2019 01 06

Dinghy 13 investigation with hull bi-convex option

Rev. 5: Bi-convex soft and Convex-concav-hard chine final versions

sharing same dimensions and similar GZ curve (when payload at center)

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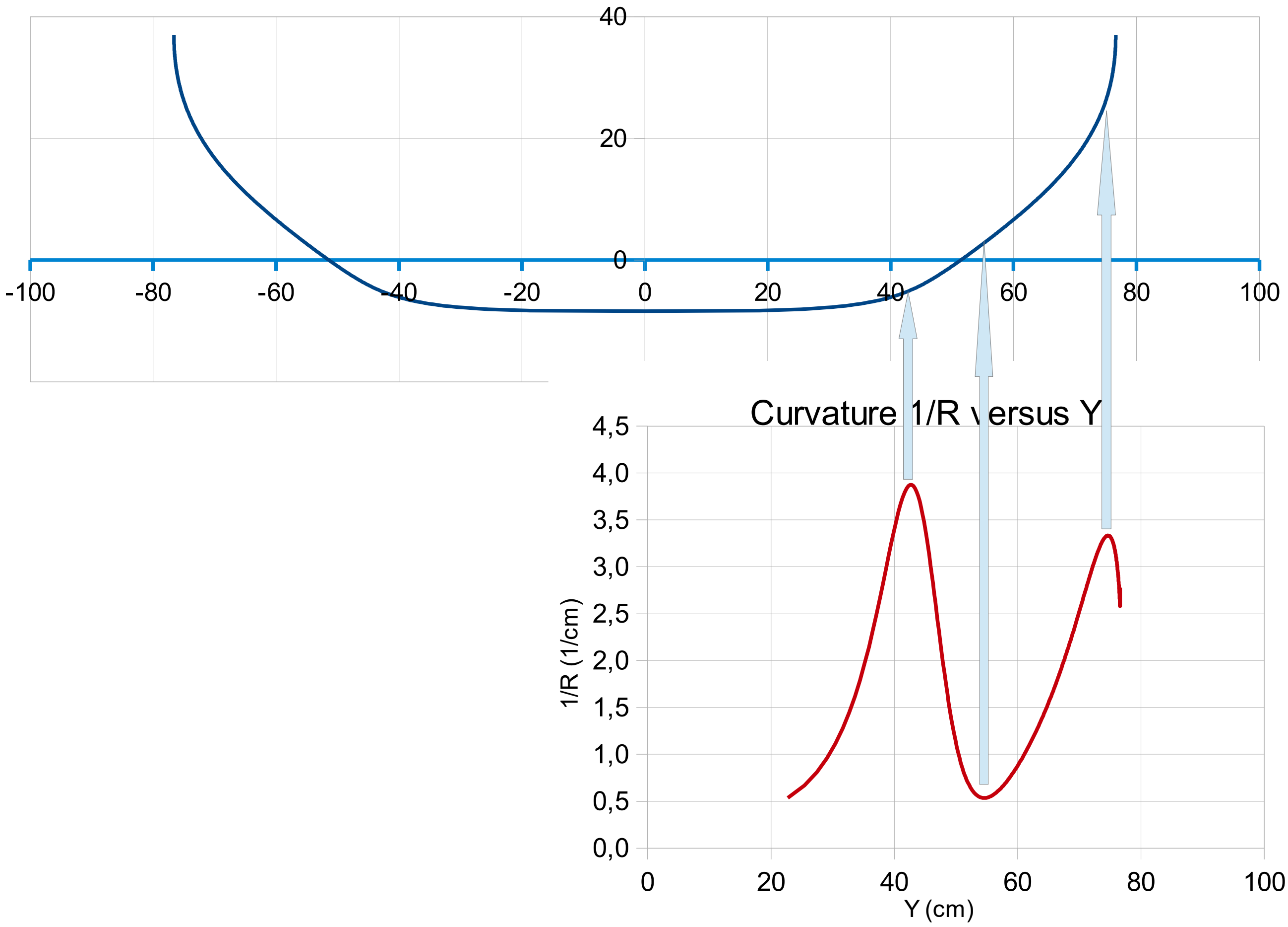
I eventually converge to two variants sharing (quasi) the same dimensions, inc. beam waterline Bwl (~ 1,00 m with the design payload 95 kg), stability and righting moment features.

