	x	8
F	50	x	6
	Z [cm ³]	I [cm ⁴]	A [cm ²]
adopted	88	1046	43
required	23	165	1
	PASS	PASS	PASS

PRELIMINARY

No.	Element of construction	n	length ₁ [m]	t ₁ [m]	length ₂	t ₂	A ₁ [m ²]	A ₂ [m ²]	A [m ²]	h ₁ [m]	d/r [m]	h×A [m ³]	h ² ×A [m ⁴]	I _{local} [m ⁴]
Midhull														
1	Bottom	1	2,78	0,004			0,0111		0,0111	0,2	0,46	0,002	0,000	1,96E-04
2	Side	1	3,5	0,004			0,0140		0,0140	2,148	3,37	0,030	0,065	1,32E-02
3	Main Deck	1	3,65	0,004			0,0146		0,0146	3,836		0,056	0,215	
4	CG	1	0,14	0,007	0,08	0,007	0,0010	0,0006	0,0015	0,0955		0,000	0,000	
5	G1	1	0,14	0,007	0,1	0,007	0,0010	0,0007	0,0017	0,2124		0,000	0,000	
6	G2	1	0,37	0,007	0,1	0,007	0,0026	0,0007	0,0033	0,3654		0,001	0,000	
7	G3	1	0,37	0,007	0,1	0,007	0,0026	0,0007	0,0033	0,5394		0,002	0,001	
8	G4-G6	3	0,2	0,005	0,06	0,005	0,0030	0,0009	0,0039	3,7129		0,043	0,161	
9	G7	1	0,2	0,005	0,06	0,005	0,0010	0,0003	0,0013	3,7129		0,005	0,018	
10	L1	1	0,08	0,025			0,0020		0,0020	0,073		0,0001	0,0000	
11	L2	1	0,08	0,025			0,0020		0,0020	0,142		0,0003	0,0000	
12	L3	1	0,08	0,025			0,0020		0,0020	0,212		0,0004	0,0001	
13	L4	1	0,08	0,025			0,0020		0,0020	0,245		0,0005	0,0001	
14	L5	1	0,08	0,025			0,0020		0,0020	0,28		0,0006	0,0002	
15	L6	1	0,08	0,025			0,0020		0,0020	0,315		0,0006	0,0002	
16	L7	1	0,08	0,025			0,0020		0,0020	0,391		0,0008	0,0003	
17	L8	1	0,08	0,025			0,0020		0,0020	0,431		0,0009	0,0004	
18	L9	1	0,08	0,025			0,0020		0,0020	0,464		0,0009	0,0004	
19	L10	1	0,05	0,015			0,0008		0,0008	1,036		0,0008	0,0008	
20	L11	1	0,05	0,015			0,0008		0,0008	1,436		0,0011	0,0015	
21	L12	1	0,05	0,015			0,0008		0,0008	1,836		0,0014	0,0025	
22	L13	1	0,05	0,015			0,0008		0,0008	2,236		0,0017	0,0037	
23	L14	1	0,05	0,015			0,0008		0,0008	2,636		0,0020	0,0052	
24	L15	1	0,05	0,015			0,0008		0,0008	3,036		0,0023	0,0069	
25	L16	1	0,05	0,015			0,0008		0,0008	3,236		0,0024	0,0079	
26	L17	1	0,05	0,015			0,0008		0,0008	3,436		0,0026	0,0089	
27	L18	1	0,05	0,015			0,0008		0,0008	3,636		0,0027	0,0099	
28	L19-L32	14	0,05	0,015			0,0105		0,0105	3,811		0,0400	0,1525	

PRELIMINARY

Element of construction	n	length ₁	t ₁	length ₂	t ₂	A ₁	A ₂	A	h ₁	d/r	hxA	h ² xA	I _{local}
No.		[m]	[m]			[m ²]	[m ²]	[m ²]	[m]	[m]	[m ³]	[m ⁴]	[m ⁴]
Sidehull													
29	Bottom inboard	1	2,1	0,008		0,0168		0,0168	0,545	1,5	0,009	0,005	3,58E-03
30	Bottom outboard	1	2,356	0,008		0,0188		0,0188	0,545	1,5	0,010	0,006	4,02E-03
31	Side inboard	1	2,49	0,008		0,0199		0,0199	2,607	2,46	0,052	0,135	1,00E-02
32	Side outboard 1	1	2,21	0,008		0,0177		0,0177	2,73		0,048	0,132	7,20E-03
33	Side outboard 2	1	2,6	0,008		0,0208		0,0208	5,136		0,107	0,549	1,17E-02
34	Long.bulkhead 1	1	2,6	0,006		0,0156		0,0156	5,136		0,080	0,412	8,79E-03
35	Long.bulkhead 2	1	2,6	0,006		0,0156		0,0156	5,136		0,080	0,412	8,79E-03
36	Cross-deck/Lower deck	1	10	0,005		0,0500		0,0500	3,836		0,192	0,736	
37	Main deck	1	10	0,005		0,0500		0,0500	6,436		0,322	2,071	
38	G1	1	0,35	0,04	0,12	0,0140	0,0048	0,0188	0,344		0,006	0,002	
39	G2	1	0,32	0,01	0,1	0,0032	0,0010	0,0042	6,308		0,026	0,167	
40	L33÷48	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	3,244		0,0083	0,0269	
41	L34÷47	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	2,718		0,0070	0,0189	
42	L35÷46	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	2,224		0,0057	0,0127	
43	L36÷45	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	1,73		0,0044	0,0077	
44	L37÷44	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	1,271		0,0033	0,0041	
45	L38÷43	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	0,829	0,48	0,0021	0,0018	
46	L39÷42	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	0,474	0,69	0,0012	0,0006	
47	L40÷41	2	0,08	0,008	0,08	0,0013	0,0013	0,0026	0,244	0,79	0,0006	0,0002	
48	L49	1	0,08	0,008	0,08	0,0006	0,0006	0,0013	3,69		0,0047	0,0174	
49	L50	1	0,08	0,008	0,08	0,0006	0,0006	0,0013	4,184		0,0054	0,0224	
50	L51	1	0,08	0,008	0,08	0,0006	0,0006	0,0013	4,678		0,0060	0,0280	
51	L52	1	0,08	0,008	0,08	0,0006	0,0006	0,0013	5,172		0,0066	0,0342	
52	L53	1	0,08	0,008	0,08	0,0006	0,0006	0,0013	5,666		0,0073	0,0411	
53	L54	1	0,08	0,008	0,08	0,0006	0,0006	0,0013	6,16		0,0079	0,0486	
54	L55÷L71	17	0,08	0,008		0,0109		0,0109	6,43		0,0700	0,4498	
									0,377		1,276	6,002	0,068

[illegible]

$\mathbf{h_D} =$	6,436	[m]
$\eta =$	3,382	[m]
$\mathbf{0,5I_{zz}} =$	6,070	[m ⁴]
$(\Sigma \mathbf{A_i})\eta^2 =$	4,314	[m ⁴]
$\mathbf{0,5I} =$	1,756	[m ⁴]
$\mathbf{I} =$	3,512	[m ⁴]
$\mathbf{A} =$	0,755	[m ²]
$\mathbf{Z_D} =$	1,150	[m ³]
$\mathbf{Z_K} =$	1,039	[m ³]

6. CROSS DECK STRENGTH

Stress type	Component stresses	Allowable stress level (N/mm ²)
Total direct stress, σ_P	$\sigma_P = \sigma_{MB} + \sigma_{MT} + \sigma_d$	$f_{\sigma g} \sigma_s$
Total shear stress, τ_P	$\tau_P = \tau_T + \tau_{MBT} + \tau_{MT}$	$f_{\tau g} \tau_s$
Equivalent stress, σ_{eq}	$\sigma_{eq} = \sqrt{\sigma^2 + 3\tau^2}$	$1,2 f_{\sigma eq} \sigma_s$

Component stress type	Nominal stress (N/mm ²)
Hull girder bending stress at strength deck amidships, see Table 6.2.1	$\sigma_d = f_{MR} \frac{M_R}{1000 Z_d}$
Stress induced by the transverse bending moment M_B , as defined in Pt 5, Ch 5.5	$\sigma_{MB} = f_{MB} \frac{M_B}{n Z} 10^3$
Stress induced by the torsional moment M_T , as defined in Pt 5, Ch 5.5	$\sigma_{MT} = f_{MT} \frac{3 x_H M_T}{n(n+1) s_p Z} 10^3$

Q_T = vertical shear force, in kN, as determined from [Pt 5, Ch 5.5](#)

M_B = transverse bending moment in kNm, as determined from [Pt 5, Ch 5.5](#)

M_T = torsional moment in kNm, as determined from [Pt 5, Ch 5.5](#)

n = total number of transverse primary stiffeners or bulkheads

A_W = stiffener web area, cm²

Z = primary stiffeners sections section modulus, in cm³

s_p = stiffener spacing, in metres

I_y = moment of inertia of stiffener, cm⁴

x_H = transverse distance between the centre of the two hulls, in metres

$\kappa = t_f$, for symmetrical I-section, in mm

$\kappa = b_b h / (b_b + h)$, for constant thickness box sections, in mm

σ_{MB} = stress induced by the transverse bending moment M_B , as defined in [Pt 5, Ch 5.5](#), in N/mm²

σ_{MT} = stress induced by the torsional moment M_T , as defined in [Pt 5, Ch 5.5](#), in N/mm²

τ_T = shear stress induced by the vertical shear force Q_T , as defined in [Pt 5, Ch 5.5](#), in N/mm²

τ_{MBT} = bending shear stress induced by the torsional moment M_T , as defined in [Pt 5, Ch 5.5](#), in N/mm²

τ_{MT} = shear stress induced by the torsional moment M_T , as defined in [Pt 5, Ch 5.5](#), in N/mm²

t_f = face plate thickness, in mm

b_b = breadth of box section, in mm

h_b = height of box section, in mm

f_{MR} , f_{MB} and f_{MT} are load combination factors reflecting the portions of each component global design load, M_R , Q_T , M_B and M_T , corresponding to the most severe load combinations. The most severe load combinations are the combinations of loads resulting in the maximum bending, shear and effective stress, respectively. The assessment of these load combinations need to take due consideration for the component load magnitude variation with wave heading and also the phasing in time between them. Generally, f_{MR} , f_{MB} and f_{MT} are to be taken as indicated in [Table 6.3.3](#).

Table 6.3.3 Load combination factors

Heading	Factors		
	f_{MB}	f_{MR}	f_{MT}
Head sea	0,1	1,0	0,1
Beam sea	1,0	0,1	0,2
Quartering sea	0,1	0,4	1,0

4.2.2 The design transverse bending moment M due to the side force is given as:

File: 1024_Midship Section_03.xlsx

Tab: 6. Cross deck

Page 1/3

WATER LINE L.t.d.
Bogišićeva 12, Zagreb, CROATIA

PRELIMINARY

G_f	T (m)	Δ (t)	L_s (m)	Ψ_1	Ψ_2	F_{FS} kN	F m	M_B kNm	n	Z (cm ³)
8,5	2	860	44,3	1,491	1,075	2464	1,84	6998	38	3041

G_f	a_v g	M_T kNm	x_H	s_p (cm ³)
0,63	1,15	27649	8	1,0

	f_{MR}	σ_D N/mm ³	f_{MB}	σ_{MB} N/mm ⁴	f_{MT}	σ_{MT} N/mm ⁵	σ_P N/mm ⁶	$f_{\sigma g v} \sigma_s$	$\sigma < \sigma_p$ check
Head sea	1,0	31	0,1	6	0,1	15	52	169	pass
Beam sea	0,1	3	1,0	61	0,2	29	93	169	pass
Quartering sea	0,4	12	0,1	6	1,0	147	166	169	pass

σ_s N/mm ²	η_{HTS}	$f_{\sigma gh}$
235	1	0,72

PRELIMINARY

	Element of construction	n	length ₁	t ₁	length ₂	t ₂	A ₁	A ₂	A	h ₁	d/r	h×A	h ² ×A	I _{local}
No.			[m]	[m]			[m ²]	[m ²]	[m ²]	[m]	[m]	[m ³]	[m ⁴]	[m ⁴]
Cross deck														
1	Cross deck	1	31,2	0,005			0,1560		0,1560	3,836		0,598	2,296	
2	Wet deck	1	31,2	0,005			0,1560		0,1560	3,236		0,505	1,634	
3	Web beam	22	0,6	0,008			0,1056		0,1056	3,536		0,373	1,320	3,17E-03
									0,418			1,477	5,249	0,003

$$h_D = 3,836 \text{ [m]}$$

$$\eta = 3,536 \text{ [m]}$$

$$0,5I_{zz} = 5,253 \text{ [m}^4\text{]}$$

$$(\Sigma A_i)\eta^2 = 5,221 \text{ [m}^4\text{]}$$

$$0,5I = 0,031 \text{ [m}^4\text{]}$$

$$I = 0,062 \text{ [m}^4\text{]}$$

$$A = 0,835 \text{ [m}^2\text{]}$$

$$Z_D = 0,208 \text{ [m}^3\text{]}$$

$$Z_K = 0,018 \text{ [m}^3\text{]}$$

PRELIMINARY

Element of construction	n	length ₁	t ₁	length ₂	t ₂	A ₁	A ₂	A	h ₁	d/r	h×A	h ² ×A	I _{local}
No.		[m]	[m]			[m ²]	[m ²]	[m ²]	[m]	[m]	[m ³]	[m ⁴]	[m ⁴]

Pt.7, Ch.3,1.10.

