As for 2019-05-27

Dinghy 13 hull investigation, for more RM and stability margin

Rev. 3 : the Convex-concav-hard chine option

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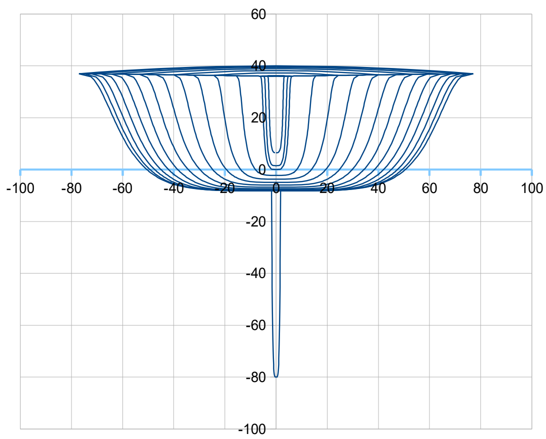
This shape investigation for the hull sections is proposed to combine a greater beam overall (to maximize the righting moment from the helmsman in hiking position) with a minimal beam at waterline (to reduce the drag) while maintaining a managable stability (especially during a tack or a gybe by rough seas).

***The Revision 3 introduces a Convex-concav-hard chine* option :**

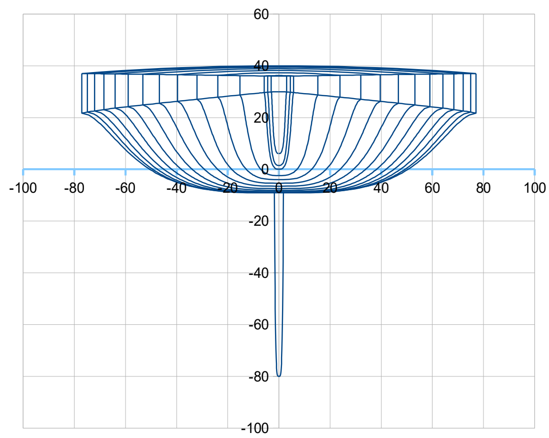
- from the convex-concav one, the concav upper end is lower to an hard chine line, introducing a upper volume contibuting to the RM for heel angle > 15°
- the comparison is made with same Bwl 1,02 m (upright, with payload 95 kg), leading to similar stability condition for 0° to 15° heel angles

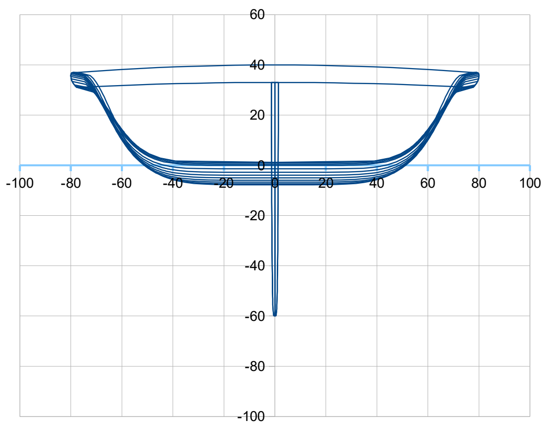
Lhull : 3,97 m (13 ft) ; Bhull : 1,60 m ; Light weight assumed 59 kg (with a 8 m2 sail)
With the design « payload » 95 kg (a heavy helmsman case) :
>>> Lwl : 3,75 m ; Bwl : 1,02 m >>> Bwl / Bhull ~ 0,64

