

Dinghy 13 hull investigation, for more RM and stability margin

V4 : comparison of some *Convex-concav-hard chine* versions

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In this V4 document, we compare various **Convex-concav-hard chine** versions :

- *Convex-concav-hard chine 1*, as designed for a 95 kg nominal payload
- *Convex-concav-hard chine 2 and 3*, with a smaller Bwl compatible with a 80 kg helmsman as design payload, and for two hard chine line versions.

Lhull : 3,97 m (13 ft) ; Bhull : 1,60 m ; Boat light weight assumed 59 kg (with a 8 m2 sail)

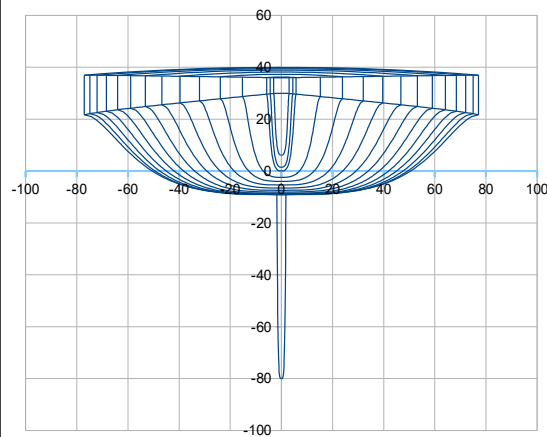
- *Convex-concav-hard chine 1*

>>> Disp : ~ 154 kg ; Lwl : 3,75 m ; Bwl : 1,02 m >>> Bwl / Bhull ~ 0,64 ; Cp 56,2 %

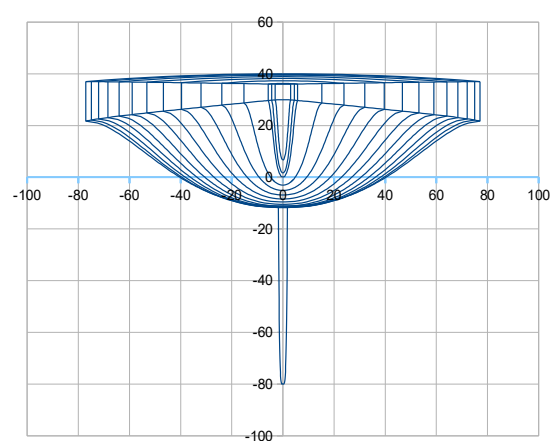
- *Convex-concav-hard chine 2 & 3 :*

>>> Disp : ~ 139 kg ; Lwl : 3,75 m ; Bwl : 0,81 m (2) ; 0,82 m (3) >>> Bwl / Bhull ~ 0,51 ; Cp 55,1 % (2) , 56,0 % (3)