1.10.4. The effective breadth of attached plating to primary support members (girders, transverses, webs, etc.) b_e is to be taken as bf , where b and f are as defined in [Pt 3, Ch 2.3.2.1](#).

b = the actual width, in metres, of the load-bearing plating, i.e. one-half of the sum of spacings between parallel adjacent members or equivalent supports

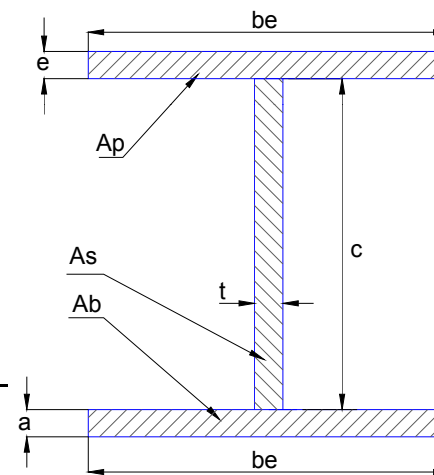
l = the overall length, in metres, of the primary support member, as indicated in [Fig. 3.1.2 in Pt 6, Ch 3](#) and [Pt 7, Ch 3](#), respectively, for steel and aluminium alloy construction and [Fig. 3.1.4 of Pt 8, Ch 3](#) for composite construction

$$f = 0,3 \left(\frac{l}{b} \right)^{\frac{2}{3}}$$

but is not to exceed 1,0. Values of this factor are given in [Table 2.3.1](#)

Cross-deck stiffening - primary webs

b	0,6	[m]				
l	3,2	[m]				
f	0,92					
c	t	t	a	b _e	d	e
[mm]	[mm]	check	[mm]	[cm]	[mm]	[mm]
800	8	NOT PASS	5	54,9	549	5
A _p	A _s	A _p	A _b	I _{Ab}	y ₁ ×A _b	A
check	[cm ²]	[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]
FALSE	64	27,47	27,47	0,572357	44508	119
I _{As}	y ₂ ×A _s	I _{Ap}	y ₃ ×I _{Ap}	η	I	Z
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]
34133	0	0.572	44508	40.50	123151	3041



ADOPTED 'T' profile:		
W	800	× 8
F	549	× 5
Z	I	A
[cm ³]	[cm ⁴]	[cm ²]
adopted	3041	123151
required	0	0
	PASS	PASS

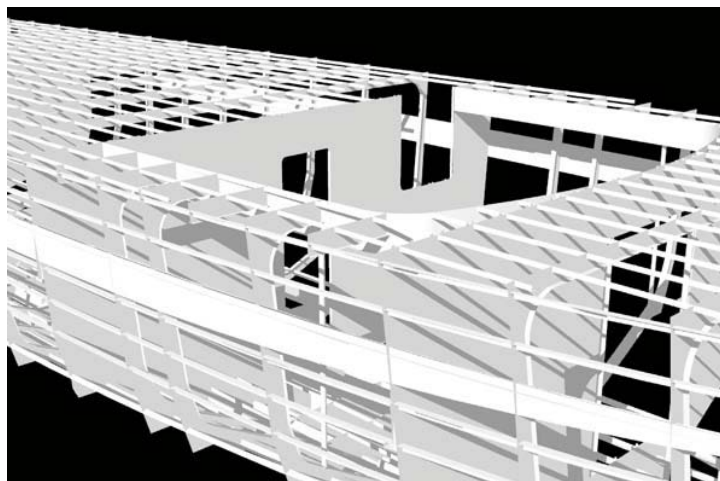
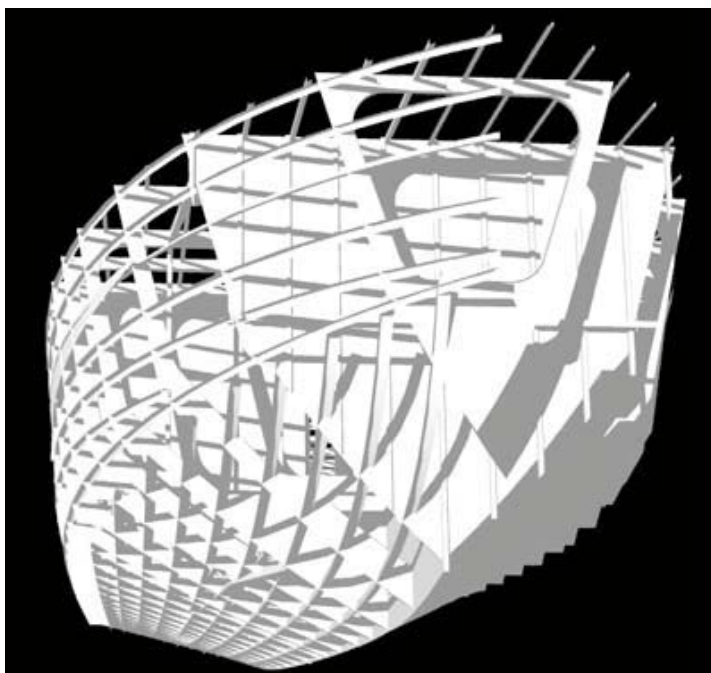
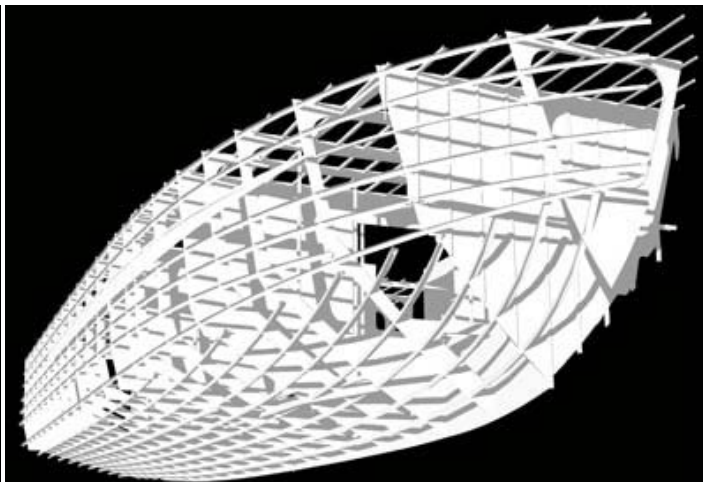
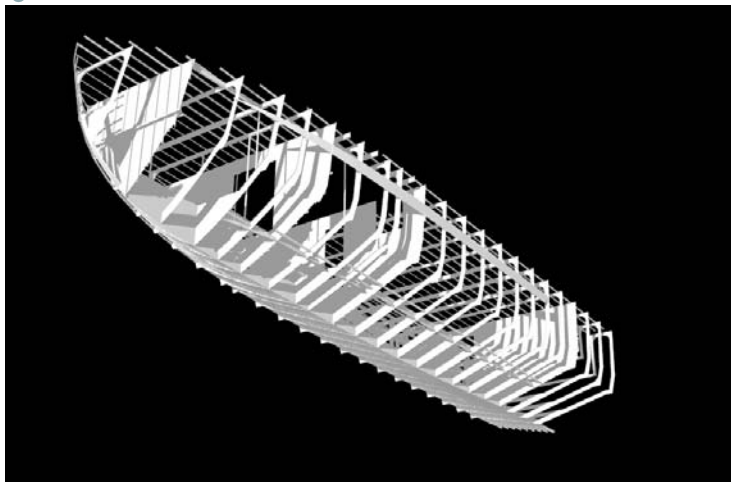
KREŠIMIR ŠKOKIĆ

address: Zelinska 5, Zagreb, CROATIA

mobile tel. : 385989803367

email: kresimir.skokic@gmail.com

MY "Liburn 77" Aluminium Powerboat 24m , Project. No. 1035



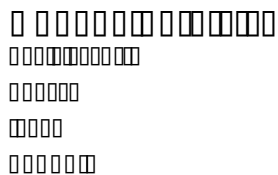
KREŠIMIR ŠKOKIĆ

address: Zelinska 5, Zagreb, CROATIA

mobile tel. : 385989803367

email: kresimir.skokic@gmail.com





UPA Yachts

1035

Liburn 77

[illegible]

STRUCTURE CALCULATION

[illegible]

1. DIMENSIONS AND DATA

Symbol	Unit	Designation/Meaning of symbol	Value
L_{WL}	[m]	Length of waterline	21,92
L_H	[m]	Length of the hull	23,07
B_H	[m]	Beam of the hull	5,70
B_{WL}	[m]	Waterline beam	5,34
B_C	[m]	Chine beam, supporting width	5,25
T_C	[m]	Design waterline for a specific loading condition	1,13
m_{LD}	[kg]	Displacement mass	55000
C_B		- totalni koeficijent punoće $C_B = \frac{\Delta}{1,025 \cdot L \cdot B_w \cdot T}$	0,385
V	[knots]	Maximum speed for a given displacement	26
$\beta_{0.4}$	[°]	Deadrise angle	13,61
τ	[°]	Running trim angle	4
		Design category of Craft	A
k_{DC}		Design category for acceleration	1
$\frac{V}{\sqrt{L_{WL}}}$			5,5528

2. BOTTOM

2.1. BOTTOM DESIGN PRESSURE

$$P_{BMD} = P_{BMD\ BASE} \times k_{AR} \times k_{DC} \times k_L \quad [\text{kN/m}^2]$$

$$P_{BMD\ BASE} = \frac{0,1 \cdot m_{LDC}}{L_{WL} \cdot B_C} \times (1 + k_{DC}^{0,5} \times n_{CG})$$

k_{DC} - design category factor

Design Category	A	B	C	D
Value of k_{DC}	1	0,8	0,6	0,4

n_{CG} - the dynamic factor

$$n_{CG} = 0,32 \left(\frac{L_{WL}}{10 \cdot B_C} + 0,084 \right) \times (50 - \beta_{0,4}) \times \frac{V^2 \times B_C^2}{m_{LDC}} \quad [g]$$

$$n_{CG} = \frac{0,5 \times V}{m_{LDC}^{0,17}} \quad [g]$$

k_L - longitudinal impact distribution factor

$$k_L = \frac{1 - 0,167 \times n_{CG}}{0,6} \frac{x}{L_{WL}} + 0,167 \times n_{CG} \quad \frac{x}{L_{WL}} \leq 0,6$$

$$k_L = 1 \quad \frac{x}{L_{WL}} > 0,6$$

n_{CG} - determined according to 7.3 but for the purpose of determination of, k_L shall not be taken less than 3.
 x - the longitudinal position of centre of the panel or middle of stiffener forward of aft end of LWL in mLDC conditions

k_{AR} - Area pressure distribution factor $k_{AR} = \frac{k_R \cdot 0,1 \cdot mLDC^{0,15}}{A_D^{0,3}}$

k_R - the structural component and boat type factor

$A_D = (l \times b) \times 10^{-6}$ for plating, but shall not be taken greater than $2,5 \times b^2 \times 10^{-6}$

$A_D = (l_u \times s) \times 10^{-6}$ for stiffeners but need not be taken less than $0,33 \times l_u^2 \times 10^{-6}$

b - the shorter dimension of the plate panel

l - the longer dimension of the plate panel

s - the stiffener spacing

l_u - is the unsupported span of a stiffener

k_{AR} shall not be taken greater than 1

2.2. BOTTOM PLATING

Material	Structural element	design stress σ_d N/mm ²
Aluminium alloys	All elements	$0,6 \cdot \sigma_{utw}^a$ or $0,9 \cdot \sigma_{yw}$
Steel	All elements	$0,6 \cdot \sigma_{ut}^a$ or $0,9 \cdot \sigma_y$

^a The lesser value applies.

for steel σ_y is the minimum tensile yield strength [N/mm²]

σ_{ut} is the minimum ultimate tensile strength [N/mm²]

for welded aluminium

σ_{yw} is the minimum tensile yield strength, welded condition [N/mm²]

σ_{utw} the minimum ultimate tensile strength, welded condition [N/mm²]

For aluminium adhesively bonded or mechanically fastened σ_y and σ_{ut} are in unwelded state

$\sigma_{yw} = 125$ [N/mm²]

$\sigma_{utw} = 280$ [N/mm²]

The thickness of metal required by the following do not take into account any corrosion margin or the effect of fabrication techniques. Coating are considered to be used where needed.

The minimum required thickness of the plating t is:

$$t = b \times k_C \times \sqrt{\frac{P \times k_2}{1000 \times \sigma_d}} \quad [\text{mm}]$$

Panel aspect ratio ℓ / b	Factor k_2 k_2 to be taken = 0,5 for laminated wood plating	Factor k_3
> 2,0	0,500	0,028
2,0	0,497	0,028
1,9	0,493	0,027
1,8	0,487	0,027
1,7	0,479	0,026
1,6	0,468	0,025
1,5	0,454	0,024
1,4	0,436	0,023
1,3	0,412	0,021
1,2	0,383	0,019
1,1	0,349	0,016
1,0	0,308	0,014
	k_2 can be approximated by the formula below, keeping $0,308 < k_2 < 0,5$	k_3 can be approximated by the formula below, keeping $0,014 < k_3 < 0,028$
	$k_2 = \frac{0,271 (\ell / b)^2 + 0,910 (\ell / b) - 0,554}{(\ell / b)^2 - 0,313 (\ell / b) + 1,351}$	$k_3 = \frac{0,027 (\ell / b)^2 - 0,029 (\ell / b) + 0,011}{(\ell / b)^2 - 1,463 (\ell / b) + 1,108}$

2. 3. BOTTOM STIFFENER

The web area A_W and minimum section modulus S_M of stiffening members including the effective plating of the stiffening members shall be not less than given by the following equation:

$$A_W = \frac{k_{SA} \times P \times s \times \ell_w}{\tau_d} 10^{-6} [\text{cm}^2] \quad S_M = \frac{83,33 \times k_{CS} \times P \times s \times \ell_w^2}{\sigma_d} 10^{-9} [\text{cm}^3]$$

k_{CS} the curvature factor for stiffeners given in Table 16
,applies to convex or concave stiffeners, it shall not be taken less than 0,5 not greater than 1.

k_{SA} the stiffener shear area factor given in Table 17

Stiffener arrangements	k_{SA}
Attached to the plating	5
Other arrangements (floating)	7,5

s the spacing of stiffeners

ℓ_w the length of the stiffener

σ_D Design stresses for stiffening members

Material	Tensile and compressive design stress σ_d N/mm ²	Design shear stress τ_d N/mm ²
FRP	$0,5 \sigma_{ut}$ and $0,5 \sigma_{uc}$ ^{a)}	$0,5 \tau_u$
Aluminium alloys	$0,7 \sigma_{yw}$ ^{b)}	$0,4 \sigma_{yw}$ ^{b)}
Steel	$0,8 \sigma_y$	$0,45 \sigma_y$
Laminated wooden frames	$0,45 \sigma_{uc}$ ^{c)}	$0,45 \tau_u$
Solid stock wooden frames	$0,4 \sigma_{uf}$ ^{c)}	$0,4 \tau_u$
Plywood on edge frames	$0,45 \sigma_{uf}$ ^{c)}	$0,45 \tau_u$
a σ_c considered where stressed in compression (usually the stiffener top flange) and σ_t considered where stressed in tension (usually the plating), both verifications need to be calculated b for welded stiffeners. If aluminium stiffeners are not welded, i.e. riveted, glued, etc., the non welded properties shall be used c σ_{uc} for laminated wooden frames and σ_{uf} for solid stock shall be taken from Table E1, for plywood, σ_{uf} shall not be taken from Table E2 but from Table E3 or E6		

BOTTOM pressure PLATING:

$$k_L = \frac{1 - 0,167 \times n_{CG}}{0,6} \frac{x}{L_{WL}} + 0,167 \times n_{CG}$$

PLATE :

L_{WL} [m]	B_c [m]	β [°]	V [knots]	m_{LDC} [kg]	k_{DC}	n_{CG} [g]	$n_{CG \max}$ [g]	n_{CG} [g]
21,92	5,25	13,61	26	55000	1	1,98	2,033	3,000

