

Technical Report

ISO 12215-Part5 Scantling Calculation

Report generated in YACHTScant powered by CompoSIDE

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Circulation:	
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Software Information:

Software Component	Release / Build Number
CompoSIDE	2.8.2.31386
ISO Calculation Engine	1.0

Vessel Scantling Results Status:

Vessel **Passes** ISO 12215-Part5 Requirements

1. Introduction



Vessel:	60' Motor Sports Fishing Boat
Classification Society:	ISO 12215-Part5
Circulation:	
Keywords:	ISO 12215-Part5

This report summarizes the scantling of the 60' Motor Sports Fishing Boat . The yacht has been engineered according to ISO 12215-Part5 guidelines.

2. Vessel

2.1 Vessel Details

Parameter	Unit	Value
Name	[-]	60' Motor Sports Fishing Boat
Craft Type	[-]	Motor Boat
Design Category	[-]	A - Ocean (Wave Height > 4m, Wind speeds > 8B)
L_{WL}	[m]	16.2
L_H	[m]	18.14
D	[m]	3.4
$\beta_{0.4}$	[°]	23
B_C	[m]	5.12
B_{WL}	[m]	5.12
V	[kt]	41
$G_{zmax<60^\circ}$	[m]	1
m_{LDC}	[kg]	37500

3. Materials Properties Summary

3.1 Ply Properties

Name	t_{pp}	$E_{11 \text{ avg}}$	$E_{22 \text{ avg}}$	ϵ_{11t}	ϵ_{11c}	ϵ_{22t}	ϵ_{22c}	ν_{12}
	[mm]	[MPa]	[MPa]	[%]	[%]	[%]	[%]	[-]
QC-SM600-EP-PP	0.64	45936.1	45936.1	0.96	-0.74	0.96	-0.74	0.32
UC-SM300-EP-PP	0.3	127889.4	9416.5	1.15	-0.77	0.45	-1.5	0.31
XC-SM300-EP-PP	0.32	64938.3	64938.3	0.96	-0.74	0.96	-0.74	0.04
XC-SM400-EP-PP	0.43	64938.3	64938.3	0.96	-0.74	0.96	-0.74	0.04

3.2 Shear Ply Properties

Name	t_{pp}	$E_{xx}(\alpha_{\text{shear}})$	$G_{xy}(\alpha_{\text{shear}})$	$\nu_{xy}(\alpha_{\text{shear}}) \text{ ult}$	$\nu_{xy}(\alpha_{\text{shear}}) \text{ lim}$	$\nu_{xy}(\alpha_{\text{shear}})$
	[mm]	[MPa]	[MPa]	[%]	[%]	[-]
2 x UC-SM300-EP-PP @ $\pm 45^\circ$	0.595	15796.98	33110.2	1.539	0.934	0.78
QC-SM600-EP-PP @ 45°	0.642	45936.08	17354.4	1.485	0.909	0.32
XC-SM300-EP-PP @ $\pm 45^\circ$	0.321	13008.03	31112.3	1.485	0.909	0.81
XC-SM400-EP-PP @ $\pm 45^\circ$	0.427	13008.03	31112.3	1.485	0.909	0.81

3.3 Core Material Properties

Name	t_{pp}	Core Type	G_{13}	G_{23}	E_{33c}	ν_{13}	ν_{23}	$\epsilon_{33 \text{ ult}}$
	[mm]	[-]	[MPa]	[MPa]	[MPa]	[%]	[%]	[%]
R63.140	34	Foams, PVC	54	54	170	3.889	3.889	2.069
T10.100	20	Foams, PVC	40	40	130	3.5	3.5	1.964
T10.100	55	Foams, PVC	40	40	130	3.5	3.5	1.964
T10.100	40	Foams, PVC	40	40	130	3.5	3.5	1.964
T10.110	17	Foams, PVC	30	30	104	3.333	3.333	1.741
T10.110	40	Foams, PVC	30	30	104	3.333	3.333	1.741
T10.110	8	Foams, PVC	30	30	104	3.333	3.333	1.741
T10.110	7	Foams, PVC	30	30	104	3.333	3.333	1.741
T10.110	30	Foams, PVC	30	30	104	3.333	3.333	1.741

4. Laminates

Deck and Hull Laminates details are summarized below.

4.1 DECK Laminates

4.1.1 Stacking

Deck Laminates/Deck Aft

#	Material Name	Orientation [°]
TOP = O.S.		
1	1 x XC-SM300-EP-PP	0

#	Material Name	Orientation [°]
2	1 x XC-SM300-EP-PP	45
3	1 x XC-SM300-EP-PP	0
4	1 x 7mm T10.110	0
5-6	2 x XC-SM400-EP-PP	0
BOTTOM = I.S.		

Deck Laminates/Deck Fwd

#	Material Name	Orientation [°]
TOP = O.S.		
1	1 x XC-SM300-EP-PP	0
2	1 x XC-SM300-EP-PP	45
3	1 x XC-SM300-EP-PP	0
4	1 x 8mm T10.110	0
5-6	2 x XC-SM400-EP-PP	0
BOTTOM = I.S.		