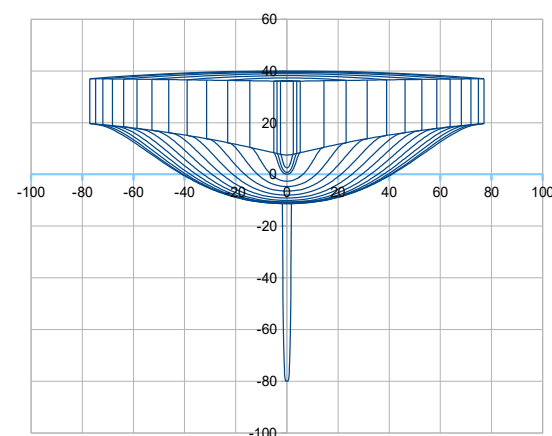
Convex-concav-hard chine 1



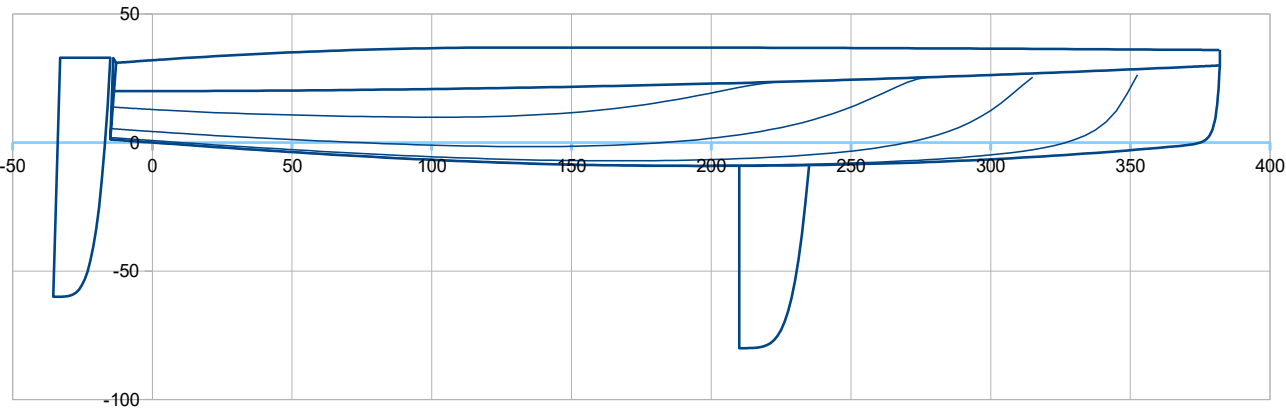
Convex-concav-hard chine 2



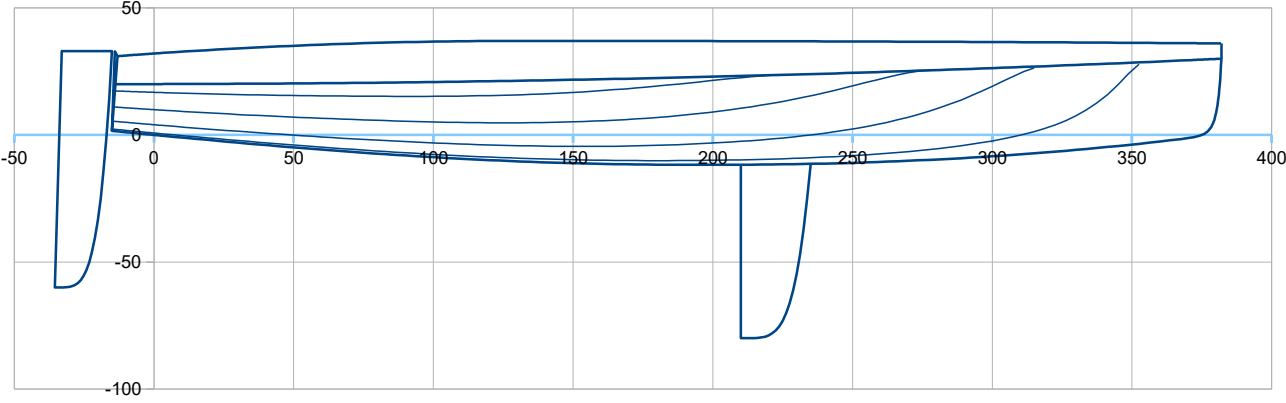
Convex-concav-hard chine 3