Area	x [m]	x/L_{WL}	k_L	I [mm]	b [mm]	A_d [m ²]	k_R [m ²]	k_{ar}	P_{BMD} [kN/m ²]
1	0	0	0,501	1350	260	0,169	1	0,876	83,9
2	1,7	0,0775	0,565	1350	260	0,169	1	0,876	94,7
3	3,4	0,1551	0,630	1350	260	0,169	1	0,876	105,5
4	4,7	0,2144	0,679	1000	260	0,169	1	0,876	113,8
5	6,8	0,3102	0,759	1000	260	0,169	1	0,876	127,1
6	7,8	0,3558	0,797	1000	260	0,169	1	0,876	133,5
7	9,7	0,4424	0,869	1000	260	0,169	1	0,876	145,6
8	10,7	0,488	0,907	1000	260	0,169	1	0,876	151,9
9	11,9	0,5428	0,952	1000	260	0,169	1	0,876	159,5
10	12,9	0,5884	0,990	1000	260	0,169	1	0,876	165,9
11	13,8	0,6294	1,000	1000	260	0,169	1	0,876	167,5
12	15	0,6842	1,000	1000	260	0,169	1	0,876	167,5
13	16,2	0,7389	1,000	1000	260	0,169	1	0,876	167,5
14	17,2	0,7845	1,000	1000	260	0,169	1	0,876	167,5
15	18,37	0,8379	1,000	1000	260	0,169	1	0,876	167,5
16	19,5	0,8894	1,000	1000	260	0,169	1	0,876	167,5
17	20,8	0,9487	1,000	1000	260	0,169	1	0,876	167,5

Bottom thickness PLATING:Aluminium Alloy
EN AW-5083 0/H111

$\sigma_{yw} =$	125	[N/mm ²]
$\sigma_{utw} =$	280	[N/mm ²]

Area	x [m]	l [mm]	b [mm]	c [mm]	c/b	k _c	k ₂	σ_D [N/mm ²]	P _{BMD} [kN/m ²]	t [mm]
1	0	1350	260	0	0	1,0	0,430	113	83,9	4,7
2	1,7	1350	260	0	0	1,0	0,430	113	94,7	4,9
3	3,4	1350	260	0	0	1,0	0,430	113	105,5	5,2
4	4,7	1000	260	0	0	1,0	0,466	113	113,8	5,6
5	6,8	1000	260	0	0	1,0	0,466	113	127,1	6,0
6	7,8	1000	260	0	0	1,0	0,466	113	133,5	6,1
7	9,7	1000	260	0	0	1,0	0,466	113	145,6	6,4
8	10,7	1000	260	0	0	1,0	0,466	113	151,9	6,5
9	11,9	1000	260	0	0	1,0	0,466	113	159,5	6,7
10	12,9	1000	260	0	0	1,0	0,466	113	165,9	6,8
11	13,8	1000	260	0	0	1,0	0,466	113	167,5	6,8
12	15	1000	260	0	0	1,0	0,466	113	167,5	6,8
13	16,2	1000	260	0	0	1,0	0,466	113	167,5	6,8
14	17,2	1000	260	0	0	1,0	0,466	113	167,5	6,8
15	18,37	1000	260	0	0	1,0	0,466	113	167,5	6,8
16	19,5	1000	260	0	0	1,0	0,466	113	167,5	6,8
17	20,8	1000	260	0	0	1,0	0,466	113	167,5	6,8

7

SIDE pressure STIFFNER:**STIFFENER :**

L _{WL} [m]	B _c [m]	β [°]	V [knots]	m _{LDC} [kg]	k _{DC}	n _{cq} [g]	n _{cq max} [g]	n _{cq} [g]
21,92	5,25	13,61	26	55000	1	1,98	2,033	3,000

Area	x [m]	x/L _{WL}	k _L	l _u [mm]	s [mm]	A _d [m ²]	k _R [m ²]	k _{ar}	P _{BMD} [kN/m ²]
1	0	0,000	0,501	1350	260	0,601	1	0,599	57,3
2	1,7	0,078	0,565	1350	260	0,601	1	0,599	64,7
3	3,4	0,155	0,630	1350	260	0,601	1	0,599	72,1
4	4,7	0,214	0,679	1000	260	0,33	1	0,717	93,1
	5,7	0,260	0,717	1000	260	0,33	1	0,717	98,3
5	6,8	0,310	0,759	1000	260	0,33	1	0,717	104,0
6	7,8	0,356	0,797	1000	260	0,33	1	0,717	109,2
7	9,7	0,442	0,869	1000	260	0,33	1	0,717	119,1
8	10,7	0,488	0,907	1000	260	0,33	1	0,717	124,3
9	11,9	0,543	0,952	1000	260	0,33	1	0,717	130,5
10	12,9	0,588	0,990	1000	260	0,33	1	0,717	135,7
11	13,8	0,629	1,000	1000	260	0,33	1	0,717	137,0
12	15	0,684	1,000	1000	260	0,33	1	0,717	137,0
13	16,2	0,739	1,000	1000	260	0,33	1	0,717	137,0
14	17,2	0,785	1,000	1000	260	0,33	1	0,717	137,0
15	18,37	0,838	1,000	1000	260	0,33	1	0,717	137,0
16	19,5	0,889	1,000	1000	260	0,33	1	0,717	137,0
17	20,8	0,949	1,000	1000	260	0,33	1	0,717	137,0

Bottom Section Modul and Shear Area LONG STIFFENER (STRINGERS):

Aluminium Alloy EN AW-5083 O/H111

$$A_W = \frac{k_{SA} \times P \times s \times \ell_u}{\tau_d} 10^{-6}$$

$$SM = \frac{83,33 \times k_{CS} \times P \times s \times \ell_u^2}{\sigma_d} 10^{-9}$$

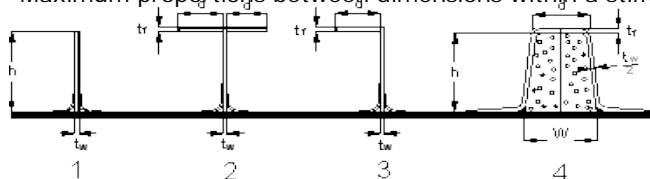
σ_{vw} [N/mm ²]	σ_{utw} [N/mm ²]	σ_D [N/mm ²]	τ_D [N/mm ²]
125	280	88	50

Area	x [m]	I _u [mm ⁴]	s [mm]	c [mm]	c/I	k _{CS}	k _{SA}	P _{b1} [kN/m ²]	SM [cm ³]	A _W [cm ²]
1	0	1350	260	0	0	1,0	5	57,3	25,9	2,01
2	1,7	1350	260	0	0	1,0	5	64,7	29,2	2,27
3	3,4	1350	260	0	0	1,0	5	72,1	32,5	2,53
4	4,7	1000	260	0	0	1,0	5	93,1	23,0	2,42
	5,7	1000	260	0	0	1,0	6	98,3	24,3	3,07
5	6,8	1000	260	0	0	1,0	5	104,0	25,8	2,70
6	7,8	1000	260	0	0	1,0	5	109,2	27,0	2,84
7	9,7	1000	260	0	0	1,0	5	119,1	29,5	3,10
8	10,7	1000	260	0	0	1,0	5	124,3	30,8	3,23
9	11,9	1000	260	0	0	1,0	5	130,5	32,3	3,39
10	12,9	1000	260	0	0	1,0	5	135,7	33,6	3,53
11	13,8	1000	260	0	0	1,0	5	137,0	33,9	3,56
12	15	1000	260	0	0	1,0	5	137,0	33,9	3,56
13	16,2	1000	260	0	0	1,0	5	137,0	33,9	3,56
14	17,2	1000	260	0	0	1,0	5	137,0	33,9	3,56
15	18,37	1000	260	0	0	1,0	5	137,0	33,9	3,56
16	19,5	1000	260	0	0	1,0	5	137,0	33,9	3,56
17	20,8	1000	260	0	0	1,0	5	137,0	33,9	3,56

The effective extent of plating shall be calculated according to Table, but shall not be taken greater than the actual stiffener spacing.

Material	Steel	Aluminium	FRP Single skin	FRP Sandwich	Wood, plywood,
b_p	80 t	60 t	20 t	20 t _i & 20 t _a	15 t
a) The attached plating is 20 times both inner and outer skins, separated by the core, considered ineffective i.e. $E_{core} = 0$.					

Maximum proportions between dimensions within a stiffener



Maximum values of h / t_w and d / t_f if actual stress σ_{act} or τ_{act} is at least 80% of respectively σ_d or τ_d given

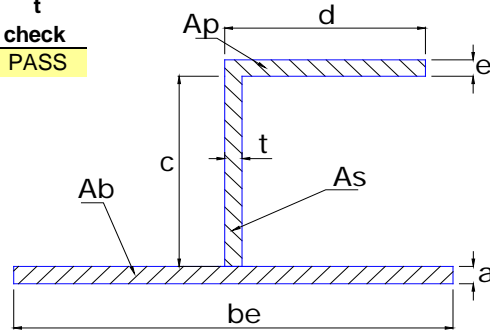
Type of profile	Flat bat	T or L shaped stiffeners	Top Hat stiffeners		
Material	$h / t_w \max$	$h / t_w \max$	$d / t_f \max$	$h / (t_w / 2) \max$	$d / t_f \max$
GFRP 35% fibres by mass	8	30	8	30	21
Aluminium	12	40	12	40	25
Steel	15	50	15	50	40
Carbon and or aramid laminate 0/90 40-50% fibre by mass	13	40	13	40	35
Plywood	10	40	10	40	25

t_p [mm]	b_e [mm]	c [mm]	t [mm]	check
7,0	260	70	6	PASS

a [mm]	b_e [cm]	d [mm]	e [mm]	A_s [cm ²]
7,0	26,0	70	6	4

A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	$y_1 \times A_b$ [cm ³]	A [cm ²]
4	18	1	60	27

I_{As} [cm ⁴]	$y_2 \times A_s$ [cm ³]	I_{Ap} [cm ⁴]	$y_3 \times I_{Ap}$ [cm ³]	η [cm]	I [cm ⁴]	Z [cm ³]
17	17	0	143	2	238	39



Adopted L profil Bottom longitudinal stiffeners			
L profil	70	70	6
		SM	A
		[cm ³]	[cm ²]
adopted		39	27
required	13	34	4
		PASS	PASS

Bottom Section Modul and Shear Area FLOORS :

Aluminium Alloy EN AW-5083 0/H111

σ_{yw} [N/mm ²]	σ_{utw} [N/mm ²]	σ_D [N/mm ²]	τ_D [N/mm ²]
125	270	88	50

$$\sigma_{yw} = 125 \text{ [N/mm}^2\text{]}$$

$$\sigma_{utw} = 270 \text{ [N/mm}^2\text{]}$$

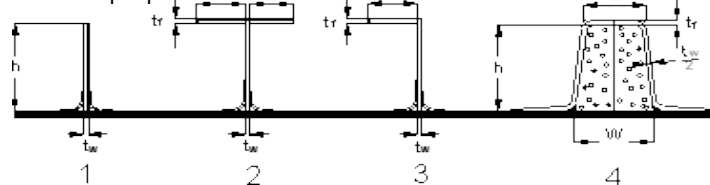
Area	x [m]	I _u [mm]	s [mm]	c [mm]	c/I	k _{cs}	k _{SA}	P _{b1} [kN/m ²]	SM [cm ³]	A _w [cm ²]
1	0	2400	260	0	0	1,0	5	57,3	81,8	3,58
		1600	260	0	0	1,0	5	57,3	36,3	2,39
2	1,7	2400	260	0	0	1,0	5	64,7	92,3	4,04
		1600	260	0	0	1,0	5	64,7	41,0	2,69
3	3,4	2400	260	0	0	1,0	5	72,1	102,8	4,50
		1600	260	0	0	1,0	5	72,1	45,7	3,00
4	4,7	2400	260	0	0	1,0	5	93,1	132,8	5,81
		1550	260	0	0	1,0	5	93,1	55,4	3,75
5	5,8	2400	260	0	0	1,0	5	98,3	140,2	6,13
		1550	260	0	0	1,0	5	98,3	58,5	3,96
6	6,8	2400	260	0	0	1,0	5	104,0	148,3	6,49
		1550	260	0	0	1,0	5	104,0	61,9	4,19
7	7,8	2400	260	0	0	1,0	5	109,2	155,8	6,81
		1550	260	0	0	1,0	5	109,2	65,0	4,40
8	9,7	2400	260	0	0	1,0	5	119,1	169,8	7,43
		1550	260	0	0	1,0	5	119,1	70,8	4,80
9	10,7	2400	260	0	0	1,0	5	124,3	177,3	7,76
		1550	260	0	0	1,0	5	124,3	73,9	5,01
10	11,9	2400	260	0	0	1,0	5	130,5	186,1	8,14
		1550	260	0	0	1,0	5	130,5	77,6	5,26
11	12,9	2300	260	0	0	1,0	5	135,7	177,8	8,12
		1550	260	0	0	1,0	5	135,7	80,7	5,47
12	13,8	2260	260	0	0	1,0	5	137,0	173,3	8,05
		1550	260	0	0	1,0	5	137,0	81,5	5,52
13	15	2100	260	0	0	1,0	5	137,0	149,6	7,48
		1550	260	0	0	1,0	5	137,0	81,5	5,52
14	16,2	2010	260	0	0	1,0	5	137,0	137,1	7,16
		1550	260	0	0	1,0	5	137,0	81,5	5,52
15	17,2	2060	260	0	0	1,0	5	137,0	144,0	7,34
		1550	260	0	0	1,0	5	137,0	81,5	5,52
16	18,37	1700	260	0	0	1,0	5	137,0	98,1	6,06
		1550	260	0	0	1,0	5	137,0	81,5	5,52
17	19,5	2240	260	0	0	1,0	5	137,0	170,3	7,98
		1550	260	0	0	1,0	5	137,0	81,5	5,52
18	20,8	2200	260	0	0	1,0	5	137,0	164,2	7,84
		1550	260	0	0	1,0	5	137,0	81,5	5,52

186,1 8,1

The effective extent of plating shall be calculated according to Table, but shall not be taken greater than the actual stiffener spacing.

Material	Steel	Aluminium	FRP Single skin	FRP Sandwich	Wood, plywood,
L_p	80 t	60 t	20 t	20 t_s & 20 t_i a	15 t
a) The attached plating is 20 times both inner and outer skins, separated by the core, considered ineffective i.e. $E_{core}=0$.					