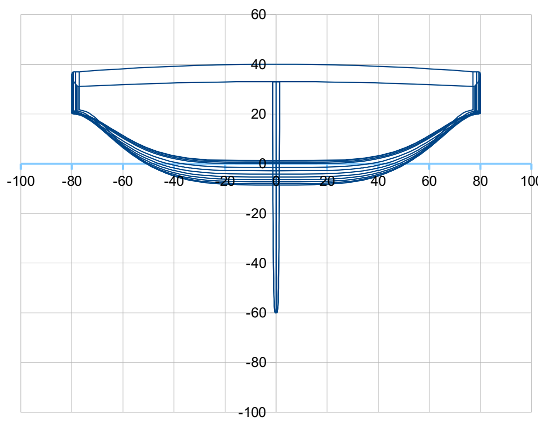
Convex-concav 1



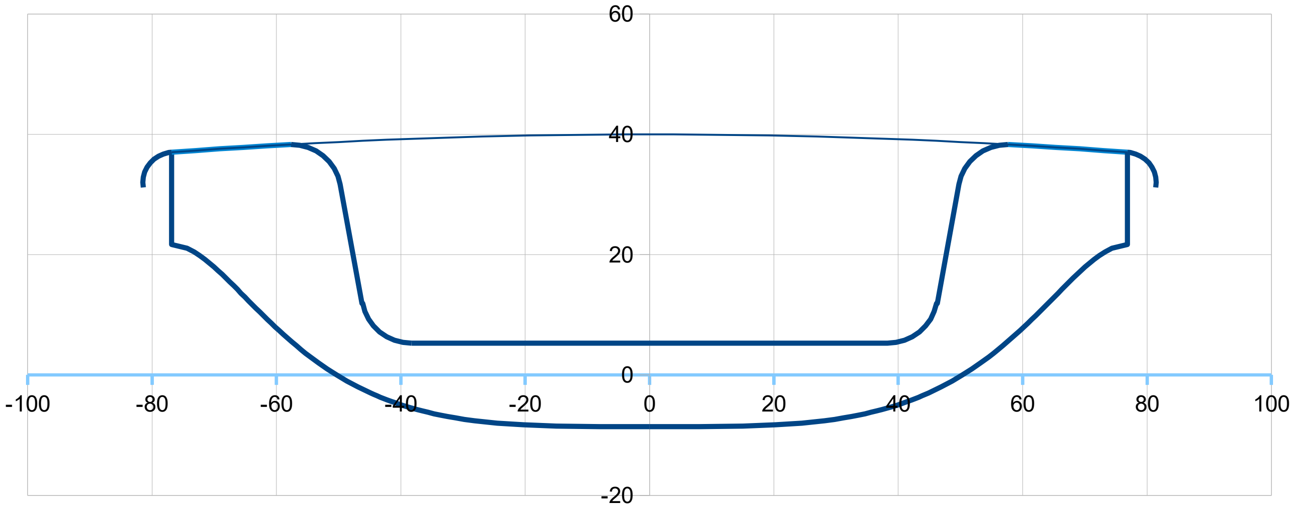
>>> Convex-concav-hard chine