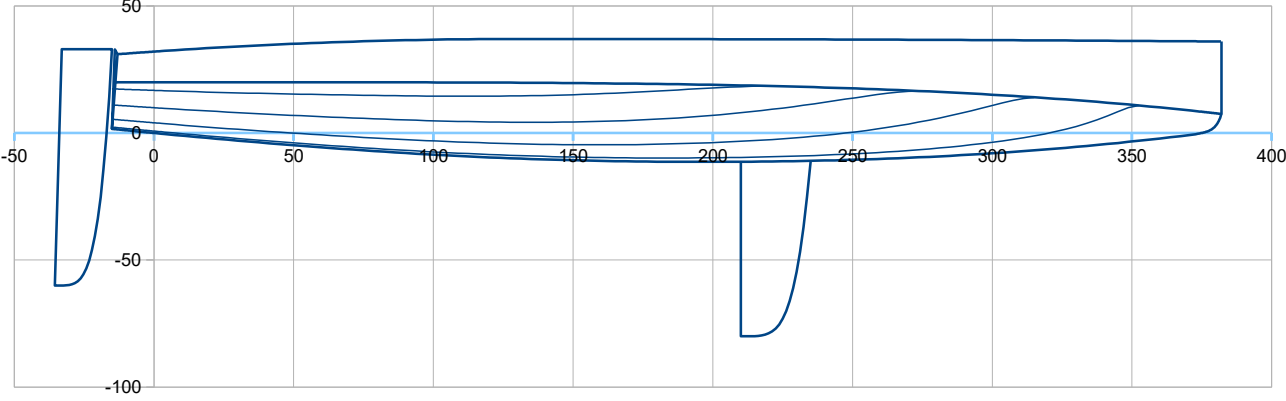
Convex-concav-hard chine 1



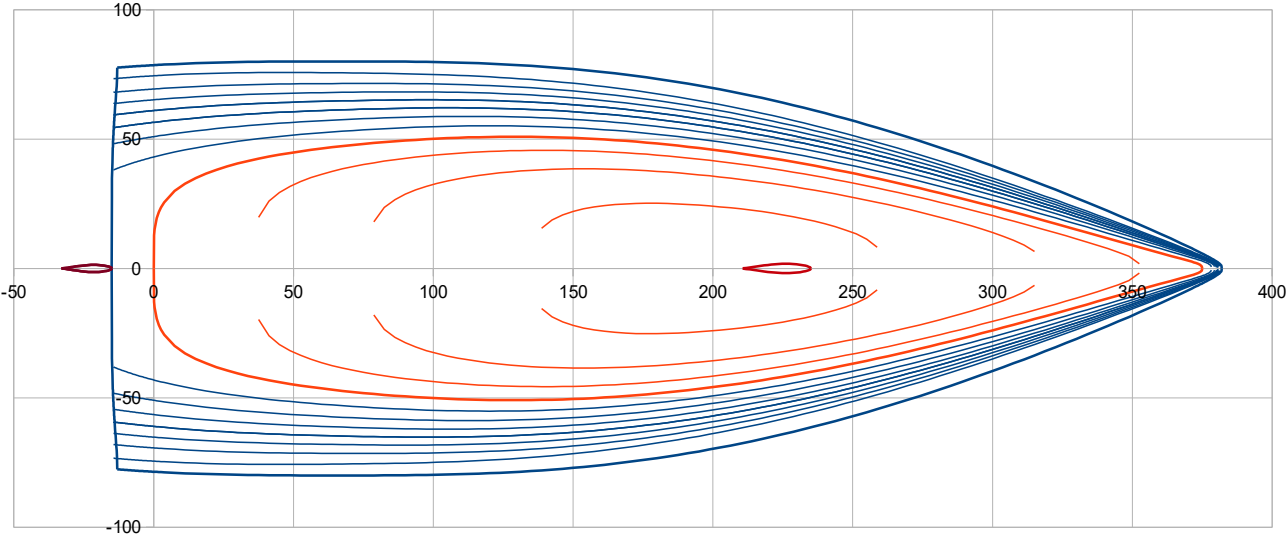
Convex-concav-hard chine 2



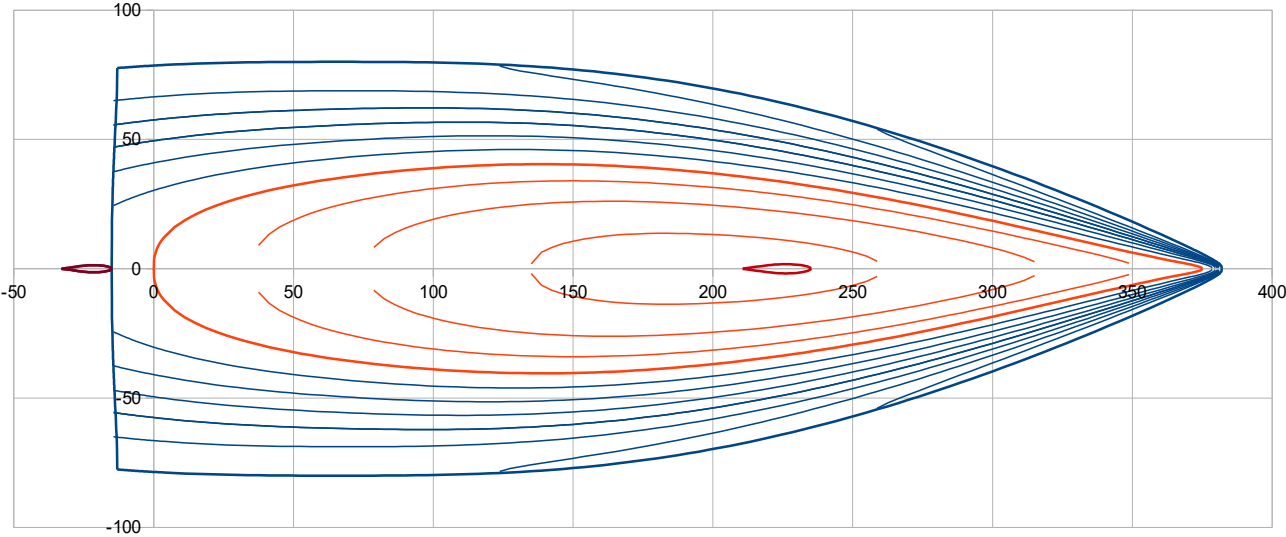
Convex-concav-hard chine 3



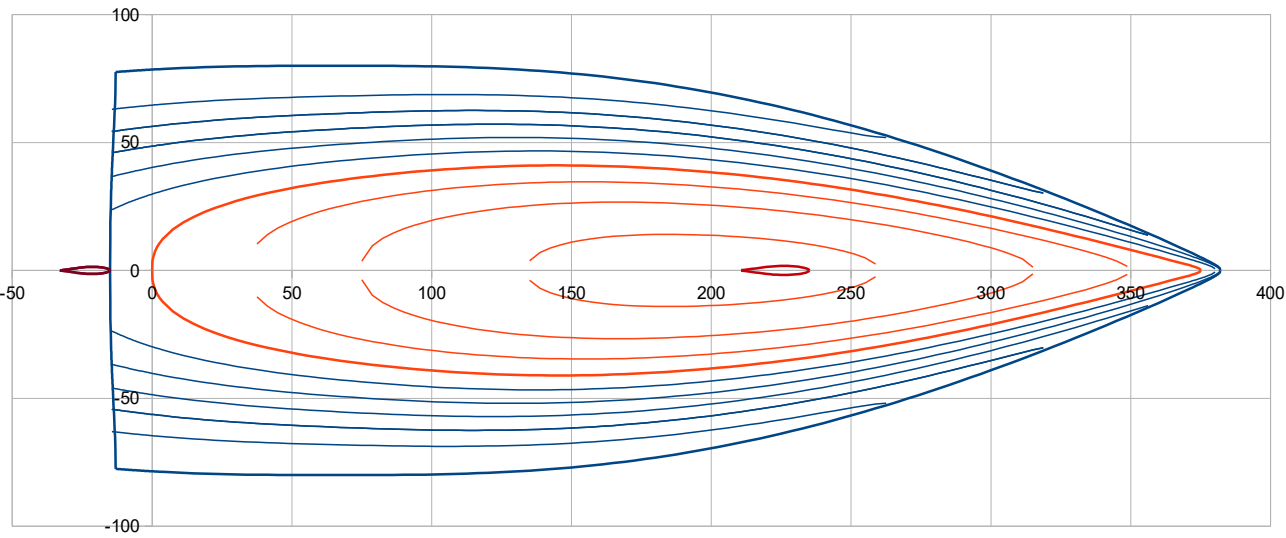