4.1.2 General Data

General Data							
Name	Laminate Type	Fibre Type	Manufacturing Technology	Fibre Factor k5	Core Type	Shear Factor	t _{total} [mm]
Deck Laminates/Deck Aft	Sandwich	Carbon (SMC, IMC) / Aramid	Prepreg	0.7	-		8.82
Deck Laminates/Deck Fwd	Sandwich	Carbon (SMC, IMC) / Aramid	Prepreg	0.7	-		9.82

Laminate Properties					Longitudinal (X)	
Name	Ex total	Ey total	Elxtotal	Ely total	+Mx*	-Mx*
	[MPa]	[MPa]	[Nmm ² /mm]	[Nmm ² /mm]	[Nmm/mm]	[Nmm/mm]
Deck Laminates/Deck Aft	12161.1	12161.1	1.6782e+06	1.6782e+06	2791.83	2967.28
Deck Laminates/Deck Fwd	10932.4	10932.4	2.1279e+06	2.1279e+06	3180.47	3378

* Positive moment (+) = O.S. in compression; Negative Moment (-) = I.S. in compression

4.1.3 Single Skin Laminates Specific Properties

Currently no single skin laminate is being used in DECK

4.1.4 Sandwich Laminates Specific Properties

Outer Skins Properties					Longitudinal (X)		Transverse (Y)	
	tos	Fibre Mass wos	Ex outer	Ey outer	ε _{uxt}	ε _{uxc}	ε _{uyt}	ε _{uyc}
Name	[mm]	[kg/m ²]	[MPa]	[MPa]	[%]	[%]	[%]	[%]
Deck Laminates/Deck Aft	0.854	900	53309.6	53309.6	0.96	-0.742	0.96	-0.742
Deck Laminates/Deck Fwd	0.854	900	53309.6	53309.6	0.96	-0.742	0.96	-0.742

Inner Skins Properties					Longitudinal (X)		Transverse (Y)	
	tis	Fibre Mass wis	Ex inner	Ey inner	ε _{uxt}	ε _{uxc}	ε _{uyt}	ε _{uyc}
Name	[mm]	[kg/m ²]	[MPa]	[MPa]	[%]	[%]	[%]	[%]
Deck Laminates/Deck Aft	0.963	800	64938.3	64938.3	0.96	-0.742	0.96	-0.742
Deck Laminates/Deck Fwd	0.963	800	64938.3	64938.3	0.96	-0.742	0.96	-0.742

Inner Skins Properties					Longitudinal (X)		Transverse (Y)	
	tis	Fibre Mass wis	Ex inner	Ey inner	ϵ_{uxt}	ϵ_{uxc}	ϵ_{uyt}	ϵ_{uyc}
Name	[mm]	[kg/m ²]	[MPa]	[MPa]	[%]	[%]	[%]	[%]
Core Properties								
Name	Core Material	tc	Gco, Gxz	Gyz	Eco	τ_{xz_u}	τ_{yz_u}	
		[mm]	[MPa]	[MPa]	[MPa]	[MPa]	[MPa]	[MPa]
Deck Laminates/Deck Aft	T10.110	7	25, 25	25	85	1	1	
Deck Laminates/Deck Fwd	T10.110	8	25, 25	25	85	1	1	

4.2 HULL Laminates

4.2.1 Stacking

Hull Laminates/Hull Bottom Aft

#	Material Name	Orientation [°]
TOP = O.S.		
1	1 x XC-SM400-EP-PP	45
2- 4	3 x XC-SM300-EP-PP	45
5	1 x 34mm R63.140	0
6- 8	3 x XC-SM300-EP-PP	45
BOTTOM = I.S.		

Hull Laminates/Hull Topside Aft

#	Material Name	Orientation [°]
TOP = O.S.		
1	1 x XC-SM300-EP-PP	0
2	1 x XC-SM300-EP-PP	45
3- 5	3 x XC-SM300-EP-PP	45
6	1 x 20mm T10.100	0
7- 8	2 x XC-SM300-EP-PP	45
9	1 x XC-SM300-EP-PP	0
10	1 x XC-SM300-EP-PP	45
BOTTOM = I.S.		

Hull Laminates/Hull Topside Fwd

#	Material Name	Orientation [°]
TOP = O.S.		
1- 4	4 x XC-SM300-EP-PP	45
5	1 x 17mm T10.110	0
6- 8	3 x XC-SM300-EP-PP	45
BOTTOM = I.S.		