Maximum proportions between dimensions within a stiffener

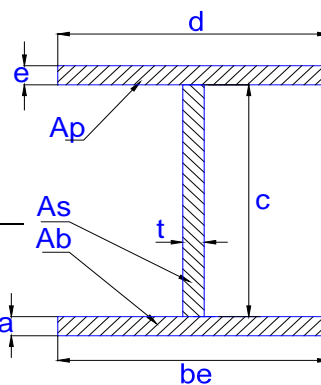


Maximum values of h / t_w and d / t_f if actual stress σ_{act} or τ_{act} is

at least 80% of respectively σ_d or f_d given					
Type of profile	Flat bar	T or L shaped stiffeners		Top Hat stiffeners	
Material	$h / t_w \max$	$h / t_w \max$	$d / t_f \max$	$h / (t_w / 2) \max$	$d / t_f \max$
FRP 35% fibres by mass	8	30	8	30	21
Aluminium	12	40	12	40	25
Steel	15	50	15	50	40
Carbon and or aramid laminate 0/90 40-50% fibre by mass	13	40	13	40	35
Plywood	10	40	10	40	25

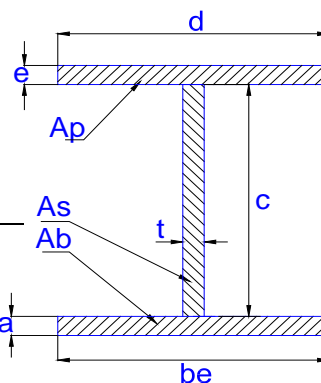
BULKHEAD

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
4	170	7,0	PASS	8,0	260	50	10
A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]	
PASS	11,9	5,00	208	11,1	157	225	
I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]	
286,5917	768	0,416667	1450	1,27	2673	152	
c [mm]	c ₂ [mm]	c ₁ [mm]					
170	PASS	90					



ADOPTED 'T' profile:			
W	170	×	7
F	50	×	10
	Z	A	
	[cm ³]	[cm ²]	
adopted	13	152	225
required		133	6
	PASS	PASS	

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
4	200	7,0	PASS	8,0	260	70	10
A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]	
PASS	14	7,00	208	11,1	338	229	
I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]	
466,6667	1166	0,583333	2696	1,67	4678	232	
c [mm]	c ₂ [mm]	c ₁ [mm]					
200	PASS	80					



ADOPTED 'T' profile:			
W	200	×	7
F	70	×	10
	Z	A	
	[cm ³]	[cm ²]	
adopted	76	232	229
required		55	4
	PASS	PASS	

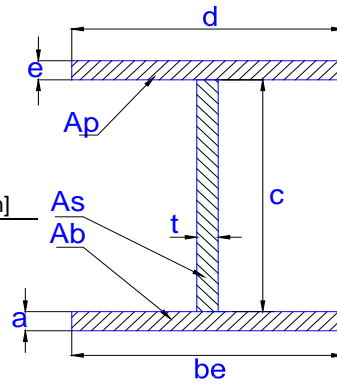
x [m]
5,8

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
5	200	6,0	PASS	7,0	260	60	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	12	4,20	182	7,4	207	198

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
400	1034	0,1715	1619	1,42	3268	164

c [mm]	c ₂ [mm]	c ₁ [mm]
200	PASS	80



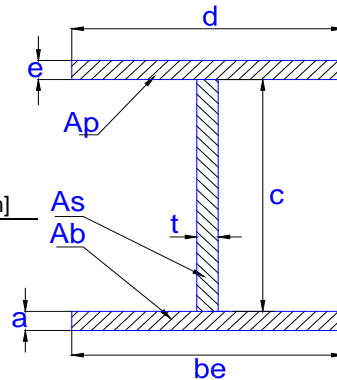
ADOPTED 'T' profile:			
W	200	×	6
F	60	×	7
	Z [cm ³]		A [cm ²]
adopted	14	164	198
required		140	6
	PASS		PASS

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
5	130	5,0	PASS	7,0	260	40	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	6,5	2,80	182	7,4	34	191

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
91,54167	268	0,114333	493	0,78	894	66

c [mm]	c ₂ [mm]	c ₁ [mm]
130	PASS	90



ADOPTED 'T' profile:			
W	130	×	5
F	40	×	7
	Z [cm ³]		A [cm ²]
adopted	11	66	191
required		58	4
	PASS		PASS

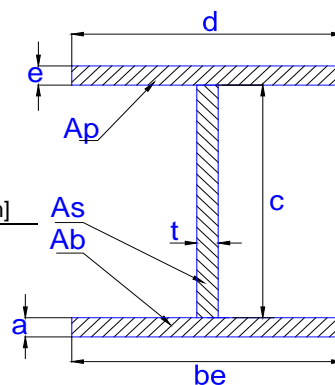
x [m]
10,7

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
9	220	6,0	PASS	7,0	260	60	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	13,2	4,20	182	7,4	275	199

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
532,4	1352	0,1715	1936	1,58	4103	188

c [mm]	c ₂ [mm]	c ₁ [mm]
220	PASS	90



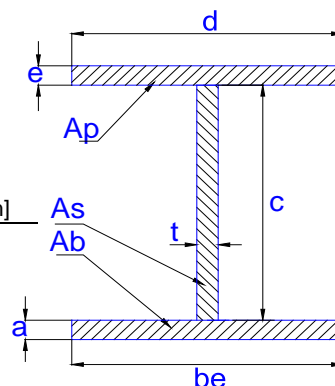
ADOPTED 'T' profile:			
W	220	×	6
F	60	×	7
	Z [cm ³]		A [cm ²]
adopted	6	188	199
required		177	8
	PASS		PASS

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
9	130	6,0	PASS	7,0	260	50	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	7,8	3,50	182	7,4	50	193

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
109,85	312	0,142917	608	0,87	1087	80

c [mm]	c ₂ [mm]	c ₁ [mm]
130	PASS	90



ADOPTED 'T' profile:			
W	130	×	6
F	50	×	7
	Z [cm ³]		A [cm ²]
adopted	8	80	193
required		74	5
	PASS		PASS

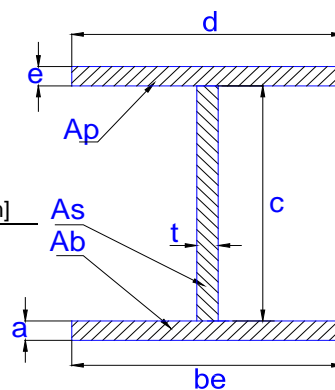
x [m]
16,2

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
14	180	6,0	PASS	7,0	260	60	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	10,8	4,20	182	7,4	151	197

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
291,6	769	0,1715	1329	1,26	2548	140

c [mm]	c ₂ [mm]	c ₁ [mm]
180	PASS	90



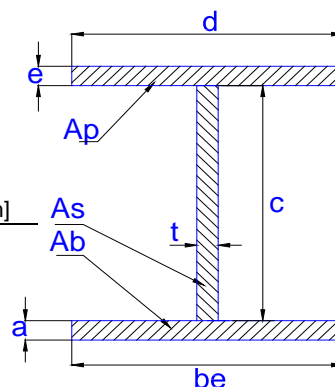
ADOPTED 'T' profile:			
W	180	×	6
F	60	×	7
	Z [cm ³]		A [cm ²]
adopted	2	140	197
required		137	7
	PASS		PASS

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
14	130	6,0	PASS	7,0	260	60	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	7,8	4,20	182	7,4	60	194

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
109,85	307	0,1715	724	0,92	1208	90

c [mm]	c ₂ [mm]	c ₁ [mm]
130	PASS	90



ADOPTED 'T' profile:			
W	130	×	6
F	60	×	7
	Z [cm ³]		A [cm ²]
adopted	9	90	194
required		82	6
	PASS		PASS

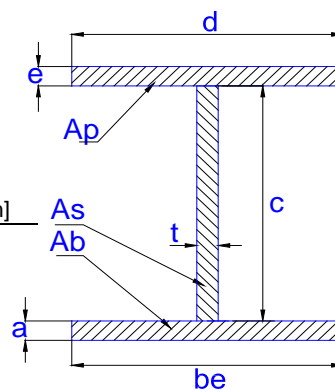
x [m]
19,5

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
17	220	6,0	PASS	7,0	260	60	7

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	13,2	4,20	182	7,4	275	199

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
532,4	1352	0,1715	1936	1,58	4103	188

c [mm]	c ₂ [mm]	c ₁ [mm]
220	PASS	90



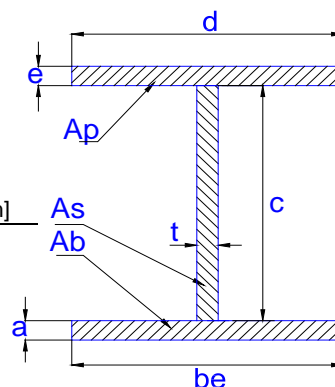
ADOPTED 'T' profile:			
W	220	×	6
F	60	×	7
	Z [cm ³]		A [cm ²]
adopted	9	188	199
required		170	8
	PASS		PASS

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
17	130	6,0	PASS	7,0	260	50	8

A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	7,8	4,00	182	7,4	57	194

I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
109,85	309	0,213333	696	0,91	1179	87

c [mm]	c ₂ [mm]	c ₁ [mm]
130	PASS	90



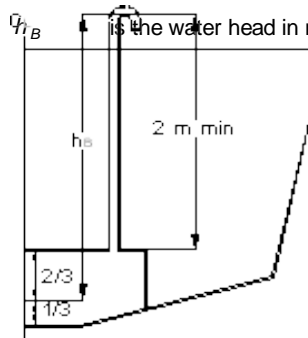
ADOPTED 'T' profile:			
W	130	×	6
F	50	×	8
	Z [cm ³]		A [cm ²]
adopted	6	87	194
required		82	6
	PASS		PASS

3. TANK TOP

2.1. TANK TOP DESIGN PRESSURE -Integral tank bulkheads and boundaries P_{TB}

$$P_{TB} = 10 h_B \quad [\text{kN/m}^2]$$

h_B is the water head in metres, measured as follows (see Figure 5):



for plating: the distance from a point 2/3 of the depth of the panel below top of tank or top of overflow, whichever is the greater.

$$t = \frac{P \times k_2}{100 \times \sigma_D}$$

The minimum required thickness of the plating t is:

[mm]

TANK TOP thickness PLATING:

Aluminium Alloy
EN AW-5083 0/H111

$\sigma_{yw} =$	125	[N/mm ²]
$\sigma_{utw} =$	270	[N/mm ²]

l [mm]	b [mm]	c [mm]	c/b	k_c	k_2	σ_D [N/mm ²]	h_B [m]	P_{TB} [kN/m ²]	t [mm]
1000	300	0	0	1,0	0,48	113	3,6	36,0	3,7
1000	300	0	0	1,0	0,48	113	3,6	36,0	3,7
1000	300	0	0	1,0	0,48	113	3,6	36,0	3,7
									4

TANK TOP Section Modul and Shear Area LONG STIFFENER (STRINGERS)

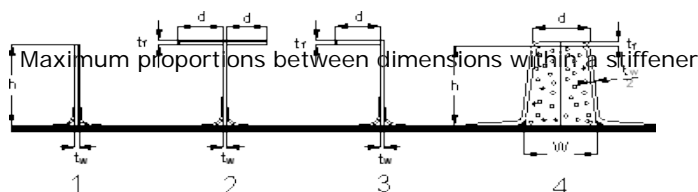
Aluminium Alloy EN AW-5083 0/H111

$$SM = \frac{83,33 \times k_{cs} \times P \times s \times l_u^2}{\sigma_D} \times 10^{-9}$$

σ_{yw} [N/mm ²]	σ_{utw} [N/mm ²]	σ_D [N/mm ²]	τ_D [N/mm ²]
125	270	88	50

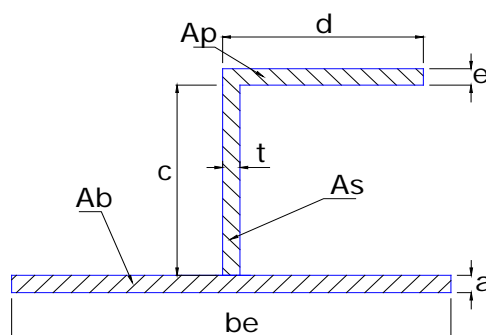
l_u [mm]	s [mm]	c [mm]	c/l	k_{cs}	k_{SA}	P_{b1} [kN/m ²]	SM [cm ³]	A_w [cm ²]
1000	300	0	0	1,0	5	36,0	10,3	1,08
1000	300	0	0	1,0	5	36,0	10,3	1,08
1000	300	0	0	1,0	5	36,0	10,3	1,08

a) The attached plating is 20 times both inner and outer skins, separated by the core, considered ineffective i.e. $E_{\text{eff}}=0$.



Material	I- and C-shaped stiffeners			Top Hat stiffeners	
	b / t_w and d / t_f if actual stress σ_d is at least 80% of respectively σ_d or σ_d given	$b / t_{w \max}$	$d / t_{f \max}$	$b / (t_w / 2)_{\max}$	$d / t_{f \max}$
FRP 35% fibres by mass	8	30	8	30	21
Aluminium	12	40	12	40	25
Steel	15	50	15	50	40
Carbon and or aramid laminate 0/90 40-50% fibre by mass	13	40	13	40	35
Plywood	10	40	10	40	25

t_p [mm]	b_e [mm]	c [mm]	t [mm]	t check
4,0	240	40	5	PASS
a [mm]	b_e [cm]	d [mm]	e [mm]	A_s [cm ²]
4,0	24,0	40	5	2
A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	$y_1 \times A_b$ [cm ³]	A [cm ²]
2	10	0	9	14
I_{As} [cm ⁴]	$y_2 \times A_s$ [cm ³]	I_{Ap} [cm ⁴]	$y_3 \times I_{Ap}$ [cm ³]	η [cm]
3	3	0	24	1



Adopted L profil_Bottom longitudinal stiffeners				
L profil		40	40	5
			SM [cm ³]	A [cm ²]
adopted			11	14
required	2		10	1
			PASS	PASS

Aluminium Alloy EN AW-5083 0/H111

EAMS :

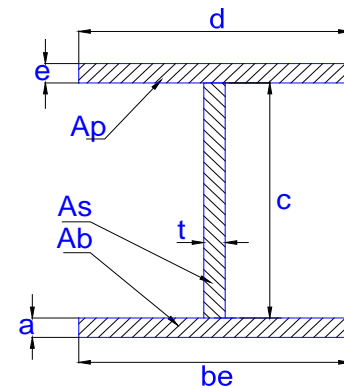
σ_{vw} [N/mm ²]	σ_{utw} [N/mm ²]	σ_D [N/mm ²]	τ_D [N/mm ²]
125	270	88	50

$SM = \frac{83,33 \times k_{cs} \times \frac{1}{\sigma_D} \times \frac{1}{\sigma_{utw}} \times \frac{1}{\sigma_D} \times \frac{1}{\tau_D} \times 10^{-6}}{10^{-6}}$

$$\sigma_{\text{Iutw}} = 270 \text{ [N/mm}^2\text{]}$$

I_u [mm]	s [mm]	c [mm]	c/I	k_{cs}	k_{SA}	P_{b1} [kN/m ²]	SM [cm ³]	A_W [cm ²]
2400	300	0	0	1,0	5	36,0	59,2	2,59
2400	300	0	0	1,0	5	36,0	59,2	2,59
2400	300	0	0	1,0	5	36,0	59,2	2,59

c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
110	6,0	PASS	4,0	182	50	8
A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]
PASS	6,6	4,00	73	1,0	74	83
I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η	I [cm ⁴]	SM [cm ³]
66,55	145	0,213333	449	1,21	736	67
c [mm]	c ₂ [mm]	c ₁ [mm]				
110	PASS	60				



ADOPTED 'T' profile:			
W	110	×	6
F	50	×	8
	Z	[cm ³]	
		A	
		[cm ²]	
adopted	11	67	83
required		59	3
	PASS	PASS	

4. WASH PLATE

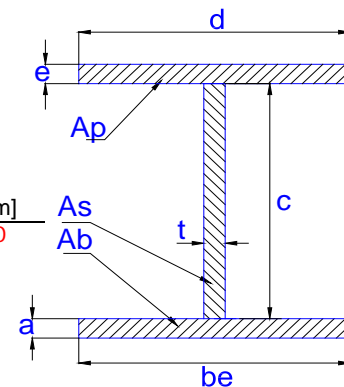
Tanks shall be subdivided as necessary by internal baffles or wash plates. Baffles or wash plates which support hull framing shall have scantlings equivalent to stiffeners located in the same position.