Convex-concav-hard chine 1



Convex-concav-hard chine 2

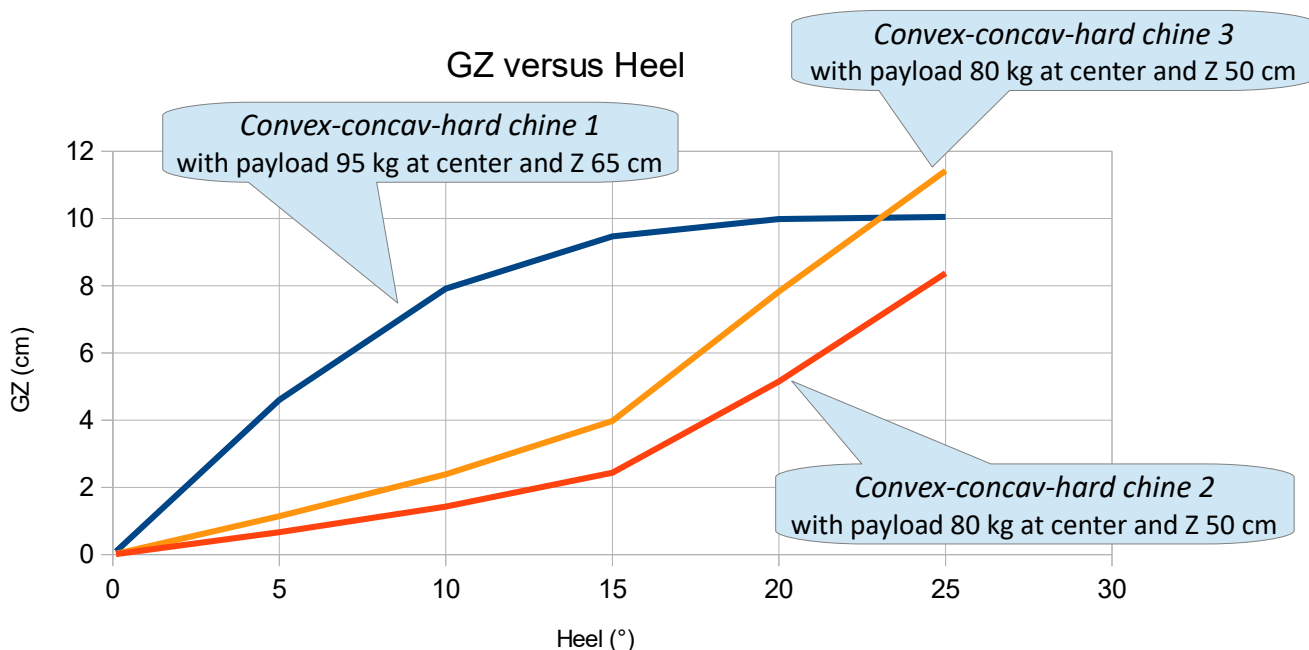


Convex-concav-hard chine 3



Stability issue when considering the « payload » in the center , assuming :