4.2.2 General Data

General Data							
Name	Laminate Type	Fibre Type	Manufacturing Technology	Fibre Factor k5	Core Type	Shear Factor	t _{total} [mm]
Hull Laminates/Hull Bottom Aft	Sandwich	Carbon (SMC, IMC) / Aramid	Prepreg	0.7	-		36.35
Hull Laminates/Hull Topside Aft	Sandwich	Carbon (SMC, IMC) / Aramid	Prepreg	0.7	-		22.89

Hull Laminates/Hull Topside Fwd	Sandwich	Carbon (SMC, IMC) / Aramid	Prepreg	0.7	-		19.25
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Laminate Properties					Longitudinal (X)	
Name	Ex total	Ey total	Elxtotal	Ely total	+Mx*	-Mx*
	[MPa]	[MPa]	[Nmm ² /mm]	[Nmm ² /mm]	[Nmm/mm]	[Nmm/mm]
Hull Laminates/Hull Bottom Aft	976.1	976.1	9.7703e+06	9.7703e+06	24604.16	19035.85
Hull Laminates/Hull Topside Aft	3893	3893	1.0435e+07	1.0435e+07	10186.22	9107.24
Hull Laminates/Hull Topside Fwd	1581.9	1581.9	2.3992e+06	2.3992e+06	12047.76	9012

* Positive moment (+) = O.S. in compression; Negative Moment (-) = I.S. in compression

4.2.3 Single Skin Laminates Specific Properties

Currently no single skin laminate is being used in HULL

4.2.4 Sandwich Laminates Specific Properties

Outer Skins Properties					Longitudinal (X)		Transverse (Y)	
Name	tos	Fibre Mass wos	Ex outer	Ey outer	εuxt	εuxc	εuyt	εuyc
	[mm]	[kg/m ²]	[MPa]	[MPa]	[%]	[%]	[%]	[%]
Hull Laminates/Hull Bottom Aft	0.963	1300	13008	13008	1.944	-1.504	1.944	-1.504
Hull Laminates/Hull Topside Aft	1.284	1500	28704.8	28704.8	0.96	-0.742	0.96	-0.742
Hull Laminates/Hull Topside Fwd	0.963	1200	13008	13008	1.926	-1.49	1.926	-1.49

Inner Skins Properties					Longitudinal (X)		Transverse (Y)	
Name	tis	Fibre Mass wis	Ex inner	Ey inner	εuxt	εuxc	εuyt	εuyc
	[mm]	[kg/m ²]	[MPa]	[MPa]	[%]	[%]	[%]	[%]
Hull Laminates/Hull Bottom Aft	1.39	900	13008	13008	1.901	-1.471	1.901	-1.471
Hull Laminates/Hull Topside Aft	1.605	1200	32021.4	32021.4	0.985	-0.762	0.985	-0.762
Hull Laminates/Hull Topside Fwd	1.284	900	13008	13008	1.914	-1.421	1.914	-1.421






Core Properties								
Name	Core Material	tc	Gco, Gxz	Gyz	Eco	τxz_u	τyz_u	
		[mm]	[MPa]	[MPa]	[MPa]	[MPa]	[MPa]	[MPa]
Hull Laminates/Hull Bottom Aft	R63.140	34	45, 45	45	142.5	2.1	2.1	
Hull Laminates/Hull Topside Aft	T10.100	20	33.33333333333333, 33.33	33.33	107	1.4	1.4	
Hull Laminates/Hull Topside Fwd	T10.110	17	25, 25	25	85	1	1	

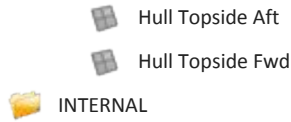
4.3 INTERNAL Laminates

Currently no laminates used in INTERNAL

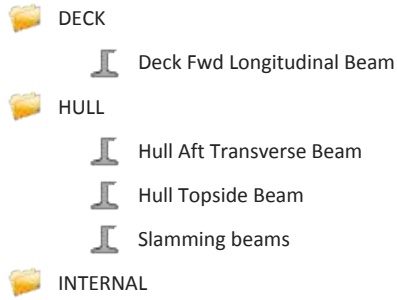
5. Panels & Beams Definition

5.1 Panels Topology

-  DECK
 -  Deck Aft
 -  Deck Fwd
-  HULL
 -  Hull Bottom Aft



5.2 Beams Topology



5.3 Definition

* Internal Structure

5.1 DECK

5.1.1 DECK Panels

Name	X	h / H _b *	Z / D _b *	Fore&Aft Dimension	Transverse Dimension	c _p	β	Laminate	Panel Position
Unit	[m]	[m]	[m]	[mm]	[mm]	[mm]	[°]		
» DECK									
Deck Aft	29554	1488	1488	3102	986	0	0	Deck Laminates/Deck Aft	Deck
Deck Fwd	11821	2092	2092	2652	1294	0	0	Deck Laminates/Deck Fwd	Deck

5.1.2 DECK Beams

Topology Group » DECK			
Name	Property	Unit	Deck Fwd Longitudinal Beam
General	H _b	[mm]	100
	B _w	[mm]	30
	T _w	[mm]	30
	X	[m]	2954
	h / H _b *	[m]	1488
	Z	[m]	1488
	l _u	[mm]	3102
	S	[mm]	993
	c _u	[mm]	0
	β	[°]	0
	Type	[]	
Capping	Width	[mm]	38
	Number of Plies	[-]	10
	Material	[-]	UC-SM300-EP-PP