Wash plates and wash bulkheads shall in general, have an area of perforation not greater than 50 % of the total area of the bulkhead. The perforations shall be so arranged that the efficiency of the bulkheads as a support is not impaired.

The general stiffener requirement for both minimum section modulus and second moment of area may be 50 % of that required for stiffener members of integral tanks.

x [m]
As

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
11	600	4,0	NOT PASS	7,0	240	0	10
A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]	
PASS	24	0,00	168	6,9	2418	192	
I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η	I [cm ⁴]	SM [cm ³]	
7200	16926	0	0	4,14	26550	461	



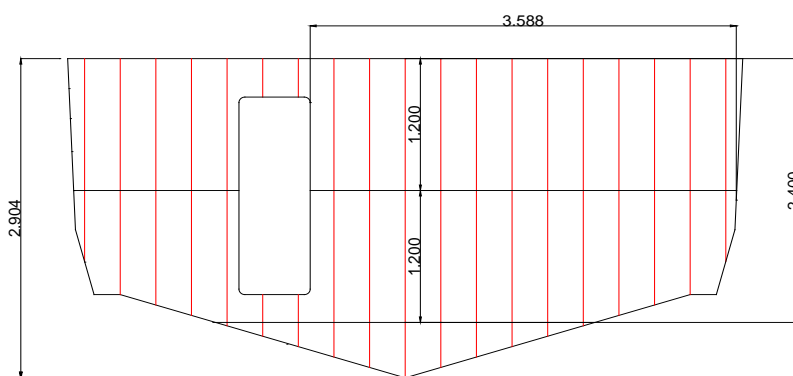
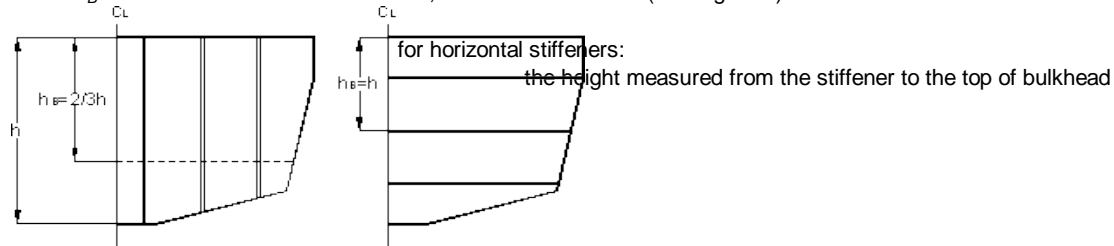
ADOPTED 'T' profile:			
W	600	×	4
F	0	×	10
	Z	[cm ³]	
		A	
		[cm ²]	
adopted	60	461	192
required		186	8
	PASS	PASS	

5. BULKHEADS

5.1. Watertight bulkheads pressure P_{WB}

$$P_{TB} = 7 h_B \quad [\text{kN/m}^2]$$

h_B is the water head in metres, measured as follows (see Figure 5):



The minimum required thickness of the plating t is:

$$t = b \times k_c \times \sqrt{\frac{P \times k_2}{\sigma_{yw}}}$$

[mm]

$$h = 2,904 \text{ [m]}$$

BULKHEAD thickness PLATING:

Aluminium Alloy
EN AW-5083 O/H111

$$\sigma_{yw} = 125 \text{ [N/mm}^2\text{]}$$

$$\sigma_{utw} = 270 \text{ [N/mm}^2\text{]}$$

l	b	c	c/b	k_c	k_2	σ_D	h_B	P_{TB}	t
[mm]	[mm]	[mm]				[N/mm ²]	[m]	[kN/m ²]	[mm]
1200	250	0	0	1,0	0,44	113	1,936	13,6	1,8
									5

BULKHEAD Section Modul and Shear Area HORIZ.STIFFENER :

Aluminium Alloy EN AW-5083 0/H111

$$A_W = \frac{k_{SA} \times P \times s \times \ell_w}{\tau_d} 10^{-6}$$

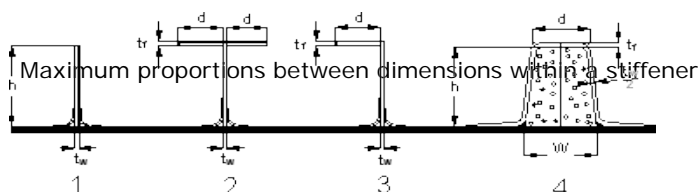
$$SM = \frac{83,33 \times k_{CS} \times P \times s \times \ell_w^2}{\sigma_d} 10^{-9}$$

σ_{vw} [N/mm ²]	σ_{utw} [N/mm ²]	σ_D [N/mm ²]	τ_D [N/mm ²]
125	270	88	50

I_u [mm]	s [mm]	c [mm]	c/I	k_{CS}	k_{SA}	P_{b1} [kN/m ²]	SM [cm ³]	A_W [cm ²]
1200	250	0	0	1,0	5	13,6	4,6	0,41

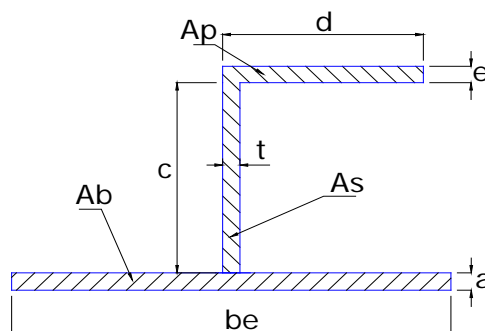
The effective extent of plating shall be calculated according to table, but shall not be taken greater than the actual stiffener spacing.

Material	Steel	Aluminium	FRP Single skin	FRP Sandwich	Wood plywood
	20 t	20 t	20 t, & 20 t, a	15 t	
a)	The attached plating is 20 times both inner and outer skins, separated by the core, considered ineffective i.e. $E_{core}=0$.				



Maximum values of h/t_w and d/t in actual stress σ_{act} or τ_{act} is	Flat hat	Top Hat	Top Hat	Top Hat	Top Hat
at least 80% of respectively σ_d or τ_d given	$h/t_w \max$	$d/t \max$	$h/(t_w/2) \max$	$d/t \max$	$d/t \max$
FRP 35% fibres by mass	8	30	8	30	21
Aluminium	12	40	12	40	25
Steel	15	50	15	50	40
Carbon and or aramid laminate 0/90 40-50% fibre by mass	13	40	13	40	35
Plywood	10	40	10	40	25

t_p [mm]	b_e [mm]	c [mm]	t [mm]	t check
5,0	250	30	5	PASS
a [mm]	b_e [cm]	d [mm]	e [mm]	A_s [cm ²]
5,0	25,0	30	5	2
A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	$y_1 \times A_b$ [cm ³]	A [cm ²]
2	13	0	3	16
I_{As} [cm ⁴]	$y_2 \times A_s$ [cm ³]	I_{Ap} [cm ⁴]	$y_3 \times I_{Ap}$ [cm ³]	η [cm]
1	2	0	13	1



Adopted L profil Bottom longitudinal stiffeners

L profil	30	30	5
SM [cm ³]			
A [cm ²]			
adopted	26	6	16
required		5	0
		PASS	PASS

BULKHEAD Section Modul and Shear Area WEB :

Aluminium Alloy EN AW-5083 0/H111

$$SM = \frac{83,33 \times k_{cs} \times \sigma_{yw}}{k_{SA} \times \sigma_{utw}} = \frac{83,33 \times 1,0 \times 125}{1,0 \times 270} = 38,5$$

σ_{yw} [N/mm ²]	σ_{utw} [N/mm ²]	σ_D [N/mm ²]	τ_D [N/mm ²]
125	270	88	50

$$\sigma_{yw} = 125 \text{ [N/mm}^2\text{]}$$

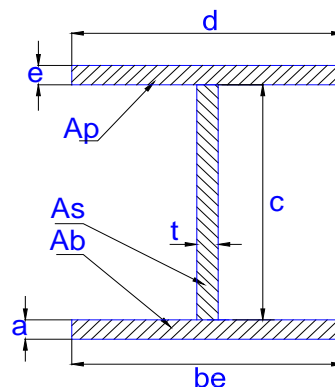
$$\sigma_{utw} = 270 \text{ [N/mm}^2\text{]}$$

I_u [mm ⁴]	s [mm]	c [mm]	c/I [cm]	k_{cs}	k_{SA}	P_{b1} [kN/m ²]	SM [cm ³]	A_w [cm ²]
3600	250	0	0	1,0	5	13,6	41,8	1,22

c [mm]	t [mm]	t check	a [mm]	b_e [cm]	d [mm]	e [mm]
90	5,0	PASS	6,0	250	40	8
A_p check	A_s [cm ²]	A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	$y_1 \times A_b$ [cm ³]	A [cm ²]
PASS	4,5	3,20	150	4,5	17	158

I_{As} [cm ⁴]	$y_2 \times A_s$ [cm ³]	I_{Ap} [cm ⁴]	$y_3 \times I_{Ap}$ [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
30,375	90	0,170667	281	0,63	422	43

c [mm]	c ₂ [mm]	c ₁ [mm]
90	PASS	60



ADOPTED 'T' profile:			
W	90	x	5
F	40	x	8
	Z [cm ³]		A [cm ²]
adopted	3	43	158
required		42	1
	PASS		PASS

1. DIMENSIONS AND DATA

Symbo	Unit	Designation/Meaning of symbol	Value	
L_{WL}	[m]	Length of waterline	21,92	
L_H	[m]	Length of the hull	23,07	
B_H	[m]	Beam of the hull	5,70	
B_{WL}	[m]	Waterline beam	5,34	
B_C	[m]	Chine beam, supporting width	5,25	
T_C	[m]	Design waterline for a specific loading condition	1,13	
m_{LD}	[kg]	Displacement mass	55000	
C_B		- totalni koeficijent punoće $C_B = \frac{\Delta}{1,025 \cdot L \cdot B_w \cdot T}$	0,385	
V	[knots]	Maximum speed for a given displacement	26	13,4
$\beta_{0.4}$	[°]	Deadrise angle	13,61	
τ	[°]	Running trim angle	4	4
		Design category of Craft	A	
k_{DC}		Design category for acceleration	1	
$\frac{V}{\sqrt{L_{WL}}} =$			5,553	

3. SIDE**3.1. SIDE DESIGN PRESSURE**

$$P_{SMP} = \{P_{DM \text{ BASE}} + k_Z \times (P_{BDM \text{ BASE}} - P_{DM \text{ BASE}})\} \times k_{AR} \times k_{DC} \times k_L \text{ or } [kN/m^2]$$

$$P_{SMP \text{ MIN}} = 0,9 \times L_{WL} \times k_{DC} [kN/m^2]$$

$$P_{DM \text{ BASE}} = 0,35 L_{WL} + 14,6 [kN/m^2]$$

$$P_{BDM \text{ BASE}} = 2,4 m_{LDC}^{0,33} + 20$$

k_Z hull side pressure reduction factor

$$k_Z = \frac{Z - h}{Z}$$

Z is the height of top of hull or hull /deck limit above the fully loaded waterline

h is the height of centre of panel or middle of stiffener above the fully loaded

k_{DC} - design category factor

Design Category	A	B	C	D
Value of k_{DC}	1	0,8	0,6	0,4

n_{CG} - the dynamic factor

$$n_{CG} = 0,32 \left(\frac{L_{WL}}{10 \cdot B_C} + 0,084 \right) \times (50 - \beta_{0,4}) \times \frac{V^2 \times B_C^2}{m_{LDC}} [g]$$

$$n_{CG} = \frac{0,5 \times V}{m_{LDC}^{0,17}} [g]$$

k_L - longitudinal impact distribution factor

$$k_L = \frac{1 - 0,167 \times n_{CG}}{0,6} \frac{x}{L_{WL}} + 0,167 \times n_{CG} \quad \frac{x}{L_{WL}} \leq 0,6$$

$$k_L = 1 \quad \frac{x}{L_{WL}} > 0,6$$

n_{CG} - determined according to 7.3 but for the purpose of determination of, k_L shall not be taken less than 3.

x - the longitudinal position of centre of the panel or middle of stiffener forward of aft end of LWL in mLDC conditions

k_{AR} - Area pressure distribution factor $k_{AR} = \frac{k_R \cdot 0,1 \cdot m_{LDC}^{0,15}}{A_D^{0,3}}$

k_R - the structural component and boat type factor

$A_D = (l \times b) \times 10^{-6}$ for plating, but shall not be taken greater than $2,5 \times b^2 \times 10^{-6}$

$A_D = (l_u \times s) \times 10^{-6}$ for stiffeners but need not be taken less than $0,33 \times l_u^2 \times 10^{-6}$

b - the shorter dimension of the plate panel

l - the longer dimension of the plate panel

s - the stiffener spacing

l_u - is the unsupported span of a stiffener

k_{AR} shall not be taken greater than 1

3.2. SIDE PLATING

Material	Structural element	design stress • σ_d N/mm ²
Aluminium alloys	All elements	$0,6 \cdot \sigma_{utw}^a$ or $0,9 \cdot \sigma_{yw}$
Steel	All elements	$0,6 \cdot \sigma_{ut}^a$ or $0,9 \cdot \sigma_y$

^a The lesser value applies.

for steel σ_y is the minimum tensile yield strength [N/mm²]

σ_{ut} is the minimum ultimate tensile strength [N/mm²]

for welded aluminium

σ_{yw} is the minimum tensile yield strength, welded condition [N/mm²]

σ_{utw} the minimum ultimate tensile strength, welded condition [N/mm²]

For aluminium adhesively bonded or mechanically fastened on and out are in unwelded state

$$\sigma_{yw} = 125 \text{ [N/mm}^2\text{]}$$

$$\sigma_{utw} = 270 \text{ [N/mm}^2\text{]}$$

The thickness of metal required by the following do not take into account any corrosion margin or the effect of fabrication techniques. Coating are considered to be used where needed.