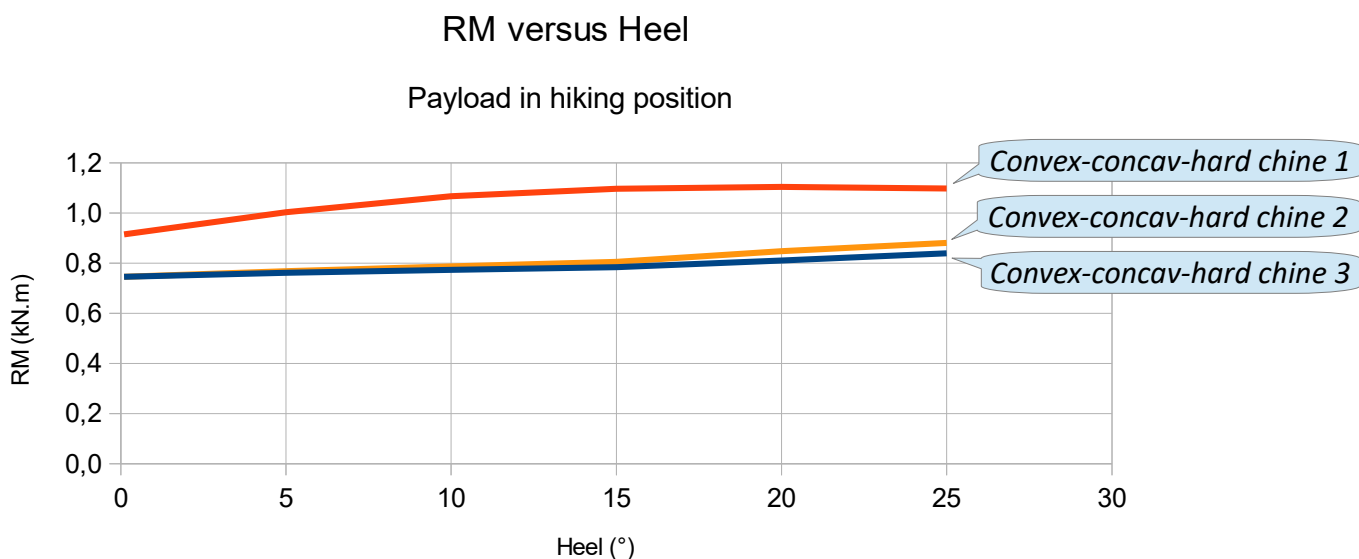
- *Convex-concav-hard chine 1* : a helmsman 95 kg squatted in the boat center under the boom, with his center of gravity at Z +65 cm.
- *Convex-concav-hard chine 2 & 3* : a helmsman 80 kg squatted in the boat center under the boom, with his center of gravity at Z +50 cm (these designs being too narrow at the waterline to provide enough stability for a 95 kg at Z 65 cm)