Side tapes	Width	[mm]	
	Number of Plies	[-]	
	Material	[-]	-
Shear web	Total Number of Plies	[-]	4
	Material	[-]	XC-SM300-EP-PP @ ±45°
Panel	Laminate	[-]	Deck Laminates/Deck Fwd
	Effective Width For ISO	[mm]	66.3
Inner Skin reinforcement	Tape Width	[mm]	50
	Number Of Plies	[-]	1
	Material	[-]	UC-SM300-EP-PP
Outer Skin reinforcement	Tape Width	[mm]	50
	Number Of Plies	[-]	2
	Material	[-]	UC-SM300-EP-PP

5.2 HULL

5.2.1 HULL Panels

Name	X	h / H _b *	Z / D _b *	Fore&Aft Dimension	Transverse Dimension	c _p	β	Laminate	Panel Position
Unit	[m]	[m]	[m]	[mm]	[mm]	[mm]	[°]		
» HULL									
Hull Bottom Aft	2909	-656	1448	3072	790	0	25	Hull Laminates/Hull Bottom Aft	Hull Bottom
Hull Topside Aft	2878	749	1488	3076	1473	0	84	Hull Laminates/Hull Topside Aft	Hull Side
Hull Topside Fwd	11811	1176	2103	2657	896	0	71	Hull Laminates/Hull Topside Fwd	Hull Side

5.2.2 HULL Beams

Topology Group			» HULL		
Name	Property	Unit	Hull Aft Transverse Beam	Hull Topside Beam	Slamming beams
General	H _b	[mm]	170	150	215
	B _w	[mm]	40	40	55
	T _w	[mm]	40	40	55
	X	[m]	4631	11811	9384
	h / H _b *	[m]	-735	1176	-567
	Z	[m]	1239	2103	1640
	l _u	[mm]	1294	2657	1435
	S	[mm]	700	954	587
	c _u	[mm]	0	0	0
	β	[°]	27	71	37
Type	[]		L-Flange	L-Flange	L-Flange
Capping	Width	[mm]	50	50	65
	Number of Plies	[-]	10	10	5
	Material	[-]	UC-SM300-EP-PP	UC-SM300-EP-PP	UC-SM300-EP-PP
	Width	[mm]			

Side tapes	Number of Plies	[-]			
	Material	[-]	-	-	-
Shear web	Total Number of Plies	[-]	4	4	6
	Material	[-]	XC-SM300-EP-PP @ ±45°	XC-SM300-EP-PP @ ±45°	XC-SM400-EP-PP @ ±45°
Panel	Laminate	[-]	Hull Laminates/Hull Bottom Aft	Hull Laminates/Hull Topside Fwd	Hull Laminates/Hull Bottom Aft
	Effective Width For ISO	[mm]	87.1	84.9	102.1
Inner Skin reinforcement	Tape Width	[mm]	50	50	
	Number Of Plies	[-]	1	2	
	Material	[-]	UC-SM300-EP-PP	UC-SM300-EP-PP	-
Outer Skin reinforcement	Tape Width	[mm]	60	60	
	Number Of Plies	[-]	2	3	
	Material	[-]	UC-SM300-EP-PP	UC-SM300-EP-PP	-

5.3 INTERNAL

5.3.1 INTERNAL Panels

Name	X	h / H _b *	Z / D _b *	Fore&Aft Dimension	Transverse Dimension	c _p	β	Laminate	Panel Position
Unit	[m]	[m]	[m]	[mm]	[mm]	[mm]	[°]		

5.3.2 INTERNAL Beams

6. Detail Results

Below is the summary of the detail results for Hull and Deck beams and panels

6.1 DECK

6.1.1 DECK Panels

Topology Group » DECK				
Name	Property	Unit	Deck Aft	Deck Fwd
Design Loads	P _d	[kN/m ²]	7.54	6.80
	P _d user defined	[-]	NO	NO
	M _{db}	[Nmm/mm]	610.06	940.12
	M _{dl}	[Nmm/mm]	372.47	603.35
	F _{db}	[N/mm]	02.81	03.27
	F _{dl}	[N/mm]	03.67	04.09
Min Requirements	EI _{min}	[Nmm ² /mm]	9.918e+05	2.021e+06
	W _{is_min}	[kg/m ²]	-	-
	W _{os_min}	[kg/m ²]	-	-
	t _{s_min}	[mm]	6.68	7.43
	W _{s_min}	[kg/m ²]	-	-
	EI	[Nmm ² /mm]	1.678e+06	2.128e+06