The minimum required thickness of the plating t is: $t = b \times k_c \times \sqrt{\frac{P \times k_2}{1000 \times \sigma_d}}$ [mm]

Panel aspect ratio l/b	Factor k_2 k_2 to be taken = 0,5 for laminated wood plating	Factor k_3
> 2,0	0,500	0,028
2,0	0,497	0,028
1,9	0,493	0,027
1,8	0,487	0,027
1,7	0,479	0,026
1,6	0,468	0,025
1,5	0,454	0,024
1,4	0,436	0,023
1,3	0,412	0,021
1,2	0,383	0,019
1,1	0,349	0,016
1,0	0,308	0,014
	k_2 can be approximated by the formula below, keeping $0,308 < k_2 < 0,5$	k_3 can be approximated by the formula below, keeping $0,014 < k_3 < 0,028$
	$k_2 = \frac{0,271(l/b)^2 + 0,910(l/b) - 0,554}{(l/b)^2 - 0,313(l/b) + 1,351}$	$k_3 = \frac{0,027(l/b)^2 - 0,029(l/b) + 0,011}{(l/b)^2 - 1,463(l/b) + 1,108}$

3. 3. SIDE STIFFENER

The web area A_W and minimum section modulus S_M of stiffening members including the effective plating of the stiffening members shall be not less than given by the following equation:

$$A_W = \frac{k_{SA} \times P \times s \times l_u}{\tau_d} 10^{-6} \text{ [cm}^2\text{]}$$

$$S_M = \frac{83,33 \times k_{CS} \times P \times s \times l_u^2}{\sigma_d} 10^{-9} \text{ [cm}^3\text{]}$$

k_{CS} the curvature factor for stiffeners given in Table 16
,applies to convex or concave stiffeners, it shall not be taken less than 0,5
not greater than 1.

k_{SA} the stiffener shear area factor given in Table 17

Stiffener arrangements	k_{SA}
Attached to the plating	5
Other arrangements (floating)	7,5

s the spacing of stiffeners

 l_u the length of the stiffener σ_D Design stresses for stiffening members

Material	Tensile and compressive design stress σ_d N/mm ²	Design shear stress τ_d N/mm ²
FRP	$0,5 \sigma_{ut}$ and $0,5 \sigma_{uc}$ ^{a)}	$0,5 \tau_u$
Aluminium alloys	$0,7 \sigma_{yw}$ ^{b)}	$0,4 \sigma_{yw}$ ^{b)}
Steel	$0,8 \sigma_y$	$0,45 \sigma_y$
Laminated wooden frames ^c	$0,45 \sigma_{uc}$ ^{b)}	$0,45 \tau_u$
Solid stock wooden frames ^c	$0,4 \sigma_{uf}$ ^{b)}	$0,4 \tau_u$
Plywood on edge frames	$0,45 \sigma_{uf}$ ^{b)}	$0,45 \tau_u$
a σ_c considered where stressed in compression (usually the stiffener top flange) and σ_t considered where stressed in tension (usually the plating), both verifications need to be calculated b for welded stiffeners. If aluminium stiffeners are not welded, i.e. riveted, glued, etc., the non welded properties shall be used c σ_{uc} for laminated wooden frames and σ_{uf} for solid stock shall be taken from Table E1, for plywood, σ_{uf} shall not be taken from Table E2 but from Table E3 or E6		

SIDE pressure PLATING:

$$k_L = \frac{1 - 0,167 \times n_{CG}}{0,6} \frac{x}{L_{WL}} + 0,167 \times n_{CG}$$

PLATE :

L_{WL} [m]	B_C [m]	β [°]	V [knots]	m_{LDC} [kg]	k_{DC}	n_{cg} [g]	$n_{cg \max}$ [g]	n_{cg} [g]	n_{cg} [g]
21,92	5,25	13,61	26	55000	1	1,98	2,033	1,979	3

Area	x [m]	x/ L_{WL}	k_L	l [mm]	b [mm]	A_d [m ²]	k_R [m ²]	k_{ar}
1	0	0	0,330	1000	300	0,225	1	0,804
5	13,4	0,6121	1,000	1000	300	0,225	1	0,804
6	16	0,7298	1,000	1000	300	0,225	1	0,804

x [m]	z [m]	h [m]	k _z	P _{BMD BASE} [kN/m ²]	P _{DM BASE} [kN/m ²]	P _{SMP MIN} [kN/m ²]	P _{SMP} [kN/m ²]
0	1,9	0	1,000	108	22,27	19,73	28,71
	1,9	0,7	0,632	108	22,27	19,73	20,31
	1,9	1,6	0,158	108	22,27	19,73	19,73
13,42	1,9	0	1,000	108	22,27	19,73	86,87
	1,9	0,7	0,632	108	22,27	19,73	61,46
	1,9	1,6	0,158	108	22,27	19,73	28,80
16	1,9	0	1,000	108	22,27	19,73	86,87
	1,9	0,7	0,632	108	22,27	19,73	61,46
	1,9	1,6	0,158	108	22,27	19,73	28,80

SIDE thickness PLATING:

Aluminium Alloy
EN AW-5083 0/H111

$\sigma_{yw} =$	125	[N/mm ²]
$\sigma_{utw} =$	270	[N/mm ²]

	x [m]	l [mm]	b [mm]	c [mm]	c/b	k _c	k ₂	σ_D [N/mm ²]	P _{b1} [kN/m ²]	t [mm]
chine	0	1000	225	0	0	1,0	0,449	113	28,7	2,4
mid pl.		1000	330	0	0	1,0	0,490	113	20,3	3,1
up pl.		1000	270	0	0	1,0	0,470	113	19,7	2,5
chine	13,4	1000	210	0	0	1,0	0,440	113	86,9	3,9
mid pl.		1000	330	0	0	1,0	0,490	113	61,5	5,4
up pl.		1000	270	0	0	1,0	0,470	113	28,8	3,0
chine	16	1000	185	0	0	1,0	0,425	113	86,9	3,4
mid pl.		1000	330	0	0	1,0	0,490	113	61,5	5,4
up pl.		1000	270	0	0	1,0	0,470	113	28,8	3,0
										5,5

SIDE pressure STIFFNER:**PLATE :**

L _{WL} [m]	B _C [m]	β [°]	V [knots]	m _{LDC} [kg]	k _{DC}	n _{cg} [g]	n _{cg max} [g]	n _{cg} [g]	n _{cg} [g]
21,92	5,25	13,61	26	55000	1	1,98	2,033	1,979	3

Area	x [m]	x/L _{WL}	k _L	I _u [mm]	s [mm]	A _d [m ²]	k _R [m ²]	k _{ar}
1	1,6	0,073	0,391	1000	225	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717
1	3,6	0,1642	0,467	1000	225	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717
1	6,7	0,3056	0,585	1000	225	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717
1	9,6	0,4379	0,695	1000	225	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717
1	12,6	0,5747	0,808	1000	220	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717
5	13,4	0,6121	1,000	1000	210	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717
6	16	0,7298	1,000	1000	185	0,33	1	0,717
				1000	270	0,33	1	0,717
				1000	270	0,33	1	0,717

	x [m]	Z [m]	h [m]	k _Z	P _{BMD BASE} [kN/m ²]	P _{DM BASE} [kN/m ²]	P _{SMP MIN} [kN/m ²]	P _{SMP} [kN/m ²]
chine	1,6	1,985	0	1,000	108	22,27	19,73	30,29
mid pl.		1,985	0,7	0,647	108	22,27	19,73	21,81
up pl.		1,985	1,6	0,194	108	22,27	19,73	19,73
chine	3,6	1,985	0	1,000	108	22,27	19,73	36,17
mid pl.		1,985	0,7	0,647	108	22,27	19,73	26,04
up pl.		1,985	1,6	0,194	108	22,27	19,73	19,73
chine	6,7	1,985	0	1,000	108	22,27	19,73	45,27
mid pl.		1,985	0,7	0,647	108	22,27	19,73	32,60
up pl.		1,985	1,6	0,194	108	22,27	19,73	19,73
chine	9,6	1,985	0	1,000	108	22,27	19,73	53,79
mid pl.		1,985	0,7	0,647	108	22,27	19,73	38,73
up pl.		1,985	1,6	0,194	108	22,27	19,73	19,73
chine	12,6	1,985	0	1,000	108	22,27	19,73	62,60
mid pl.		1,985	0,7	0,647	108	22,27	19,73	32,60
up pl.		1,985	1,6	0,194	108	22,27	19,73	19,73
chine	13,4	1,985	0	1,000	108	22,27	19,73	77,44
mid pl.		1,985	0,7	0,647	108	22,27	19,73	55,76
up pl.		1,985	1,6	0,194	108	22,27	19,73	27,89
chine	16	1,985	0	1,000	108	22,27	19,73	77,44
mid pl.		1,985	0,7	0,647	108	22,27	19,73	55,76
up pl.		1,985	1,6	0,194	108	22,27	19,73	27,89

SIDE Section Modul and Shear Area STIFFENER:

Aluminium Alloy EN AW-5083 0/H111

$$\sigma_{yw} = 125 \text{ [N/mm}^2\text{]}$$

$$\sigma_{utw} = 270 \text{ [N/mm}^2\text{]}$$

$$A_W = \frac{k_{SA} \times P \times s \times \ell_u}{\tau_d} 10^{-6} \text{ [cm}^2\text{]}$$

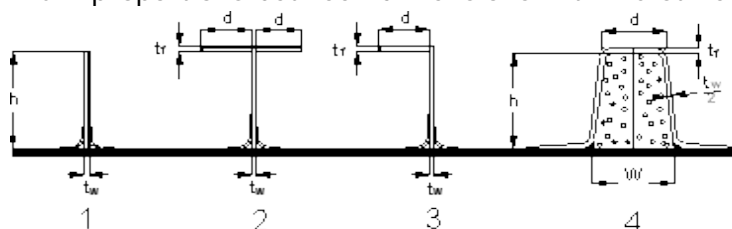
$$SM = \frac{83,33 \times k_{CS} \times P \times s \times \ell_u^2}{\sigma_d} 10^{-9} \text{ [cm}^3\text{]}$$

x [m]	I _u [mm]	s [mm]	c/l	k _{CS}	k _{SA}	σ _D [N/mm ²]	τ _D [N/mm ²]	P _{b1} [kN/m ²]	SM [cm ³]	A _W [cm ²]	c [mm]
1,6	1000	225	0	1,0	5	88	50	30,3	6,5	0,68	0
	1000	270	0	1,0	5	88	50	21,8	5,6	0,59	0
	1000	270	0	1,0	5	88	50	19,7	5,1	0,53	0
3,6	1000	225	0	1,0	5	88	50	36,2	7,7	0,81	0
	1000	270	0	1,0	5	88	50	26,0	6,7	0,70	0
	1000	270	0	1,0	5	88	50	19,7	5,1	0,53	0
6,7	1000	225	0	1,0	5	88	50	45,3	9,7	1,02	0
	1000	270	0	1,0	5	88	50	32,6	8,4	0,88	0
	1000	270	0	1,0	5	88	50	19,7	5,1	0,53	0
9,6	1000	225	0	1,0	5	88	50	53,8	11,5	1,21	0
	1000	270	0	1,0	5	88	50	38,7	10,0	1,05	0
	1000	270	0	1,0	5	88	50	19,7	5,1	0,53	0
12,6	1000	225	0	1,0	5	88	50	62,6	13,4	1,41	0
	1000	270	0	1,0	5	88	50	32,6	8,4	0,88	0
	1000	270	0	1,0	5	88	50	19,7	5,1	0,53	0
13,42	1000	210	0	1,0	5	88	50	77,4	15,5	1,63	0
	1000	270	0	1,0	5	88	50	55,8	14,3	1,51	0
	1000	270	0	1,0	5	88	50	27,9	7,2	0,75	0
16	1000	185	0	1,0	5	88	50	77,4	13,6	1,43	0
	1000	270	0	1,0	5	88	50	55,8	14,3	1,51	0
	1000	270	0	1,0	5	88	50	27,9	7,2	0,75	0

The effective extent of plating be shall be calculated according to Table, but shall not be taken greater than the actual stiffener spacing.

Material	Steel	Aluminium	FRP Single skin	FRP Sandwich	Wood, plywood,
h_e	80 t	60 t	20 t	20 t _a & 20 t _b	15 t
a) The attached plating is 20 times both inner and outer skins, separated by the core, considered ineffective i.e. $E_{core}=0$.					

Maximum proportions between dimensions within a stiffener



Maximum values of h / t_w and d / t_f if actual stress σ_{act} or τ_{act} is at least 80% of respectively σ_d or τ_d given

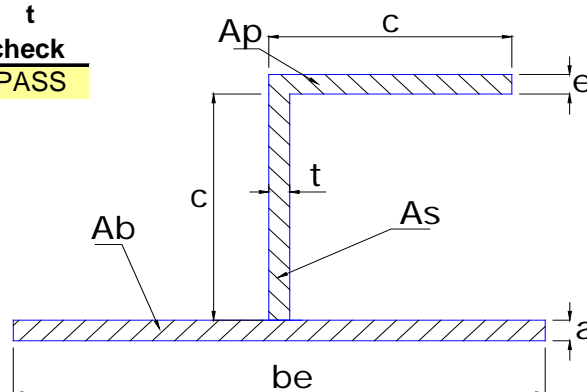
Type of profile	Flat bat.	T or L shaped stiffeners		Top Hat stiffeners	
Material	$h / t_w \max$	$h / t_w \max$	$d / t_f \max$	$h / (t_w / 2) \max$	$d / t_f \max$
GFRP 35% fibres by mass	8	30	8	30	21
Aluminium	12	40	12	40	25
Steel	15	50	15	50	40
Carbon and or aramid laminate 0/90 40-50% fibre by mass	13	40	13	40	35
Plywood	10	40	10	40	25

Area	t_p	b_e	c	t	t
	[mm]	[mm]	[mm]	[mm]	check
chine	6,0	225	50	5	PASS

a	b_e	d	e	A_s
[mm]	[cm]	[mm]	[mm]	[cm ²]
6,0	22,5	50	5	3

A_p	A_b	I_{Ab}	$y_1 \times A_b$	A
[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]
3	14	0	17	19

I_{As}	$y_2 \times A_s$	I_{Ap}	$y_3 \times I_{Ap}$	η	I	Z
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]
5	7	0	49	1	79	17



Adopted L profil_Bottom longitudinal stiffeners

L profil	50	50	5
	Z	A	
	[cm ³]	[cm ²]	
adopted	8	17	19
required		15	1
	PASS	PASS	

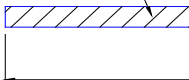
Area	t_p	b_e	c	t	t
	[mm]	[mm]	[mm]	[mm]	check
mid pl.	6,0	360	50	5	PASS

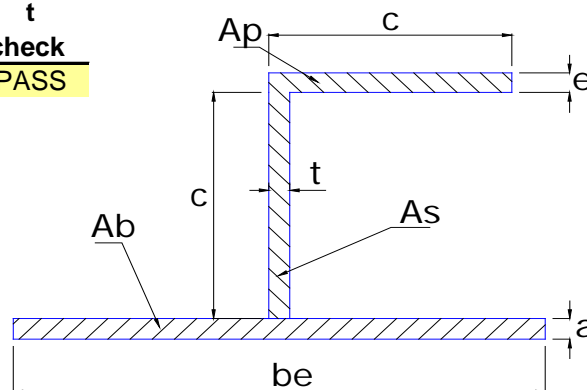
a	b_e	d	e	A_s
[mm]	[cm]	[mm]	[mm]	[cm ²]
6,0	36,0	50	5	3

A_p	A_b	I_{Ab}	$y_1 \times A_b$	A
[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]
3	22	1	13	27

I_{As}	$y_2 \times A_s$	I_{Ap}	$y_3 \times I_{Ap}$	η	I	Z
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]
5	10	0	57	1	86	17

Ab





Adopted L profil_Bottom longitudinal stiffeners

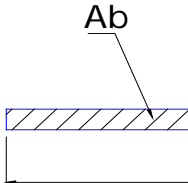
L profil	50	50	5
	Z		A
	[cm ³]		[cm ²]
adopted	17	17	27
required		14	0
	PASS		PASS

