Design of the DreamCatcherOne hull structure in accordance with GL regulations for Yachts and Boats up to 24m

Description	Formula	Base design (large frame spacing) Calculated value	Chosen value	Alternate design (small frame spacing) Calculated value	Chosen value	Comments
Length [m]	L	20,50		20,50		
Width [m]	B	11,20		11,20		
Loads and material parameters						
Aluminium grade 5383 (Sealium): (values from GL Special Crafts: High Speed Crafts, page 3-7)						
Minimum yield stress at 0,2% [N/mm²]	$R_{p0,2}$	145,00		145,00		
Minimum tensile strength [N/mm²]	R_m	290,00		290,00		
Material factor	$k = 635/(R_{p0,2} + R_m)$	1,46		1,46		
Design loading for hulls						
Hull bottom >= 0,4L to fore (PdBS) [kN/m²]	3,29 L -1,41	66,04		66,04		
Hull bottom < 0,4 to aft (PdBS) [kN/m²]	2,63 L -1,13	52,79		52,79		
Hull side >= 0,4L to fore (PdSS) [kN/m²]	2,06 L -2,94	39,29		39,29		
Hull side < 0,4 to aft (PdSS) [kN/m²]	1,65 L -2,25	31,58		31,58		
Main Deck (PdD) [kN/m²]	0,26 L + 8,24	13,57		13,57		
Design loading for deckhouse						
Height of Deckhouse above main deck	h' = 0,5 * h	0,60		0,60		
Deck (roof, PdDR) [kN/m²] (not walked on decks minimum: 4,0 [kN/m²]	(0,235 L + 7,42)(1-h'/10)	11,50		11,50		
Sidewalls (PdDS)	(0,26 L + 8,24)(1-h'/10)	12,76		12,76		
Front (PdDF)	1,25*(0,26 L + 8,24)(1-h'/10)	15,94		15,94		
Shell Plating						
Frame spacing [m] (taken from design according to Gerr)		0,26		0,26		Bottom and sides longitudinal girder distance. The girders are placed closely together to achieve a nice dent-free finish of the hull (to prevent buckling during welding).

Shell bottom >= 0,4 L [mm]	1,62 * a*(PdBS*k)^0,5	4,14	8	4,14	8 8mm appears to be heavily overdesigned. Even the method according to Gerr only requires 7mm of 5083 grade aluminium. However, in order to meet the requirements of load bearing hard chines according to GL, a minimum thickness of 7,5mm would be required for the weakes chine. Considering that some growler contact cannot be excluded in worldwide travel and occasionally beaching the cat is seriously considered, it makes a lot of sense to overdesign a little bit.
Shell bottom < 0,4 L [mm]	1,62 * a*(PdBS*k)^0,5	3,70	8	3,70	8 According to GL the bottom shell thickness has to extend up to the first hard chine above the waterline or at least 15cm. In my design the 8mm therfore goes up to 0,5m above the water at the stern and up to 1,5 m at the bow (which is nice if you hit something big).
Shell sides >= 0,4 L [mm]	1,62 * a*(PdSS*k)^0,5	3,19	5	3,19	5
Shell side < 0,4 L [mm]	1,62 * a*(PdSS*k)^0,5	2,86	5	2,86	5
Minimum thickness [mm]	0,9*(L*k)^0,5	4,92		4,92	5 Since this vallue is larger than the load based values, this value has to be taken as a minimum.
Deck					
Deck beam spacing a (nach Gerr) [m]		0,23		0,23	
Deck shell [mm]	1,65*a*(PdD*k)^0,5	1,69		1,69	
Minimum thickness [mm]	0,75*(L*k)^0,5	4,10	4	4,10	4 All deck and deckhouse plating will be 4 mm
Transverse frames in the hulls					
Unsupported length [m]		1,50		1,50	The hard chine at z = 0,5m and at z = 2,0m (above waterline) define the unsupported length at 1,5m. At the bow the maximum unsupported length is at 1,7 m. Since the bow is supported by bulkheads, the unsupported length in practice is 0,0m there. Thus, the 1,5m is the design length to be used.
Maximum spacing a [m]		1,15		0,75	Note: To achieve maximum leakage safety, every second or third frame is designed as a partial bulkhead up to the lower floor (6mm).