The principle of the *Bi-convex soft* is : between the lower and the upper convexity of sections shape, the line is flatten but not up to a zero curvature neither to a concavity :



>>> the convexity is kept positive

Common data : Lhull : 3,97 m (13 ft) ; Bhull : 1,60 m (at sheer line) , 1,70 m (overall, with the roudned benches to ease the hiking posture) ; Light weight assumed ~ 59 kg (with a 8 m2 sail)

With the design « payload » 95 kg (a heavy helmsman case) :

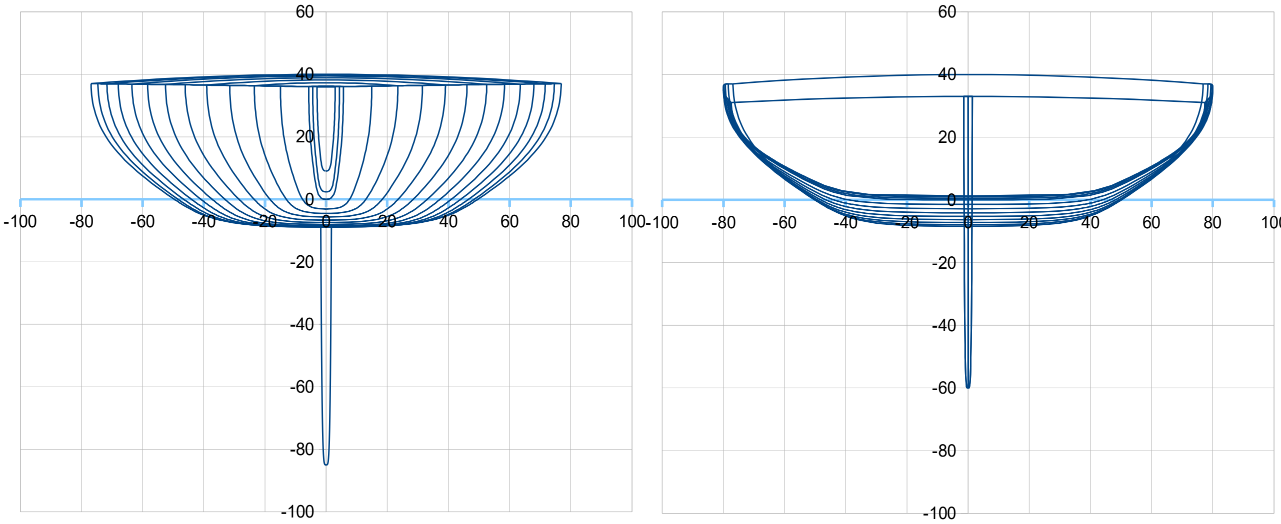
Lwl : 3,75 m

Bwl : 1,00 m (*Bi-convex soft)* , 1,01 m *(Convex-concav-hard chine)*

Bi-convex soft :