Calculated Properties	W_{IS}	[kg/m ²]	8.0e-01	8.0e-01
	W_{OS}	[kg/m ²]	9.0e-01	9.0e-01
	t_s	[mm]	7.91	8.91
	W_s	[kg/m ²]	-	-
Bending RF (with wrinkling)	short span	[-]	1.55	1.15
	long span	[-]	2.55	1.79
Bending RF (without wrinkling)	short span	[-]	2.43	1.80
	long span	[-]	3.98	2.80
Shear RF	short span	[-]	1.55	1.50
	long span	[-]	1.18	1.20
Stiffness RF	bending	[-]	1.69	1.05
	deflection	[-]	1.67	1.07
Thickness RF	single/outer skin	[-]	1.04	1.04
	inner skin	[-]	1.32	1.32
	thickness RF	[-]	-	-
Critical	name	[-]	Outer Skin Minimum Fibre	Outer Skin Minimum Fibre
	value	[-]	1.04	1.04

6.1.2 DECK Beams

Topology Group » DECK				
Name	Property	Unit	Deck Fwd Longitudinal Beam	
Design Loads	P_d	[kN/m ²]	6.96	
	P_d user defined	[-]	NO	
	M_d	[Nmm]	5539281.02	
	F_{dl}	[N]	10714.71	
Min Requirements	EI_{min}	[Nmm ²]	1.072e+10	
	W_e	[mm]	66.3	
Calculated Properties	EI_{prov}	[Nmm ²]	8.024e+10	
	W_e	[mm]	6.634e+01	
Bending RF	Capping in compression	[-]	1.07	
Shear RF	Shear web	[-]	2.77	
Stiffness RF	Bending	[-]	7.48	
Buckling BLF	L-Flange	[-]	4.84	
	Shear Web	[-]	10.22	
Critical	name	[-]	Capping	
	value	[-]	1.07	

6.2 HULL

6.2.1 HULL Panels

Topology Group » HULL					
Name	Property	Unit	Hull Bottom Aft	Hull Topside Aft	Hull Topside Fwd
Design Loads	P_d	[kN/m ²]	99.94	23.46	21.74
	P_d user defined	[-]	NO	NO	NO
	M_{db}	[Nmm/mm]	5194.81	4208.91	1452.25

	M_{dl}	[Nmm/mm]	3103.81	2693.97	892.14
	F_{db}	[N/mm]	29.91	12.87	07.34
	F_{dl}	[N/mm]	39.42	16.09	09.58
Min Requirements	EI_{min}	[Nmm ² /mm]	6.763e+06	1.029e+07	2.146e+06
	W_{is_min}	[kg/m ²]	-	-	-
	W_{os_min}	[kg/m ²]	-	-	-
	t_s	[mm]	34.13	20.90	17.42
	W_s	[kg/m ²]	-	-	-
Calculated Properties	EI	[Nmm ² /mm]	9.77e+06	1.043e+07	2.399e+06
	W_{IS}	[kg/m ²]	9.0e-01	1.2e+00	9.0e-01
	W_{OS}	[kg/m ²]	1.3e+00	1.5e+00	1.2e+00
	t_s	[mm]	35.18	21.44	18.12
	W_s	[kg/m ²]	-	-	-
Bending RF (with wrinkling)	short span	[-]	2.50	1.28	3.03
	long span	[-]	4.18	2.00	4.93
Bending RF (without wrinkling)	short span	[-]	1.83	1.08	3.10
	long span	[-]	3.07	1.69	5.05
Shear RF	short span	[-]	1.36	1.28	1.36
	long span	[-]	1.03	1.03	1.04
Stiffness RF	bending	[-]	1.44	1.01	1.12
	deflection	[-]	1.42	1.02	1.11
Thickness RF	single/outer skin	[-]	1.05	1.35	1.08
	inner skin	[-]	1.04	1.54	1.15
	thickness RF	[-]	-	-	-
Critical	name	[-]	Core Shear Short Span	Stiffness	Core Shear Short Span
	value	[-]	1.03	1.01	1.04

6.2.2 HULL Beams

Topology Group » HULL					
Name	Property	Unit	Hull Aft Transverse Beam	Hull Topside Beam	Slamming beams
Design Loads	P_d	[kN/m ²]	99.95	19.95	102.15
	P_d user defined	[-]	NO	NO	NO
	M_d	[Nmm]	9762066.21	11198821.74	10289156.04
	F_{dl}	[N]	45266.41	25290.03	43022.58
Min Requirements	EI_{min}	[Nmm ²]	7.883e+09	1.857e+10	9.214e+09
	W_e	[mm]	87.1	84.9	102.1
Calculated Properties	EI_{prov}	[Nmm ²]	2.531e+11	2.163e+11	1.97e+11
	W_e	[mm]	8.706e+01	8.494e+01	1.021e+02
Bending RF	Capping in compression	[-]	1.45	1.07	1.04
Shear RF	Shear web	[-]	1.11	1.76	2.96
Stiffness RF	Bending	[-]	32.11	11.65	21.38
Buckling BLF	L-Flange	[-]	3.87	3.87	1.93
	Shear Web	[-]	4.60	6.55	9.27
Critical	name	[-]	O.S. / O.S. Reinforcement Bending	Capping	O.S. / O.S. Reinforcement Bending
	value	[-]	1.06	1.07	1.02

6.3 INTERNAL

6.3.1 INTERNAL Panels

6.3.2 INTERNAL Beams

7. Results Summary

7.1 Vessel Critical Panels and Beams

No Critical Panels in current vessel.