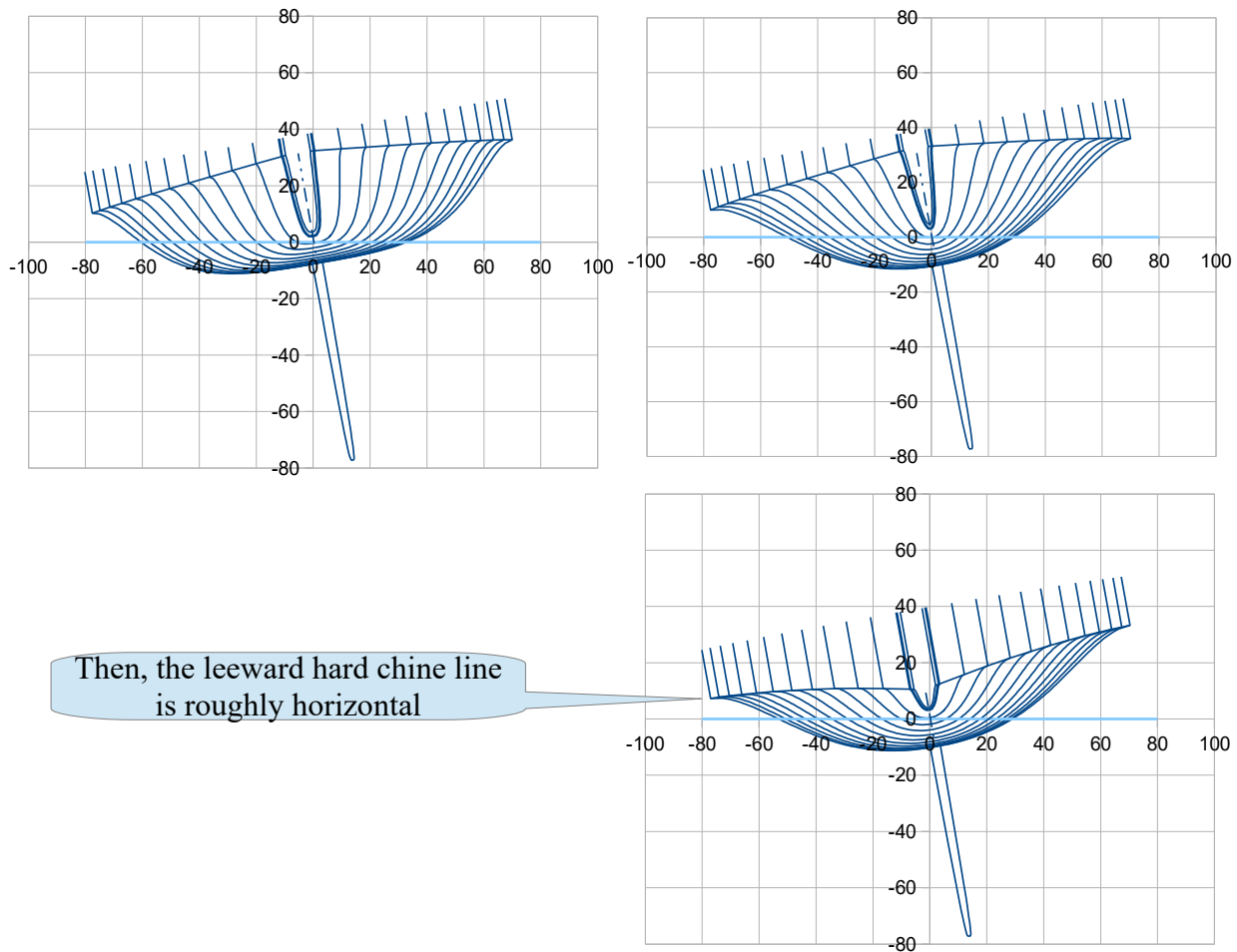
>>> For the 2 and 3 versions with a very low Bwl, the stability is low at small heel angles, but when the heel becomes > 15° the upper eccentric volumes contribute to the righting moment and the GZ curves increase to similar values as to 1 version. The hard chine line 3, with a bit more length forward of the upper volume involved, leads to a GZ bonus.

Righting moment when the « payload » is hiking at windward :