Bwl : 1,00 m ; Cp : 57,0 % ; LCB : 46,4 % Lwl ; Total Sw (at 10° heel) : 3,17 m2

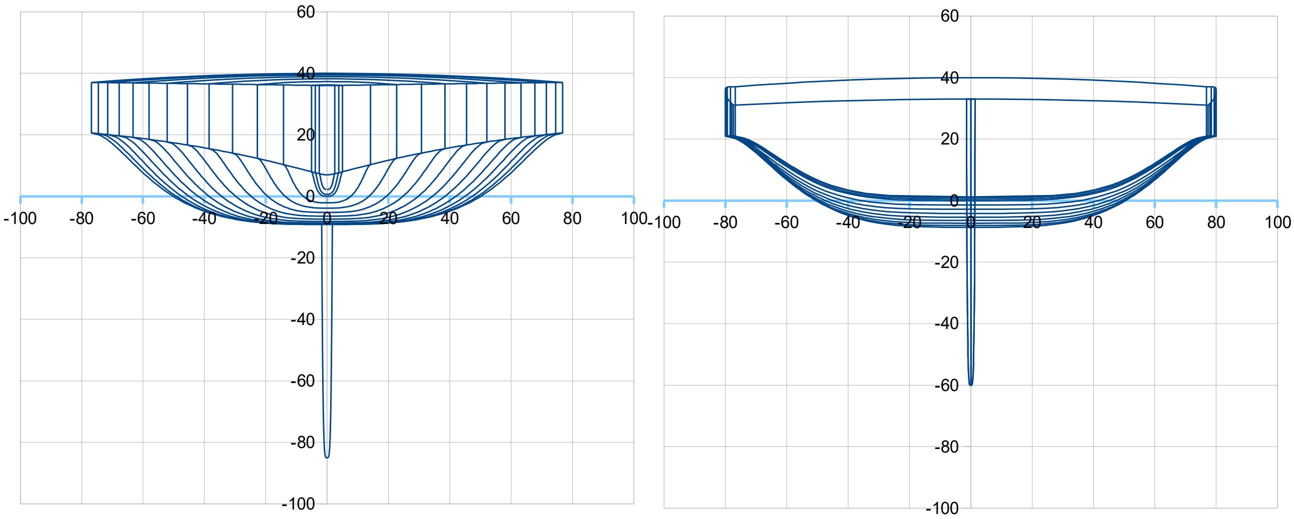
Stability (with payload 95 kg at center) : **GM0,1° = 53,6 cm** ; GZ at 20° heel = 10,1 cm



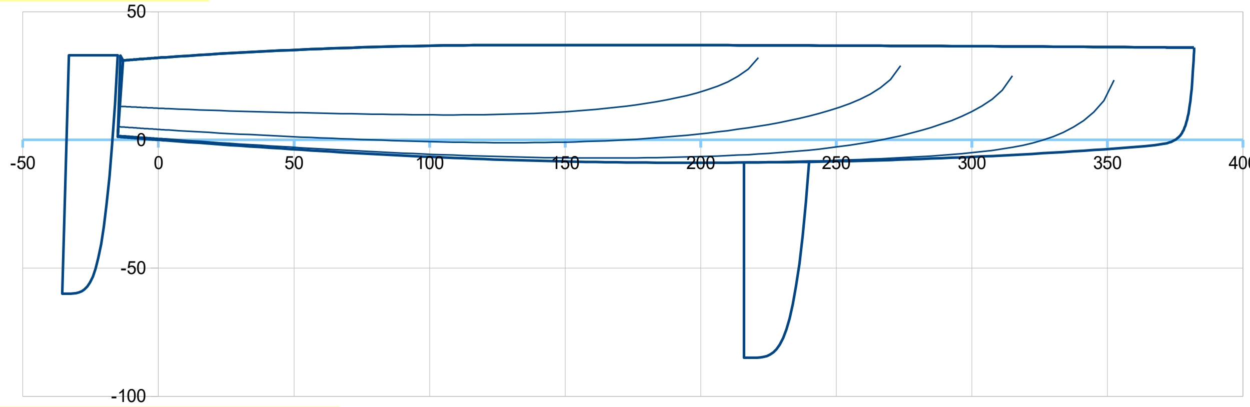
Convex-concav-hard chine :