No Critical Beams in current vessel.

7.2 Panels and Beams with min. RF by Topology

Topology	Beam / Panel	Laminate / Type	Critical Name	RF Value
» DECK	Deck Fwd Longitudinal Beam	L-Flange	Capping	1.07
	Deck Aft	Deck Laminates/Deck Aft	Outer Skin Minimum Fibre	1.04
	Deck Fwd	Deck Laminates/Deck Fwd	Outer Skin Minimum Fibre	1.04
» HULL	Slamming beams	L-Flange	O.S. / O.S. Reinforcement Bending	1.02
	Hull Topside Aft	Hull Laminates/Hull Topside Aft	Stiffness	1.01

8. Conclusion

According to the analysis the yacht **Passes** the required criteria.

9. Appendix

9.1 Appendix 1 - Analysis Settings

	Unit	Value
ISO - RF Pass Flag Level	[-]	1
ISO Factors		
ISO Factor	Unit	Value
k_6	[-]	1
ISO Core Design Shear Strength Factors - ISO12215-5:2008, 10.5.4 Table 11		
Core Type (Ultimate Shear Elongation Strain)	Unit	Value
High elongation core i.e. Linear PVC, SAN (> 35%)	[-]	0.65
Standard foam core i.e. cross-linked PVC etc. (< 35%)	[-]	0.55
End Grain Balsa	[-]	0.5
Honeycomb	[-]	0.5
ISO Design Category Factor (Kdc) - ISO12215-5:2008, 7.2 Table 2		
Category	Unit	Value
A - Ocean - Wave height >4m (calculations assume 7m), Wind speeds > Force 8	[-]	1
B - Offshore - Wave height <4m, Wind speeds < Force 8	[-]	0.8
C - Inshore - Wave height <2m, Wind speeds < Force 6	[-]	0.6
D - Sheltered Waters - Wave height typically < 0.3m, occasionally 0.5m. Wind speed < Force 4	[-]	0.4

9.2 Appendix 2 - Definitions

Vessel

Symbol	Unit	Description
LWL	[m]	Length of the fully loaded waterline / Length between perpendiculars
LH	[m]	Hull length
D	[m]	Total hull depth
$\beta_{0.4}$	[°]	Deadrise angle at 0.4 LWL forward of aft end of LWL
BC	[m]	Breadth from chine to chine at 0.4 LWL
BWL	[m]	Breadth of the fully loaded waterline at full displacement at 0.4 LWL
V	[kts]	Maximum speed at full mass of the craft
Gzmax<60	[m]	Maximum righting moment
mLDC	[kg]	Displacement / Mass of the fully loaded craft

Ply properties

Symbol	Unit	Description
tpp	[mm]	thickness per ply
E11 avg	[MPa]	Young modulus (average of tensile and compressive)
E22 avg	[MPa]	Young modulus (average of tensile and compressive)
$\epsilon_{11\ tu}$	[%]	Longitudinal Ultimate Tensile Strain
$\epsilon_{11\ cu}$	[%]	Longitudinal Ultimate Compressive Strain
$\epsilon_{22\ tu}$	[%]	Transverse Ultimate Compressive Strain
$\epsilon_{22\ cu}$	[%]	Transverse Ultimate Tensile Strain
v12		Major Poisson ratio

Shear Ply Properties

Properties derived for balanced biaxial laminates for ply at +- 45° to the laminate coordinate system (xy)

Symbol	Unit	Description
tsh	[mm]	shear thickness per ply
Ex@45	[MPa]	Young modulus @ 45
Ey@45	[MPa]	Young modulus @ 45
Gxy @45	[MPa]	Kirchoff modulus @ 45
$\gamma_{xy@45ult}$	[%]	Allowable Ultimate Shear Strain
exytu@45	[%]	Ultimate tensile Strain
exycu@45	[%]	Ultimate Compressive Strain
vxy @45		Major Poisson ratio @45

Core properties

Symbol	Unit	Description
tc	[mm]	core thickness
G13	[MPa]	Shear modulus in 13 plane
G23	[MPa]	Shear modulus in 23 plane
E33c	[MPa]	Young modulus (compressive)
$\gamma_{13 ult}$	[%]	Allowable Ultimate Shear Strain in 13 plane
$\gamma_{23 ult}$	[%]	Allowable Ultimate Shear Strain in 23 plane
$\epsilon_{33 ult}$	[%]	Allowable Ultimate Through-thickness Compressive Strain