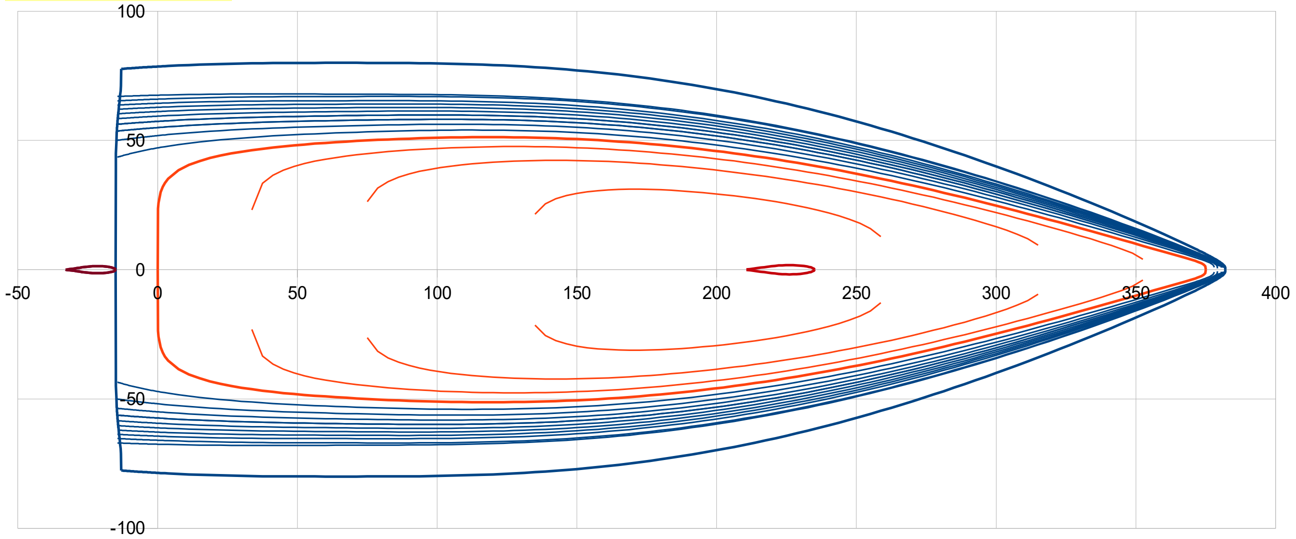




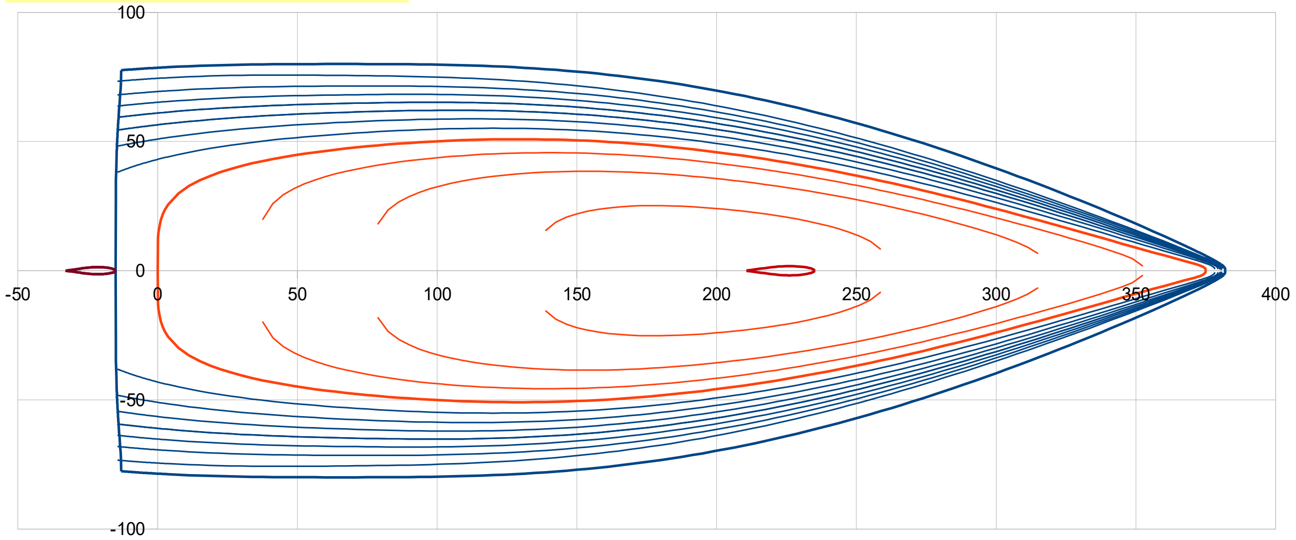
Convex-concav-hard chine section at X 150