Bwl : 1,01 m ; Cp : 56,2 % ; LCB : 46,5 % Lwl ; Total Sw (at 10° heel) 3,14 m2

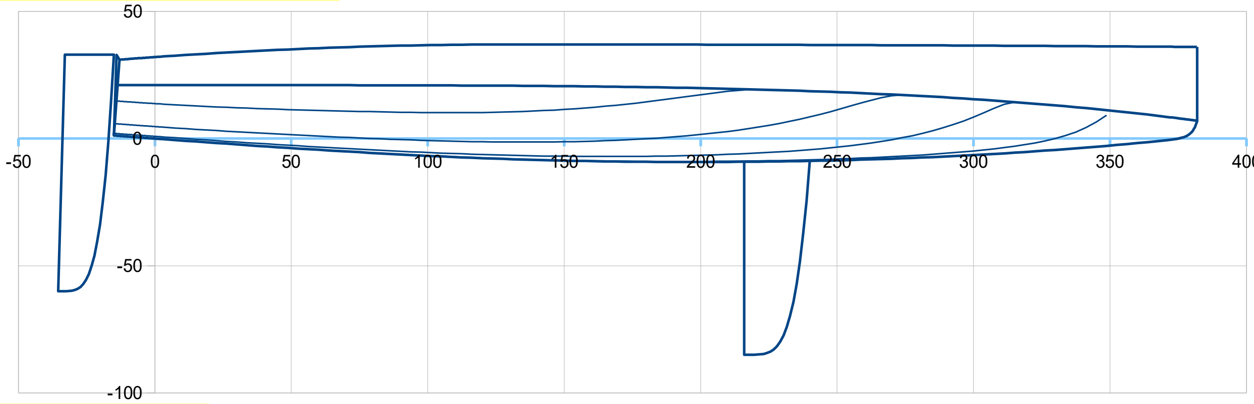
Stability (with payload 95 kg at center) : **GM0,1° = 53,8 cm** ; GZ at 20° heel = 10,3 cm



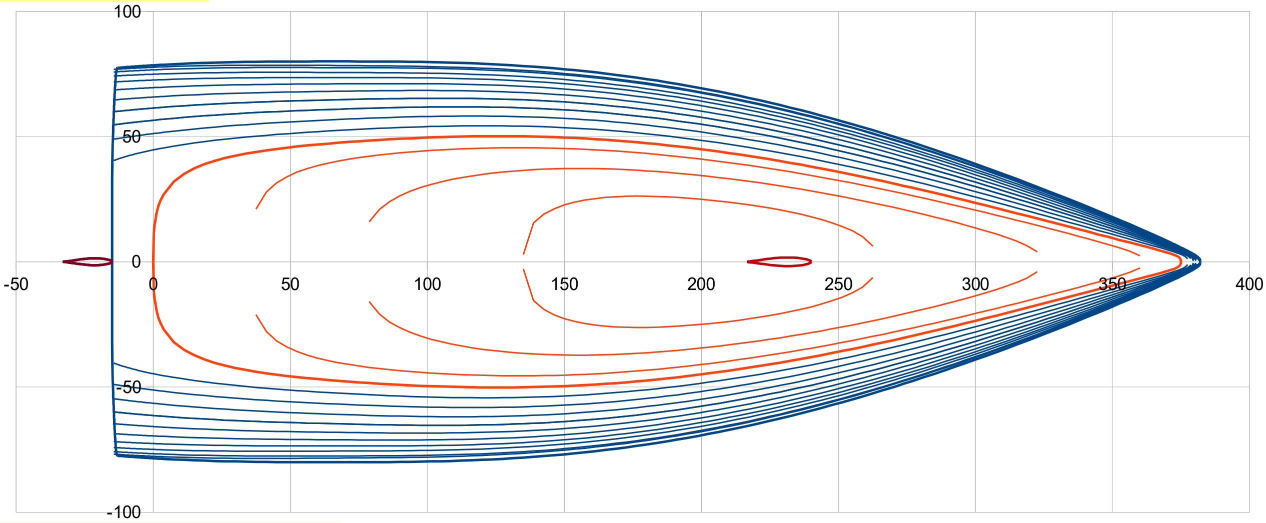
Bi-convex soft :