Laminate properties

Symbol	Unit	Description
ttotal	[mm]	Laminate thickness
Ex total	[MPa]	Young modulus
Ey total	[MPa]	Young modulus
Elx total	[Nmm ² /mm]	Bending Stiffness in direction x
Ely total	[Nmm ² /mm]	Bending Stiffness in direction y
-Mx	[Nmm/mm]	longitudinal allowable bending moments (inner skin in compression)
+Mx	[Nmm/mm]	longitudinal allowable bending moments (outer skin in compression)

Single skin laminate specific properties

Symbol	Unit	Description
Fibre mass ws	[kg/m ²]	Laminate total fibre mass
eu _{xt}	[%]	Ultimate tensile strain in direction x
eu _{xc}	[%]	Ultimate compressive strain in direction x
eu _{yt}	[%]	Ultimate tensile strain in direction y
eu _{yc}	[%]	Ultimate compressive strain in direction y

Sandwich laminate specific properties

Skin:

Symbol	Unit	Description
t(os/is)	[mm]	Skin thickness
Fibre mass w(os/is)	[kg/m ²]	Laminate total fibre mass
eu _{xt}	[%]	Ultimate tensile strain in direction x
eu _{xc}	[%]	Ultimate compressive strain in direction x
eu _{yt}	[%]	Ultimate tensile strain in direction y
eu _{yc}	[%]	Ultimate compressive strain in direction y
Ex	[MPa]	Young modulus
Ey	[MPa]	Young modulus

Symbol	Unit	Description
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Core:

Symbol	Unit	Description
tc	[mm]	core thickness
Gco Gxz	[MPa]	Shear modulus in plane
Gyz	[MPa]	Shear modulus in plane
Eco	[MPa]	Young modulus
τ_{xz-u}	[MPa]	Ultimate shear strain
τ_{yz-u}	[MPa]	Ultimate shear strain

Panel Definition:

Symbol	Unit	Description
X	[m]	Position of the panel's centroid from the origin
H	[m]	Position of the panel's centroid in respect of the DWL
Z	[m]	Local height of deck above DWL
Fore & Aft Dimension	[mm]	Span of the panel in the LWL direction
Transverse Dimension	[mm]	Span of the panel in the transverse to the LWL direction
cp	[mm]	Curvature (short span)
β	[°]	Angle to Horizontal - Used to calculate the percentage of panel above or below WL

Beam Definition:

Symbol	Unit	Description
Hb	[mm]	Beam height
BW	[mm]	Base width
TW	[mm]	Top width
X	[m]	Position of the panel's centroid from the origin
h	[m]	Position of the panel's centroid in respect of the DWL, Negative value (-) = Under DWL
Z	[m]	Local height of deck above DWL (m)
lu	[mm]	Unsupported length. Long dimension of panel between stiffeners
S	[mm]	Stiffener spacing, width of shell supported
cu	[mm]	Curvature
β	[°]	Angle To Horizontal
Type		Beam type (see appendix)
#		number of plies

Panel Results:

Symbol	Unit	Description
Pd	[kN/m ²]	Design pressure
Mdb	[Nmm/mm]	Design Bending Moment in short direction
Mdl	[Nmm/mm]	Design bending moment in long direction
Fdb	[N/mm]	Design shear force at the midspan of the short edge
Fdl	[N/mm]	Design shear Force at the midspan of the long edge
EI min	[Nmm ² /mm]	Minimum requirement bending stiffness
Wis min	[kg/m ²]	Minimum requirement fibre mass inner skin
Wos min	[kg/m ²]	Minimum requirement fibre mass outer skin
ts min	[mm]	Minimum panel thickness
EI	[Nmm ² /mm]	Panel bending stiffness

Symbol	Unit	Description
Wis	[kg/m ²]	fibre mass inner skin
Wos	[kg/m ²]	fibre mass outer skin
ts	[mm]	panel thickness

Bending RF	short span	Bending reserve factor in the short span direction
	long span	Bending reserve factor in the long span direction
Shear RF	short edge	Reserve factor for short Span Shear (at the mid-point of short edge)
	long edge	Reserve factor for long Span Shear (at the mid-point of long edge)
Stiffness RF	bending	Reserve factor for the bending stiffness (EI)
	deflection	Reserve factor for the panel lateral deflection
Thickness RF	outer skin	Reserve factor for the outer skin weight of reinforcement
	inner skin	Reserve factor for the inner skin weight of reinforcement

Beam Results:

Symbol	Unit	Description
Pd	[kN/m ²]	Design pressure (kPa)
Md	[Nmm]	Design bending moment (Nmm)
Fdl	[N]	Design shear Force (N)
EI min	[Nmm ²]	Minimum requirement bending stiffness
We	[mm]	minimum supported panel effective width
EI	[Nmm ²]	bending stiffness
We input	[mm]	Supported panel effective width

Bending RF	Capping in compression	Bending reserve factor for capping in compression
Shear RF	Shear web	Shear reserve factor for the beam web
Stiffness RF	Bending	Reserve factor for the bending stiffness (EI)
Buckling BLF	Shear web	Buckling reserve factor for the shear web
	Flange	Buckling reserve factor for the flange