Section Modulus [cm³]	0,32*a*l^2*PdSS*k	47,50	90x60x8	30,98	90x60x6	The first value (90x60x8) is only an estimate since the GL table only oes up to 44cm³. The second one (90x60x6) has a section modulus of 43, i.e. even this is heavily overdesigned. It appears that here lies potential for weight savings. According to the GL table an 80x50x6 would be sufficient in the second case.
Bottom girders (bottom part of transverse frames)						
Unsupported length l [m]		0,75		0,75		Since there is a centreline girder, the unsupported length is maximum 0,6 m from centerline to the first hard chine that count as support minus the transvers girder height of 0,1m, i.e. 0,5 m. However, the GL calculations require a minimum unsupported length of 0,75m to be considered..
Maximum spacing a [m]		1,15		0,76		
Section Modulus [cm³]	0,37*a*l^2*PdBS*k	23,08	90x8	15,25		Even using the height of the bottom sides as a simple bar profile heavily over designs the dimensions. On the other hand, no sane person would make them thinner than the side frames (see below).
Deckhouse transverse frames						The idea is to put 3 support pillars at the front at y=-2,5, 0 and 2,5m (about 3m in front of the main bulkhead at 6,4m).
Unsupported length l [m]	2,5-3,0m (worst case)	3,00		3,00		
Maximum spacing a [m]		1,15		0,76		
Factor n (transverse frames)		0,28		0,28		
Korrectionfactor	k8=0,9-0,01*L	0,70		0,70		
Section Modulus [cm³]	n*PaD*k8*a*l^2*k	46,38	90x60x8	30,65	90x60x6	About 50% over-sized, but useful against large breaking waves and ice.
Longitudinal girders						
Bottom:						
Unsupported length for longitudinals (max) >=0,4L [m]		1,04		0,76		Between bulkheads 11,6m und 6,4m (all values measured from stern)
Section Modulus longitudinal frames b>=0,4L [cm³]	0,37*a*l^2*PdBS*k	10,03	60x8	5,36	50x6	Flat profile (delivers 10 cm³)

Unsupported length for longitudinals (max) < 0,4L [m]		1,15		0,76		Between bulkheads 6,4m und 3,0m
Section Modulus longitudinal frames < 0,4L [cm³]	0,37*a*l^2*PdBS*k	9,80	60x8	4,28	50x6	
Sides:						
Unsupported length for longitudinals (max) >=0,4L [m]		1,04		0,76		Between bulkheads 11,6m und 6,4m
Unsupported length for longitudinals (max) >=0,4L [cm³]	0,33*a*l^2*PdSS*k	5,32	50x6	2,84	40x6	Flat profile (delivers 6 cm³)
Unsupported length for longitudinals (max) < 0,4L [m]		1,15		0,76		Between bulkheads 6,4m und 3,0m
Section Modulus longitudinal frames < 0,4L [cm³]	0,33*a*l^2*PdSS*k	4,28	50x6	2,28	40x6	
Centreline girder						
Maximum unsupported length (l) [m]		1,15		0,76		Distance between transverse frames
Floor spacing (a) [m]		1,15		1,15		Can only mean the distance keel-floor I suppose.
Section modulus (as for floors) [cm³]	0,37*a*l^2*PdBS*k	54,25		23,69	80x10	This value appears more realistic than that following the calculations according to Gerr (150x15mm). An additional point of criticism regarding Gewrrs method is, that it would require that the floor cross beam should be of the same dimensions. That is completely unrealistical in my design: Because of the hard chine the free length of the frame sides is short enough to be self-supporting, i.e. the transverse floor frame is only reqired to carry the loads of the floor... Even choosing a 80x10 crossection is already oversizing it, but with 10mm width it is possible to weld the bottom plates directly onto it (no T required).