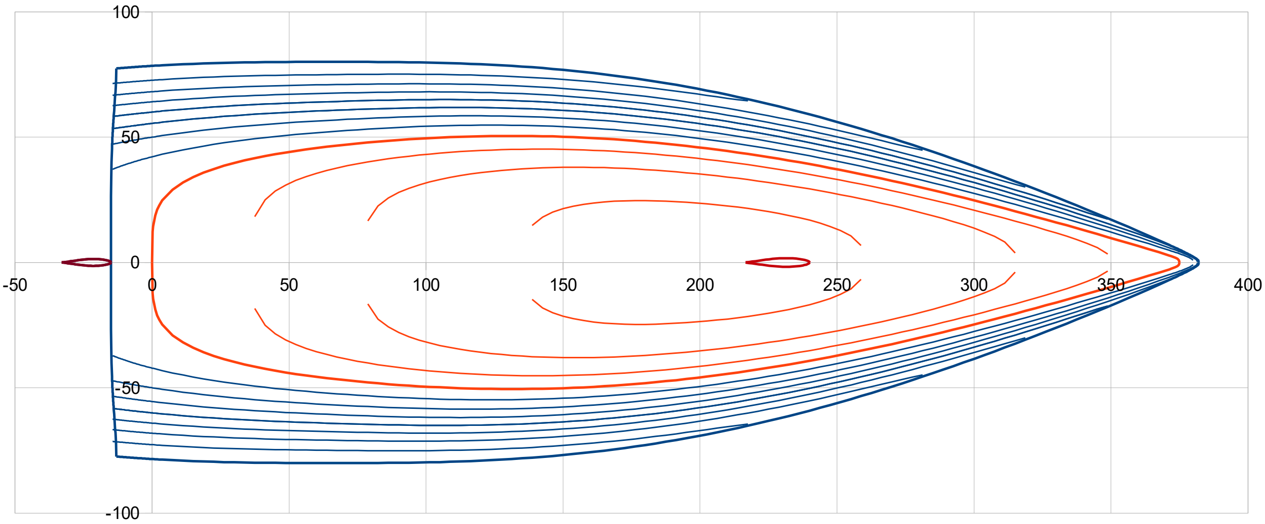
Convex-concav-hard chine



Bi-convex soft :