9.3 Appendix 3 - Beam Type Definition

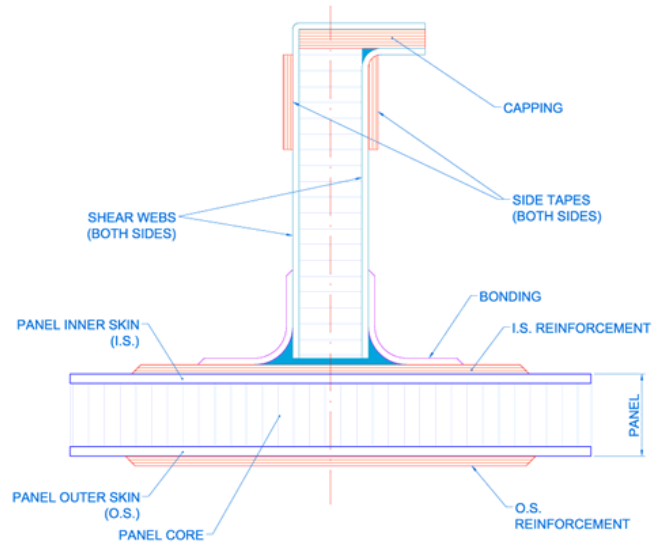


Figure 1: L Flange

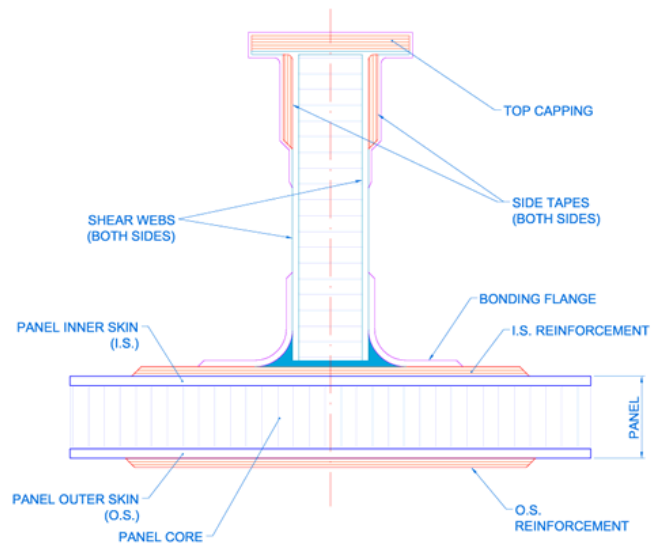


Figure 2: T flange

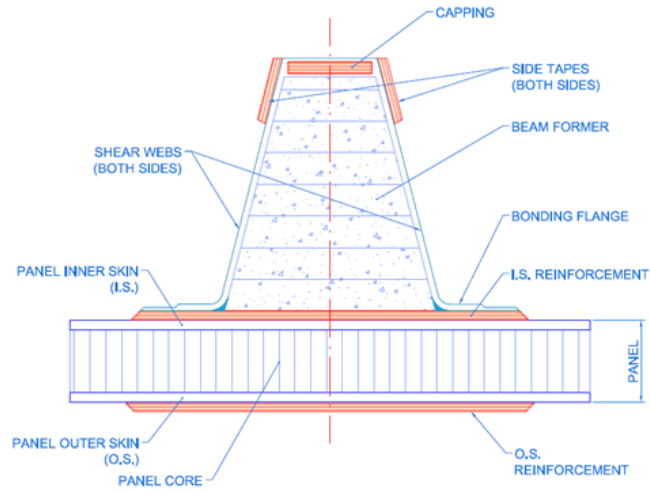


Figure 3: Top Hat (with foam former)

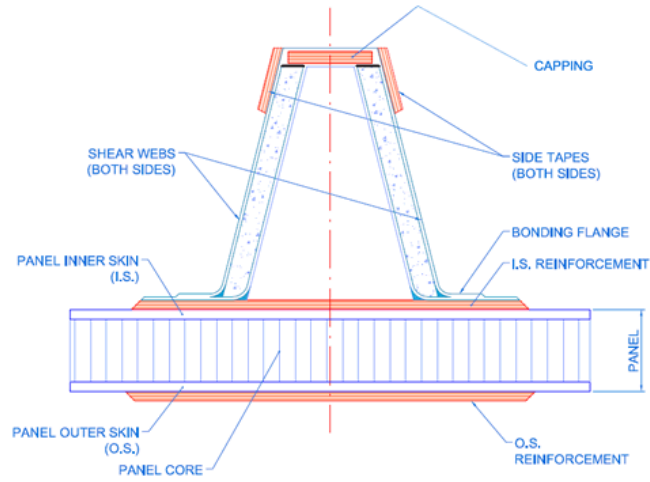


Figure 4: Top Hat Hollow (without former)