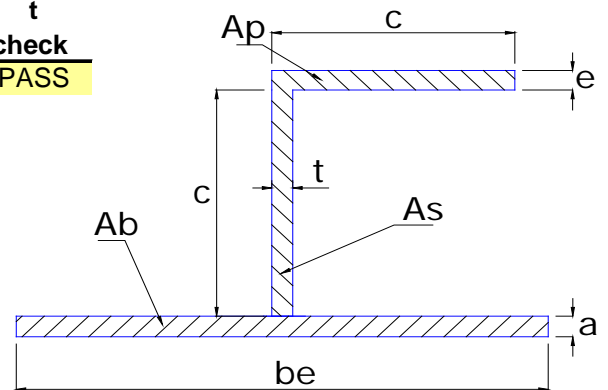
Area	t_p	b_e	c	t	
	[mm]	[mm]	[mm]	[mm]	check
up pl.	6,0	360	40	4	PASS

a	b_e	d	e	A_s	
[mm]	[cm]	[mm]	[mm]	[cm ²]	
6,0	36,0	40	4	2	

A_p	A_b	I_{Ab}	$y_1 \times A_b$	A	
[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]	
2	22	1	4	25	

I_{As}	$y_2 \times A_s$	I_{Ap}	$y_3 \times I_{Ap}$	η	I	Z
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]
2	6	0	26	1	39	9





Adopted L profil_Bottom longitudinal stiffeners

L profil	40	40	4
	Z		A
	[cm ³]		[cm ²]
adopted	21	9	25
required		7	1
	PASS		PASS

Bottom Section Modul and Shear Area Web FRAMES :

Aluminium Alloy EN AW-5083 O/H111

$$\sigma_{yw} = 125 \text{ [N/mm}^2\text{]}$$

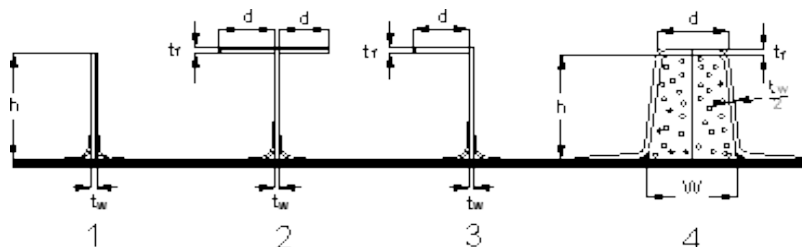
$$\sigma_{utw} = 270 \text{ [N/mm}^2\text{]}$$

x [m]	I _u [mm]	s [mm]	c/I	k _{CS}	k _{SA}	σ_D [N/mm ²]	τ_D [N/mm ²]	P _{b1} [kN/m ²]	SM [cm ³]	A _w [cm ²]	c [mm]
1,6	2000	310	0	1,0	5	88	50	30,3	35,8	1,88	0
	2000	330	0	1,0	5	88	50	21,8	27,4	1,44	0
	2000	240	0	1,0	5	88	50	19,7	18,0	0,95	0
3,6	2000	310	0	1,0	5	88	50	36,2	42,7	2,24	0
	2000	330	0	1,0	5	88	50	26,0	32,7	1,72	0
	2000	240	0	1,0	5	88	50	19,7	18,0	0,95	0
6,7	2000	310	0	1,0	5	88	50	45,3	53,5	2,81	0
	2000	330	0	1,0	5	88	50	32,6	41,0	2,15	0
	2000	240	0	1,0	5	88	50	19,7	18,0	0,95	0
9,6	2000	310	0	1,0	5	88	50	53,8	63,5	3,34	0
	2000	330	0	1,0	5	88	50	38,7	48,7	2,56	0
	2000	240	0	1,0	5	88	50	19,7	18,0	0,95	0
12,6	2000	310	0	1,0	5	88	50	62,6	73,9	3,88	0
	2000	330	0	1,0	5	88	50	32,6	41,0	2,15	0
	2000	240	0	1,0	5	88	50	19,7	18,0	0,95	0
13,42	2000	310	0	1,0	5	88	50	77,4	91,4	4,80	0
	2000	330	0	1,0	5	88	50	55,8	70,1	3,68	0
	2000	240	0	1,0	5	88	50	27,9	25,5	1,34	0
16	2000	310	0	1,0	5	88	50	77,4	91,4	4,80	0
	2000	330	0	1,0	5	88	50	55,8	70,1	3,68	0
	2000	240	0	1,0	5	88	50	27,9	25,5	1,34	0

The effective extent of plating be shall be calculated according to Table, but shall not be taken greater than the actual stiffener spacing.

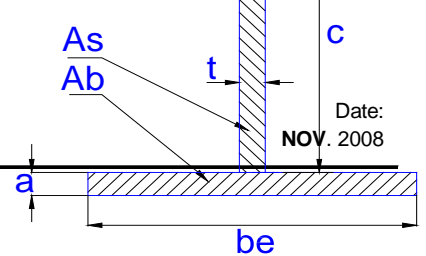
Material	Steel	Aluminium	FRP Single skin	FRP Sandwich	Wood , plywood,
b_p	80 t	60 t	20 t	20 t _a & 20 t _i a	15 t
a) The attached plating is 20 times both inner and outer skins, separated by the core, considered ineffective i.e $E_{core}=0$.					

Maximum proportions between dimensions within a stiffener



Maximum values of h / t_w and d / t_f if actual stress σ_{act} or τ_{act} is at least 80% of respectively σ_d or τ_d given

Type of profile	Flat bar	T or L shaped stiffeners		Top Hat stiffeners	
Material	$h / t_w \max$	$h / t_w \max$	$d / t_f \max$	$h / (t_w / 2) \max$	$d / t_f \max$
GRP 35% fibres by mass	8	30	8	30	21
Aluminium	12	40	12	40	25
Steel	15	50	15	50	40
Carbon and or aramid laminate 0/90 40-50% fibre by mass	13	40	13	40	35
Plywood	10	40	10	40	25

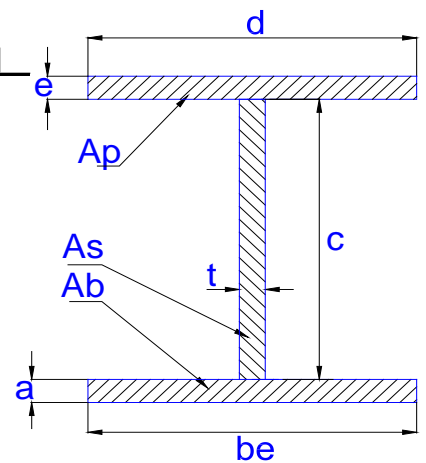


c	c ₂	c ₁
[mm]	[mm]	[mm]
90	PASS	60

ADOPTED 'T' profile:			
W	90	x	5
F	40	x	7
	Z		A
	[cm ³]		[cm ²]
adopted	54	40	151
required		18	1
	PASS		PASS

x
[m]
9,6

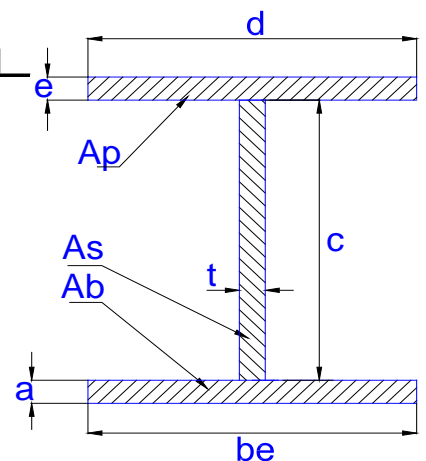
Area	c	t	t	a	b _e	d	e
	[mm]	[mm]	check	[mm]	[cm]	[mm]	[mm]
chine	120	5,0	PASS	6,0	300	50	7
A _p	A _s	A _p	A _b	I _{Ab}	y ₁ ×A _b	A	
check	[cm ²]	[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]	
PASS	6	3,50	180	5,4	34	190	
I _{As}	y ₂ ×A _s	I _{Ap}	y ₃ ×I _{Ap}	η	I	SM	
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]	
72	207	0,142917	522	0,73	840	67	



c	c ₂	c ₁
[mm]	[mm]	[mm]
120	PASS	80

ADOPTED 'T' profile:			
W	120	x	5
F	50	x	7
	Z		A
	[cm ³]		[cm ²]
adopted	5	67	190
required		64	3
	PASS		PASS

Area	c	t	t	a	b _e	d	e
	[mm]	[mm]	check	[mm]	[cm]	[mm]	[mm]
mid pl.	120	5,0	PASS	6,0	300	50	7
A _p	A _s	A _p	A _b	I _{Ab}	y ₁ ×A _b	A	
check	[cm ²]	[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]	
PASS	6	3,50	180	5,4	34	190	
I _{As}	y ₂ ×A _s	I _{Ap}	y ₃ ×I _{Ap}	η	I	SM	
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]	
72	207	0,142917	522	0,73	840	67	



c	c ₂	c ₁
[mm]	[mm]	[mm]
120	PASS	80

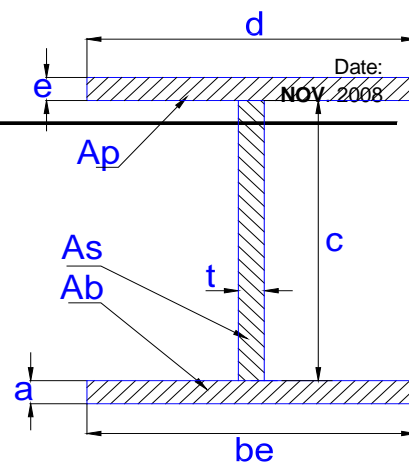
ADOPTED 'T' profile:			
W	120	x	5
F	50	x	7

Project:
1035

STRUCTURE CALCULATION Side

Date:
NOV 2008

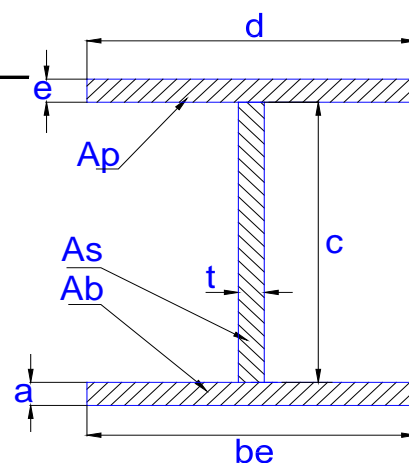
A_p check	A_s [cm ²]	A_p [cm ²]	A_b [cm ²]	I_{Ab} [cm ⁴]	$y_1 \times A_b$ [cm ³]	A [cm ²]
PASS	6	4,20	144	4,3	35	154
I_{As} [cm ⁴]	$y_2 \times A_s$ [cm ³]	I_{Ap} [cm ⁴]	$y_3 \times I_{Ap}$ [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]
50	138	0,1715	433	0,80	661	63
c [mm]	c_2 [mm]	c_1 [mm]				
100	PASS	60				



ADOPTED 'T' profile:			
W	100	x	6
F	60	x	7
	Z	A	
	[cm ³]	[cm ²]	
adopted	60	63	154
required		26	1
	PASS	PASS	

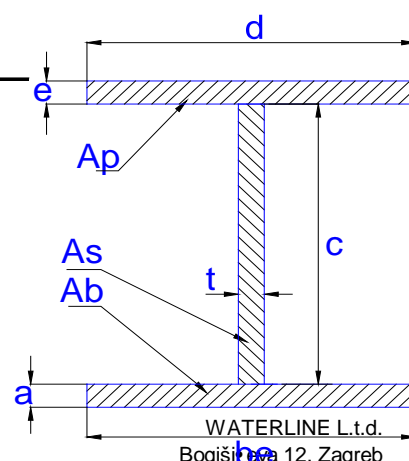
x [m]
16

Area	c [mm]	t [mm]	t check	a [mm]	b _e [cm]	d [mm]	e [mm]
chine	140	6,0	PASS	6,0	310	60	7
A _p check	A _s [cm ²]	A _p [cm ²]	A _b [cm ²]	I _{Ab} [cm ⁴]	y ₁ ×A _b [cm ³]	A [cm ²]	
PASS	8,4	4,20	186	5,6	71	199	
I _{As} [cm ⁴]	y ₂ ×A _s [cm ³]	I _{Ap} [cm ⁴]	y ₃ ×I _{Ap} [cm ³]	η [cm]	I [cm ⁴]	SM [cm ³]	
137,2	375	0,1715	827	0,92	1416	98	
c [mm]	c ₂ [mm]	c ₁ [mm]					
140	PASS	80					



ADOPTED 'T' profile:			
W	140	x	6
F	60	x	7
	Z	A	
	[cm ³]	[cm ²]	
adopted	7	98	199
required		91	5
	PASS	PASS	

Area	c	t	t	a	b _e	d	e
	[mm]	[mm]	check	[mm]	[cm]	[mm]	[mm]
mid pl.	120	6,0	PASS	6,0	330	60	7
A _p	A _s	A _p	A _b	I _{Ab}	y ₁ ×A _b	A	
check	[cm ²]	[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]	
PASS	7,2	4,20	198	5,9	44	209	
I _{As}	y ₂ ×A _s	I _{Ap}	y ₃ ×I _{Ap}	η	I	SM	
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]	



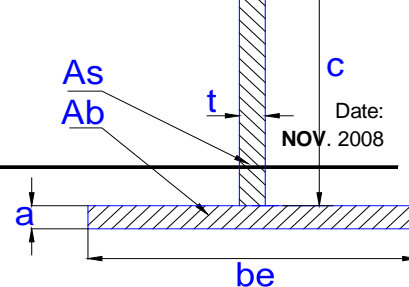
Project:
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STRUCTURE CALCULATION Side

Date:
NOV. 2008

86,4 245 0,1715 623 0,77 1004 80

c	c ₂	c ₁
[mm]	[mm]	[mm]
120	PASS	80



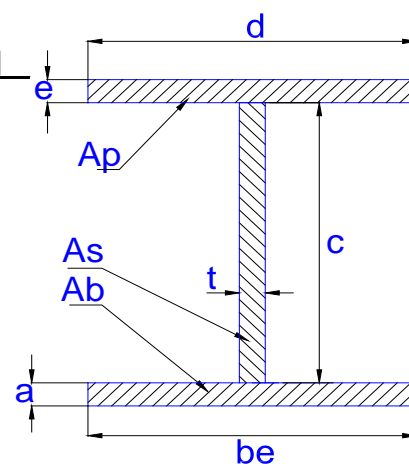
ADOPTED 'T' profile:			
W	120	x	6
F	60	x	7
	Z		A
	[cm ³]		[cm ²]
adopted	13	80	209
required		70	4
	PASS		PASS

Area	c	t	t	a	b _e	d	e
	[mm]	[mm]	check	[mm]	[cm]	[mm]	[mm]
up pl.	100	6,0	PASS	6,0	240	60	7