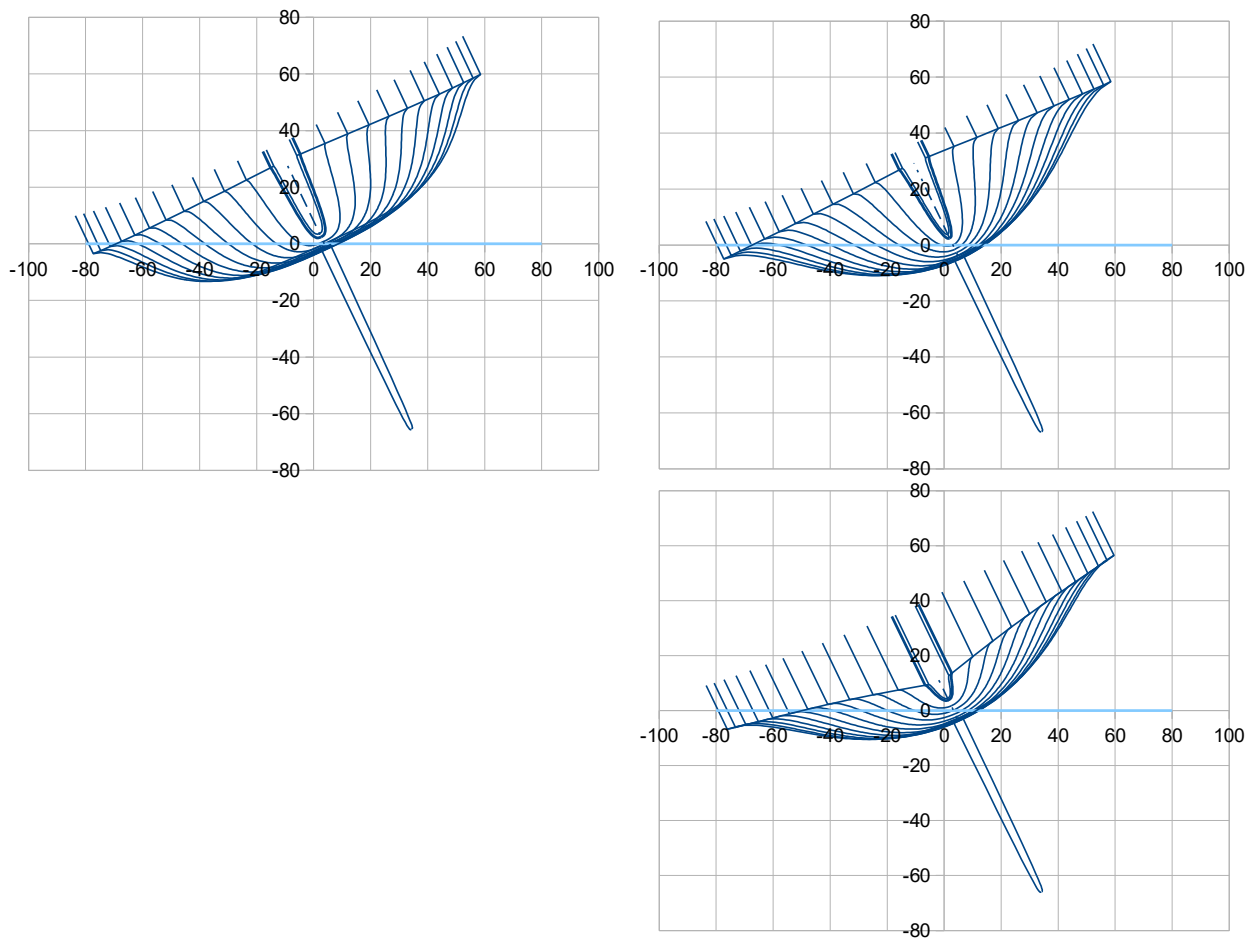
e.g. the helmsman (95 kg for the version 1, 80 kg for versions 2 & 3) is hiking with its center of gravity estimated at about $Y = B/2 + 15$ cm and $Z = 35$ cm (and X still at 150 cm).



Comparison at 10° heel angle (usual dinghy sailing)



Comparison at 25° heel angle (as a last step before a capsize) :



Hydrostatics data upright for the *Convex-concav-hard chine 2* (with 80 kg payload)

2.1 Hull

Loa (m)	3,97	Lwl (m)	3,75	>Hull speed	4,7	(at Fn 0,4)		
>> ft	13,02		12,30					
B (m)	1,60	at X (% Lwl)	18,0					
>> ft	5,25							
Bwl (m)	0,81	at X (% Lwl)	37,0	> Bwl / B	0,505			
>> ft	2,65							
Tc (m)	0,1177	at X (%Lwl)	50			Freeboards (m) >	Aft	Midship
>> ft	0,39						0,31	0,37
							>> ft	>> ft
							1,02	1,21
Displacement at H0 (m3)	0,13098	at Xc (m)	1,751	Xc (%Lwl)	46,70	Zc (m)	-0,041	
>> lbs	296	w. seawater	1025	kg/m3		>> ft	-0,13	
Disp at h (cm)	-0,742931622	at Xc (m)	1,767	Xc (%Lwl)	47,12	Zc (m)	-0,016	
Disp at h (cm)	0,742931622	at Xc (m)	1,735	Xc (%Lwl)	46,26	Zc (m)	-0,066	
Cp (%)	55,11							
Sf (m2)	2,11	at Xf (m)	1,611	Xf (%Lwl)	42,96	>>> Xc – Xf (%Lwl)	3,74	
>> ft2	22,66	>> ft	5,29					
Angle immersed sheer li (°)	25,6	at section C4 (40% Lwl)						
Sw (m2)	2,21	>Sw/D^(2/3)	8,57					
>> ft2	23,80							
Shull (m2)	6,67	at X (m)	1,601	Z (m)	0,083			
>> ft2	71,77	>> ft	5,25	>> ft	0,27			
Sdeck (m2)	4,81	at X (m)	1,456					
>> ft2	51,75	>> ft	4,78					