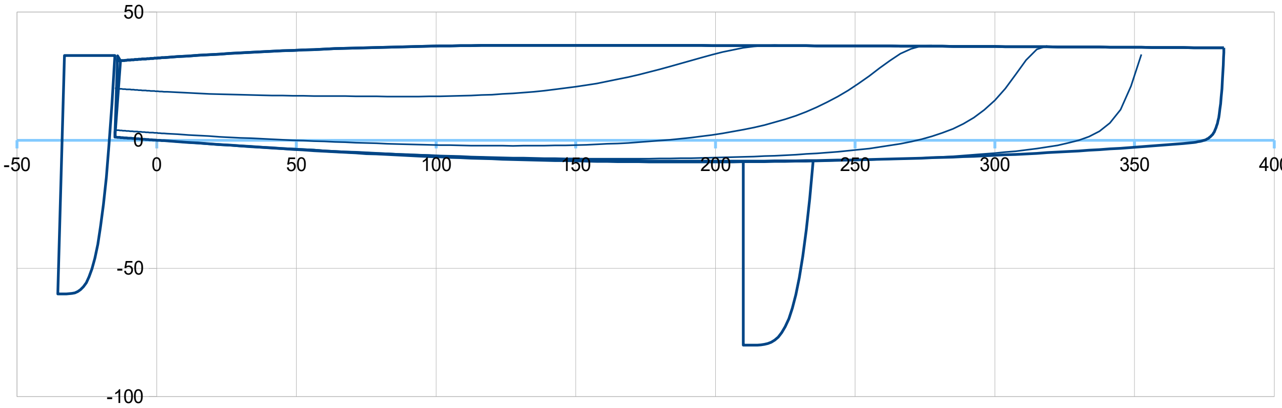
Convex-concav 1



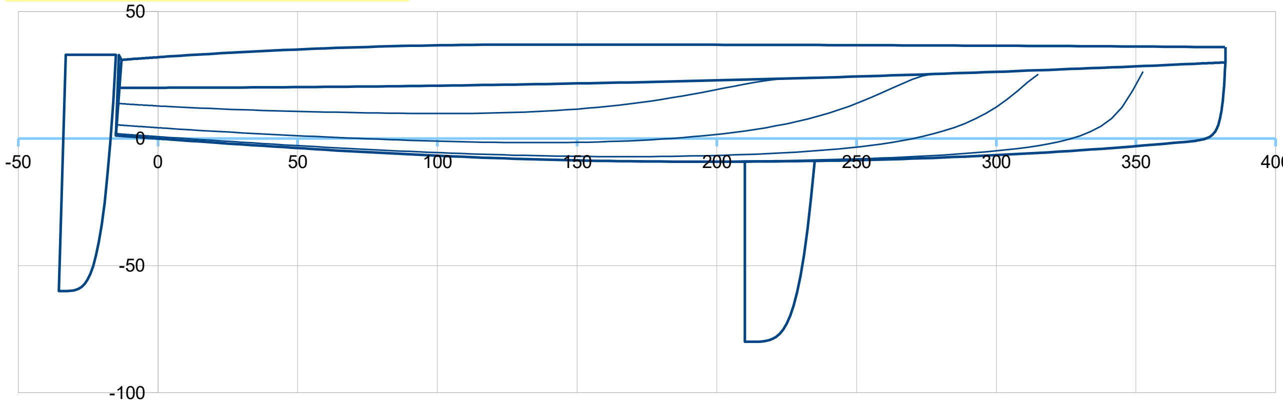
>>> Convex-concav-hard chine



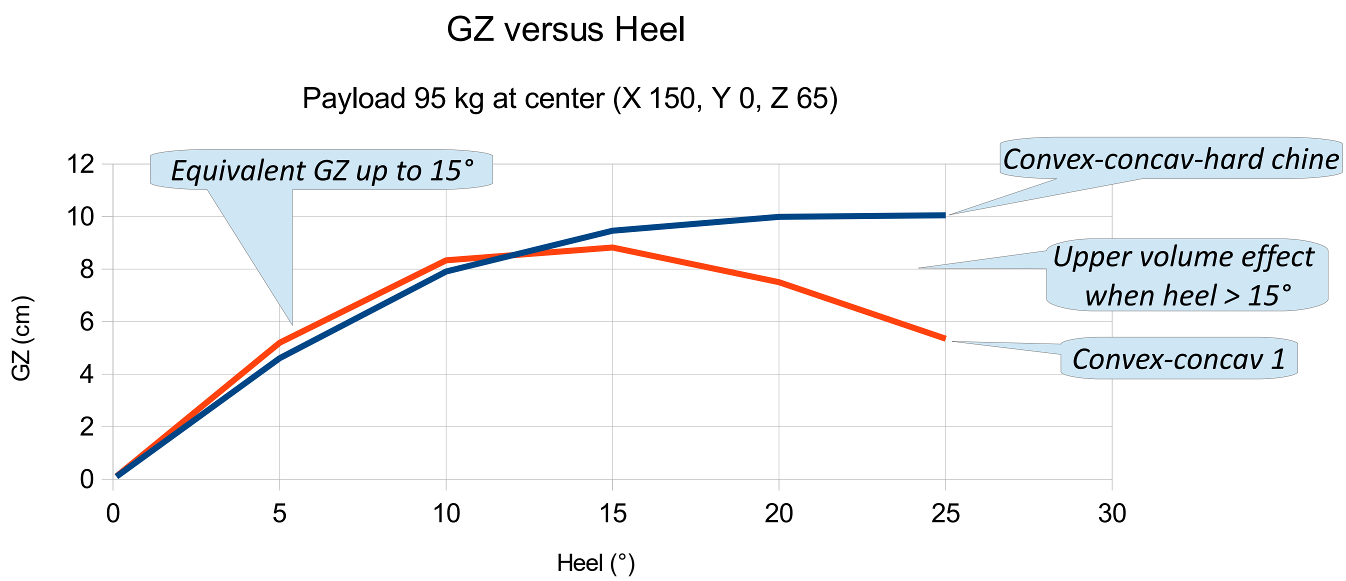
Convex-concav 1



>>> Convex-concav-hard chine

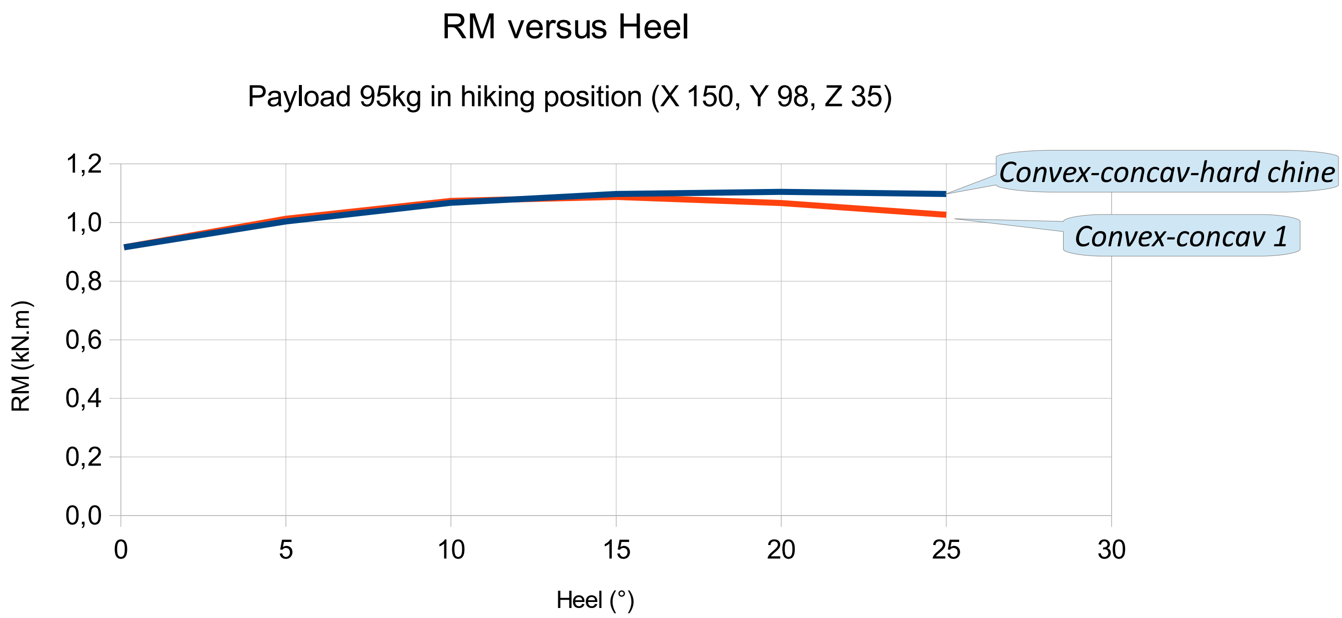


Stability issue when considering the « payload » in the center :
assuming a (heavy) helmsman (95kg) squatted in the boat center under the boom, with his center of gravity at Z +65 cm. It is typically the tack or gybe configuration. Here for the stability comparison it is assumed that the helsman is (temporarly) fixed like a statue in the center of the boat. and we look at the righting arm GZ evolution for heel up to 25°, able to counter a decentering of the payload and/or an external action (waves, dynamics of a manoeuver) :