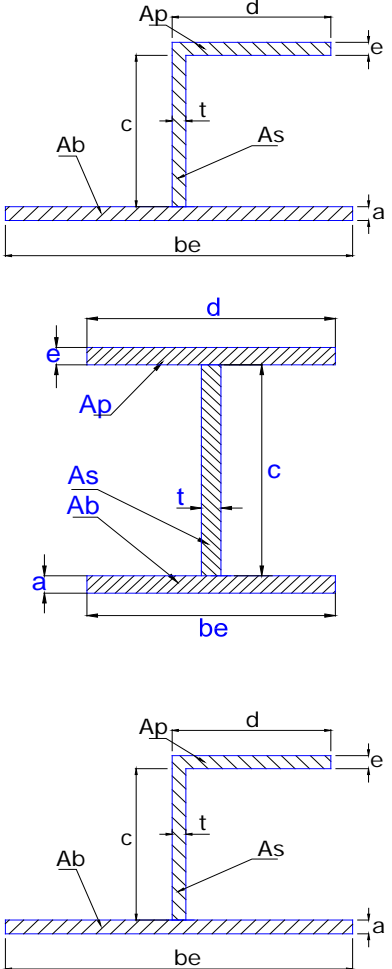
A _p	A _s	A _p	A _b	I _{Ab}	y ₁ x A _b	A
check	[cm ²]	[cm ²]	[cm ²]	[cm ⁴]	[cm ³]	[cm ²]
PASS	6	4,20	144	4,3	35	154

I _{As}	y ₂ x A _s	I _{Ap}	y ₃ x I _{Ap}	η	I	SM
[cm ⁴]	[cm ³]	[cm ⁴]	[cm ³]	[cm]	[cm ⁴]	[cm ³]
50	138	0,1715	433	0,80	661	63

c	c ₂	c ₁
[mm]	[mm]	[mm]
100	PASS	60



ADOPTED 'T' profile:			
W	100	x	6
F	60	x	7
	Z		A
	[cm ³]		[cm ²]
adopted	60	63	154
required		26	1
	PASS		PASS

AREA	STRUCTURE ELEMENT	PROFIL TYPE	X (m)		DIMENSIONS				Required Z (mm ³)	Addopted Z (mm ³)	Addopted Z (mm ³)	
					c (mm)	t (mm)	d (mm)	e (mm)				
BOTTOM	Plate				7							
	Stringers	L			70	6	70	6	34	39	PASS	
	Floor-Central Floor-Side	T	0	1	150	5	50	7	82	92	PASS	
		T	0	1	130	6	40	7	36	72	PASS	
		T	1,7	2	160	5	50	7	92	100	PASS	
		T	1,7	2	130	5	40	7	41	66	PASS	
		T	3,4	3	170	5	50	7	103	108	PASS	
		T	3,4	3	130	5	40	7	46	66	PASS	
		T	4,7	4	170	7	50	10	133	152	PASS	
		T	4,7	4	200	7	70	10	55	232	PASS	
		T	5,8	5	200	6	60	7	140	164	PASS	
		T	5,8	5	130	5	40	7	58	66	PASS	
		T	6,8	6	200	6	60	7	148	165	PASS	
		T	6,8	6	130	5	40	7	62	66	PASS	
		T	7,8	7	200	6	60	7	156	164	PASS	
		T	7,8	7	130	5	40	7	65	66	PASS	
		T	9,7	8	220	6	60	7	170	188	PASS	
		T	9,7	8	130	5	50	7	71	75	PASS	
		T	10,7	9	220	6	60	7	177	188	PASS	
		T	10,7	9	130	6	50	7	74	80	PASS	
		T	11,9	10	230	6	60	7	186	202	PASS	
		T	11,9	10	130	6	50	7	78	80	PASS	
		T	12,9	11	220	6	60	7	178	188	PASS	
		T	12,9	11	140	6	50	7	81	89	PASS	
		T	13,8	12	210	6	60	7	173	176	PASS	
		T	13,8	12	140	6	60	7	82	99	PASS	
		T	15	13	200	6	60	7	150	164	PASS	
		T	15	13	140	6	50	7	82	89	PASS	
		T	16,2	14	180	6	60	7	137	140	PASS	

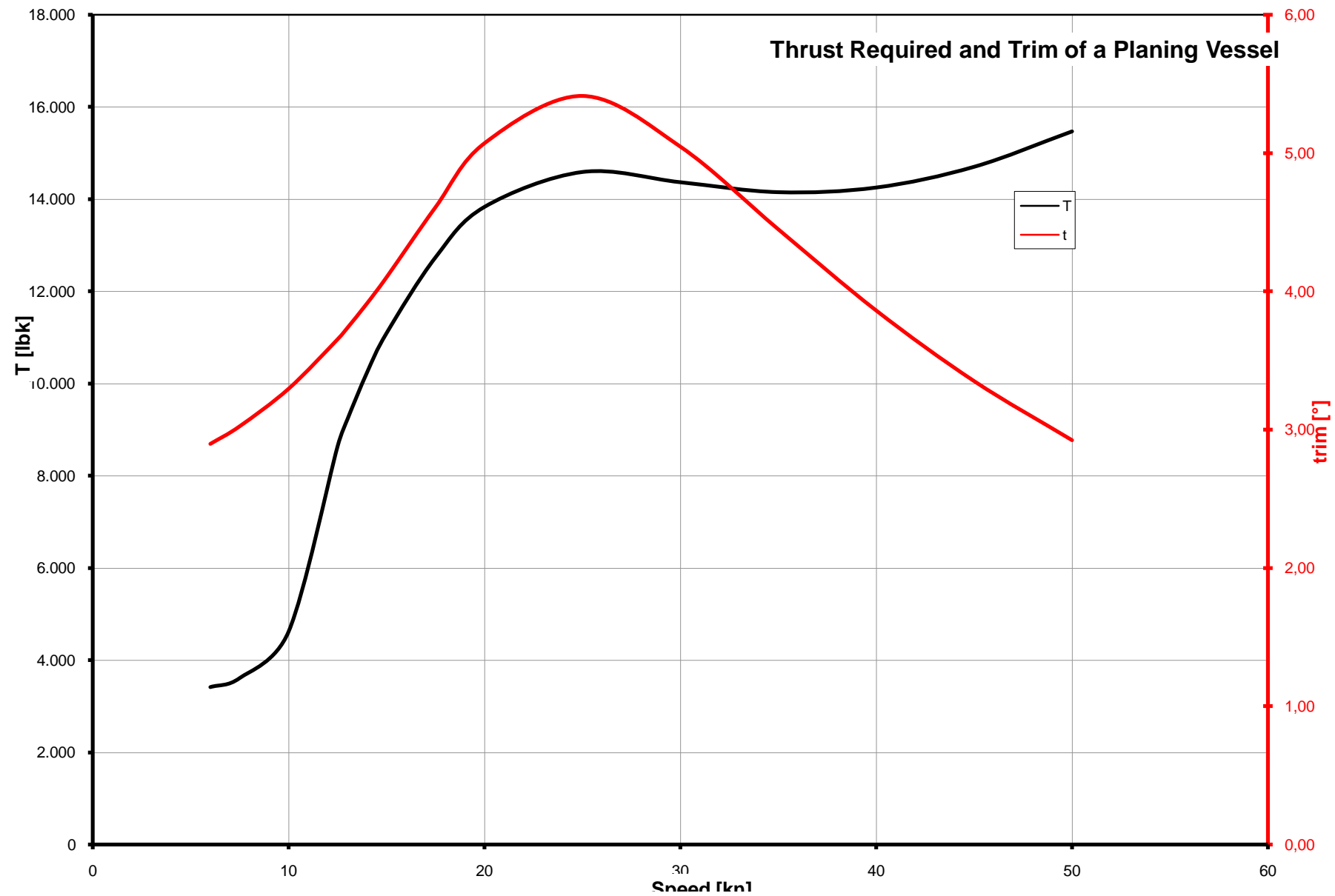
Inputs

Hull	Beam	B	18,51	feet		
	VCG	VCG	6,9	feet	=	2,103 metres
	Displacement	Δ	98.000	lbf	=	44.453 kg
	Deadrise @ Transom	β_T	15,98	°		
	Deadrise @ Amidships	β_{00}	22,11	°		
	Distance to Amidships	L_{00}	35,530	feet	=	10,830 metres
		f	7,40	feet	=	2,256 metres
		ε	0,00	°		
		θ	1,789	°		
	Minimum Speed	V_{min}	8,7	kn	=	14,6 feet/s This is the minimum speed valid for this analysis
	Maximum Speed	V_{max}	187,9	kn	=	317,2 feet/s This is the maximum speed valid for this analysis
Number	Number of Propellers	N	3			
Trim Tab	Chord	C_F	0	feet	=	0,000 metres
	Span Ratio	σ	0	(≤ 1)		
	Deflection Angle	δ	0	°		
Rudder	Chord	C_{rudder}	0,00	feet	=	0,000 metres
	Thickness	t	0,00	feet	=	0,000 metres
	Area	A_{rudder}	0,00	feet ²	=	0,000 m ²
	Centrepont	x_c	0,00	feet from transom	=	0,000 metres (+ve fwd)
		y_c	0,00	feet from baseline	=	0,000 metres (+ve up)

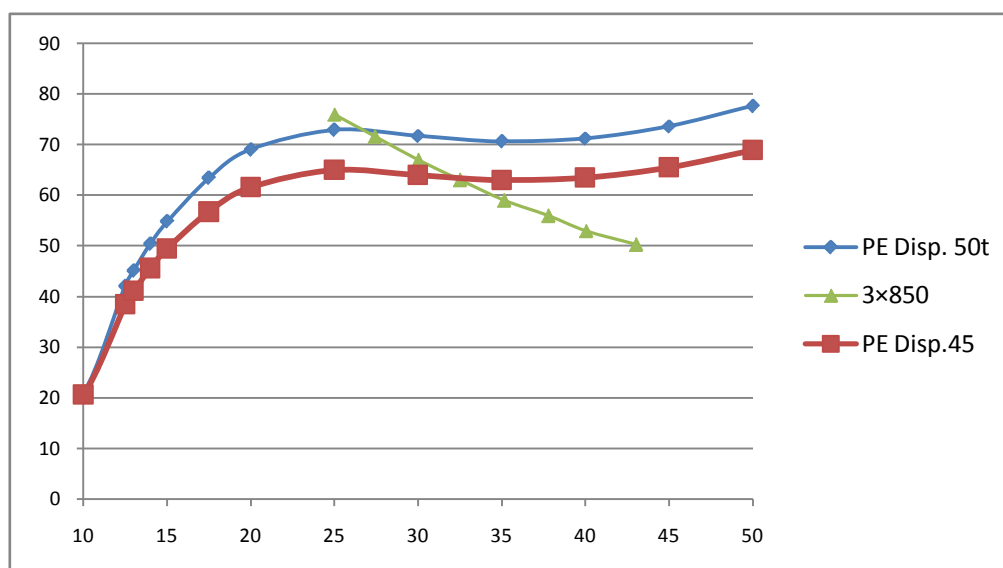
Shaft	Diameter of Shaft	Φ_{shaft}	0,00	feet	=	0,000	metres	
	Length of Shaft & Hub	l	0,00	feet	=	0,000	metres	
	Centrepoint	x_c	0,00	feet from transom	=	0,000	metres	(+ve fwd)
		y_c	0,00	feet from baseline	=	0,000	metres	(+ve up)
Strut	Chord	C_{strut}	0,00	feet	=	0,000	metres	
	Thickness	t	0,00	feet	=	0,000	metres	
	Area	A_{strut}	0,00	feet ²	=	0,000	m ²	****
	Centrepoint	x_c	0,00	feet from transom	=	0,000	metres	(+ve fwd)
		y_c	0,00	feet from baseline	=	0,000	metres	(+ve up)

Output

V	LCG		τ	D		T		P _{effective}		h	
[kn]	[ft]	[metres]	[°]	[lbf]	[kN]	[lbf]	[kN]	[ehp]	[ekW]	[ft]	[metres]
6	25	7,62	2,8985	3.412	15,2	3.420	15,2	63	47	4,47	1,362
7,5	25	7,62	3,0259	3.608	16,1	3.616	16,1	83	62	4,55	1,387
10	25	7,62	3,2972	4.615	20,5	4.627	20,6	142	106	4,70	1,433
12,5	25	7,62	3,6545	8.618	38,3	8.645	38,5	331	247	4,86	1,481
13	25	7,62	3,7371	9.196	40,9	9.227	41,1	367	274	4,89	1,490
14	25	7,62	3,9134	10.205	45,4	10.241	45,6	438	327	4,96	1,512
15	25	7,62	4,1028	11.054	49,2	11.096	49,4	509	380	5,02	1,530
17,5	25	7,62	4,609	12.680	56,4	12.739	56,7	681	508	5,12	1,561
20	25	7,62	5,0708	13.757	61,2	13.832	61,5	844	630	5,10	1,554
25	25	7,62	5,4122	14.500	64,5	14.589	64,9	1.113	830	4,69	1,430
30	25	7,62	5,0457	14.289	63,6	14.366	63,9	1.316	982	4,07	1,241
35	25	7,62	4,4488	14.089	62,7	14.151	63,0	1.513	1.129	3,51	1,070
40	25	7,62	3,8619	14.203	63,2	14.252	63,4	1.744	1.301	3,07	0,936
45	25	7,62	3,3519	14.661	65,2	14.701	65,4	2.025	1.511	2,73	0,832
50	25	7,62	2,925	15.434	68,7	15.469	68,8	2.368	1.767	2,46	0,750



3×850		Disp. 50t		Disp. 45t	
V [kn]	T [kN]	V [kn]	T [kN]	V [kn]	T [kN]
25	76	6	17,1	6	15,2
27,4	71,59	7,5	18,1	7,5	16,1
30	67	10	21,1	10	20,6
32,49	63	12,5	42,1	12,5	38,5
35,13	59	13	45,1	13	41,1
37,77	56	14	50,4	14	45,6
40,03	53	15	54,8	15	49,4
43	50,3	17,5	63,4	17,5	56,7
		20	69	20	61,5
		25	72,9	25	64,9
		30	71,7	30	63,9
		35	70,6	35	63,0
		40	71,2	40	63,4
		45	73,6	45	65,4
		50	77,6	50	68,8



AREA	STRUCTURE ELEMENT	PROFIL TYPE	X (m)		DIMENSIONS				Required Z (mm ³)	Addopted Z (mm ³)	Addopted Z (mm ³)
					c (mm)	t (mm)	d (mm)	e (mm)			
BOTTOM	Floor-Central Floor-Side	T	16,2	15	130	6	60	7	82	90	PASS
		T	17,2		170	6	60	7	144	130	NOT PASS
		T	17,2		140	6	50	7	82	89	PASS
		T	18,37	16	160	6	50	7	98	108	PASS
		T	18,37		140	6	50	7	82	89	PASS
		T	19,5	17	220	6	60	7	170	188	PASS
		T	19,5		130	6	50	8	82	87	PASS
	Wash plate				4						
TANK TOP	Plate				4						
	Stringers	L			40	5	40	5	10	11	PASS
	Web beam	T			110	6	50	8	59	67	PASS
BULK-HEAD	Plate				5						
	Stringers	L			30	5	30	5	5	6	PASS
	Web beam	T			90	5	40	8	42	43	PASS