2.2 Daggerboard

Volume (m3)	0,00273	at X (m)	2,226	X (%Lwl)	59,36	Z (m)	-0,39	
Draft oa (m)	0,80	Sw (m2)	0,29			Sxz (m2)	0,14	
>> ft	2,62	>> ft2	3,13			>> ft2	1,50	
CLR (m)	2,288	CLR (%Lwl)	61,00	method : keel profile extended to the waterline, 25% c at 45% draft oa				
>> ft	7,50							

2.3 Rudder(s)

Number	1							
Volume (m3)	0,00143	at X (m)	-0,246	X (%Lwl)	-6,57	Z (m)	-0,054	
Sw (m2)	0,18	>> ft	-0,81			Sxz (m2)	0,09	per rudder
>> ft2	1,92					>> ft2	0,92	

2.4 Hull + Daggerboard + Rudder(s)

Displacement at H0 (m3)	0,13513	at Xc (m)	1,740	Xc (%Lwl)	46,40	Zc (m)	-0,048	
Disp. (kg)	138,5	>> ft	0,53			>> ft	-0,16	
>> lbs	305							
Sw (m2)	2,68	>Sw/D^(2/3)	10,17	Lwl/D^(1/3)	7,31			
>> ft2	28,84			DLR	73	$M(lbs/2240)/(Lwl(ft)/100)^3$		

2.5 Data from the mass spreadsheet

Boat with payload	M(kg)	138,5	at Xg (m)	1,571	Xc (%Lwl)	41,88	at Zg (m)	0,496
Light boat		58,5		1,667				0,491

Hydrostatics data upright for the *Convex-concav-hard chine 3* (with 80 kg payload)

2.1 Hull

Loa (m)	3,97	Lwl (m)	3,75	>Hull speed	4,7	(at Fn 0,4)		
>> ft	13,02		12,30					
B (m)	1,60	at X (% Lwl)	18,0					
>> ft	5,25							
Bwl (m)	0,82	at X (% Lwl)	39,0	> Bwl / B	0,513			
>> ft	2,69							
Tc (m)	0,1133	at X (%Lwl)	50					
>> ft	0,37							
Displacement at H0 (m3)	0,13137	at Xc (m)	1,773	Xc (%Lwl)	47,27			
>> lbs	297	w. seawater	1025	kg/m3				
Disp at h (cm)	-0,727634986	at Xc (m)	1,786	Xc (%Lwl)	47,63			
Disp at h (cm)	0,727634986	at Xc (m)	1,758	Xc (%Lwl)	46,88			
Cp (%)	56,03							
Sf (m2)	2,19	at Xf (m)	1,652	Xf (%Lwl)	44,04	>>> Xc – Xf (%Lwl)	3,23	
>> ft2	23,60	>> ft	5,42					
Angle immersed sheer li (°)	25,7	at section C4 (40% Lwl)						
Sw (m2)	2,28	>Sw/D^(2/3)	8,82					
>> ft2	24,54							
Shull (m2)	6,77	at X (m)	1,617	Z (m)	0,079			
>> ft2	72,89	>> ft	5,30	>> ft	0,26			
Sdeck (m2)	4,79	at X (m)	1,450					
>> ft2	51,53	>> ft	4,76					

2.2 Daggerboard

Volume (m3)	0,00275	at X (m)	2,226	X (%Lwl)	59,36	Z (m)	-0,38	
Draft oa (m)	0,80	Sw (m2)	0,29			Sxz (m2)	0,14	
>> ft	2,62	>> ft2	3,15			>> ft2	1,51	
CLR (m)	2,288	CLR (%Lwl)	61,00	method : keel profile extended to the waterline, 25% c at 45% draft oa				
>> ft	7,50							

2.3 Rudder(s)

Number	1							
Volume (m3)	0,00143	at X (m)	-0,246	X (%Lwl)	-6,57	Z (m)	-0,054	
Sw (m2)	0,18	>> ft	-0,81			Sxz (m2)	0,09	per rudder
>> ft2	1,92					>> ft2	0,92	

2.4 Hull + Daggerboard + Rudder(s)

Displacement at H0 (m3)	0,13554	at Xc (m)	1,761	Xc (%Lwl)	46,95	Zc (m)	-0,046	
Disp. (kg)	138,9	>> ft	0,54			>> ft	-0,15	
>> lbs	306							
Sw (m2)	2,75	>Sw/D^(2/3)	10,42	Lwl/D^(1/3)	7,30			
>> ft2	29,60			DLR	73			
								$M(lbs/2240)/(Lwl(ft)/100)^3$

2.5 Data from the mass spreadsheet

Boat with payload	M(kg)	138,9	at Xg (m)	1,573	Xc (%Lwl)	41,95	at Zg (m)	0,408
Light boat		58,9		1,673				0,486