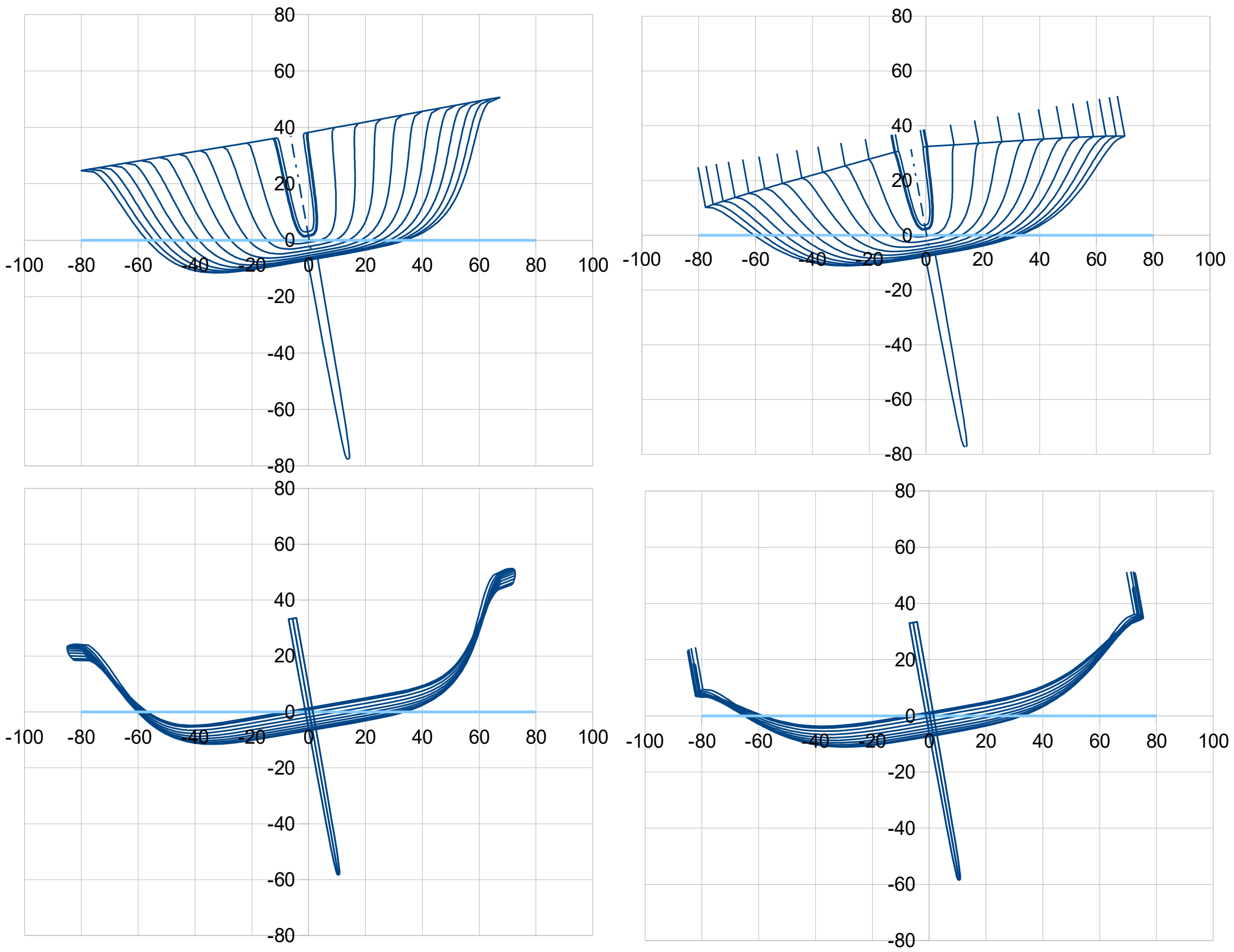


>>> we can have a GZ curve like the one with the bi-convex options, i.e. without drop after 15° heel angle.

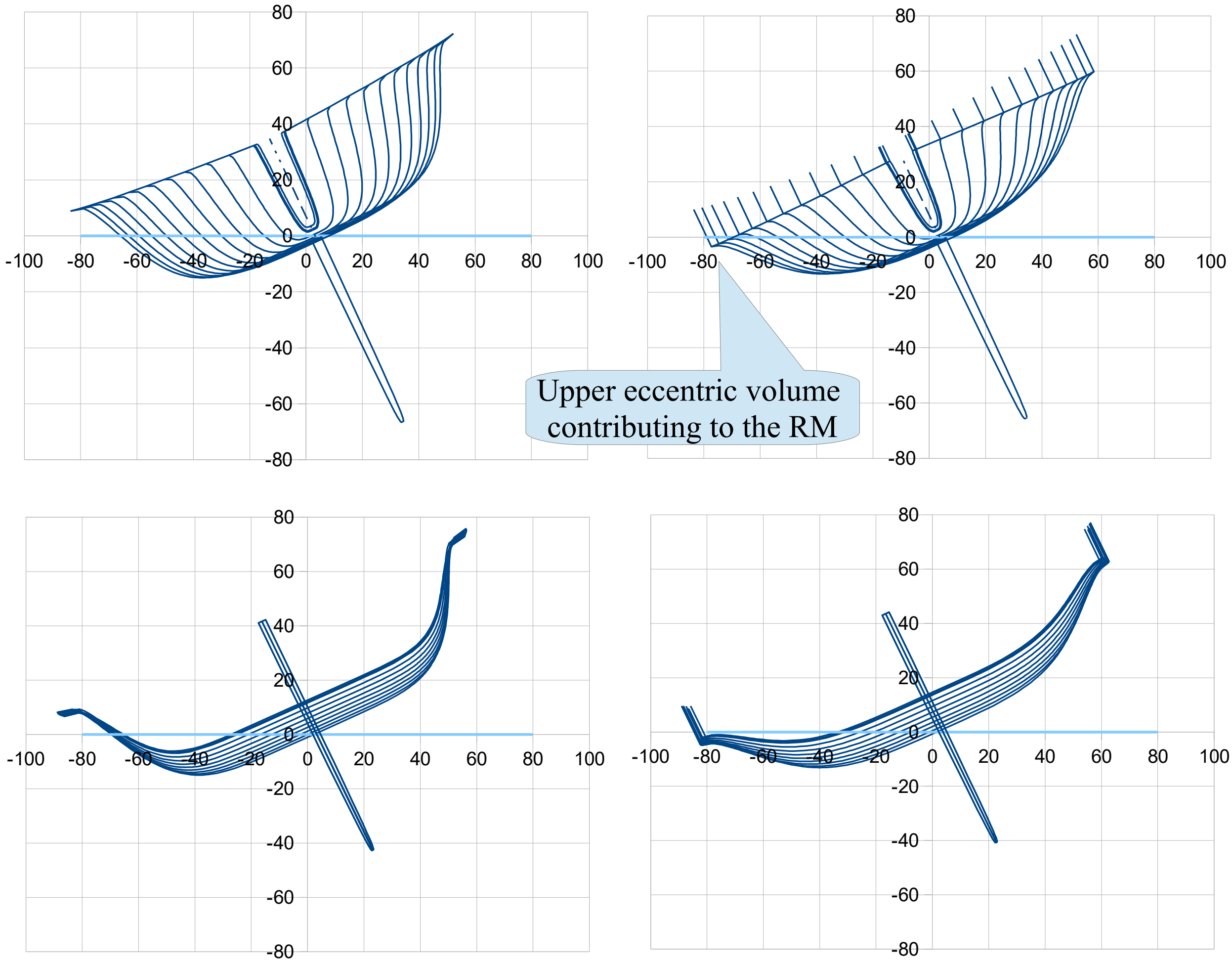
Righting moment when the « payload » is hiking at windward :
e.g. the helmsman is hiking with its center of gravity estimated at about Y = B/2 + 15 cm and Z = 35 cm (and X still at 150 cm).



Comparison at 10° heel angle (usual dinghy sailing)



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



>>> the upper volume effect can help prevent a capsize

Hydrostatics data upright for the *Convex-concav-hard chine* version (with 95 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)	1,02	at X (% Lwl)	34,0	> Bwl / B	0,636			
					Freeboards (m) >	Aft	Midship	Fore
Tc (m)	0,091	at X (%Lwl)	50			0,31	0,37	0,36
>> ft	0,30				>> ft	1,02	1,21	1,18
Displacement at H0 (m3)		0,14589	at Xc (m)	1,738	Xc (%Lwl)	46,35	Zc (m)	-0,033
	>> lbs	330	w. seawater	1025	kg/m3		>> ft	-0,11
Disp at h (cm)	-0,366432561	0,13606	at Xc (m)	1,748	Xc (%Lwl)	46,61	Zc (m)	-0,006
Disp at h (cm)	0,366432561	0,15610	at Xc (m)	1,727	Xc (%Lwl)	46,05	Zc (m)	-0,061
Cp (%)	56,19							
Sf (m2)	2,76	at Xf (m)	1,574	Xf (%Lwl)	41,99		>>> Xc – Xf (%Lwl)	4,36
>> ft2	29,68	>> ft	5,17					
Angle immersed sheer li (°)		25,6	at section C4 (40% Lwl)					
Sw (m2)	2,79	>Sw/D^(2/3)	10,09					
>> ft2	30,08							
Shull (m2)	6,76	at X (m)	1,605	Z (m)	0,068			
>> ft2	72,76	>> ft	5,26	>> ft	0,22			
Sdeck (m2)	4,81	at X (m)	1,456					
>> ft2	51,75	>> ft	4,78					
2.2 Daggerboard								
Volume (m3)	0,00283	at X (m)	2,226	X (%Lwl)	59,36	Z (m)	-0,37	
Draft oa (m)	0,80		Sw (m2)	0,30		Sxz (m2)	0,15	
>> ft	2,62		>> ft2	3,25		>> ft2	1,56	
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)		0,15015	at Xc (m)	1,728	Xc (%Lwl)	46,09	Zc (m)	-0,040
	Disp. (kg)	153,9	>> ft	0,53			>> ft	-0,13
	>> lbs	339						
	Sw (m2)	3,27	>Sw/D^(2/3)	11,59	Lwl/D^(1/3)	7,06		
	>> ft2	35,25			DLR	81	M(lbs/2240)/(Lwl(ft)/100)^3	
2.5 Data from the mass spreadsheet								
Boat with payload	M(kg)	153,9	at Xg (m)	1,564	Xc (%Lwl)	41,71	at Zg (m)	0,400
Light boat		58,9		1,668				0,481

Sailplan (with sail 8 m2 and small sail option 6 m2)