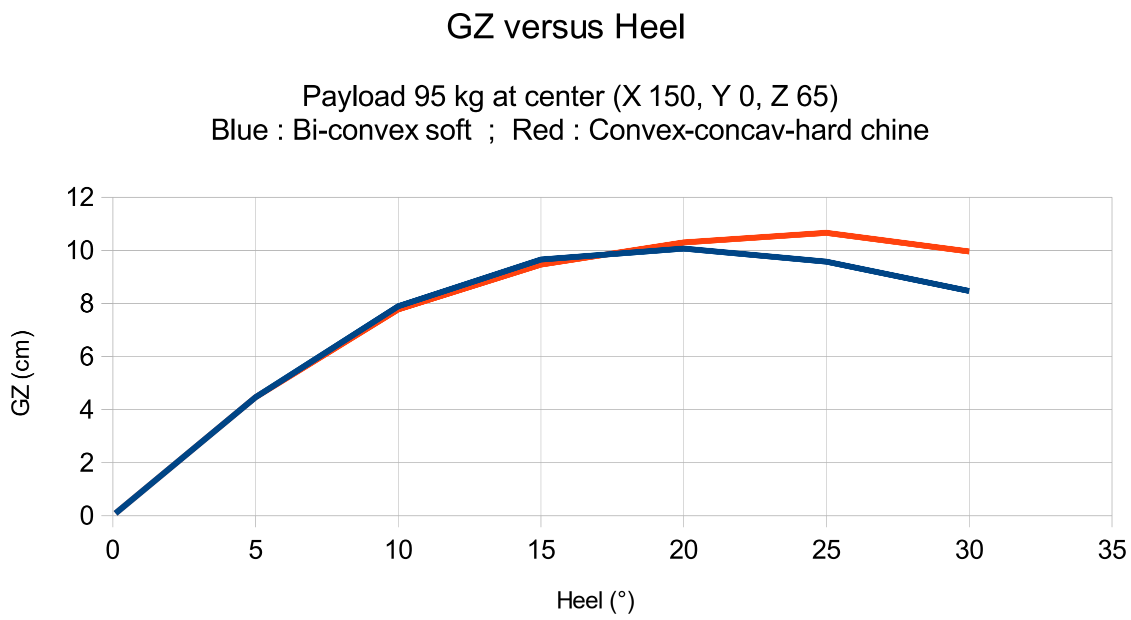


Convex-concav-hard chine



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

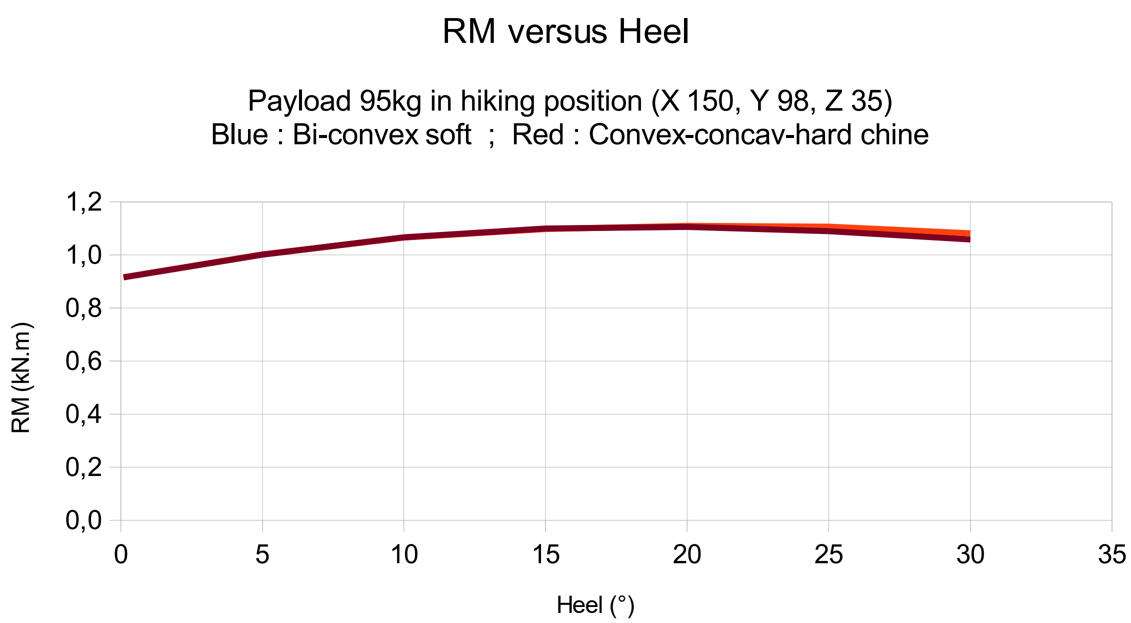
e.g. the (heavy) helmsman (95 kg) squatted in the boat center under the boom, with his center of gravity at Z +65 cm. It is typically the tack or gybe configuration. Here for the stability comparison it is assumed that the helsman is (temporarly) fixed like a statue in the center of the boat. and we look at the righting arm GZ evolution for heel up to 25°, due to external action (waves, dynamics of a manoeuver) and/or due to a transversal offset of the payload.



>>> equivalent GZ up to 20° heel angle, then a slight advantage for the Convex-concav-hard chine

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

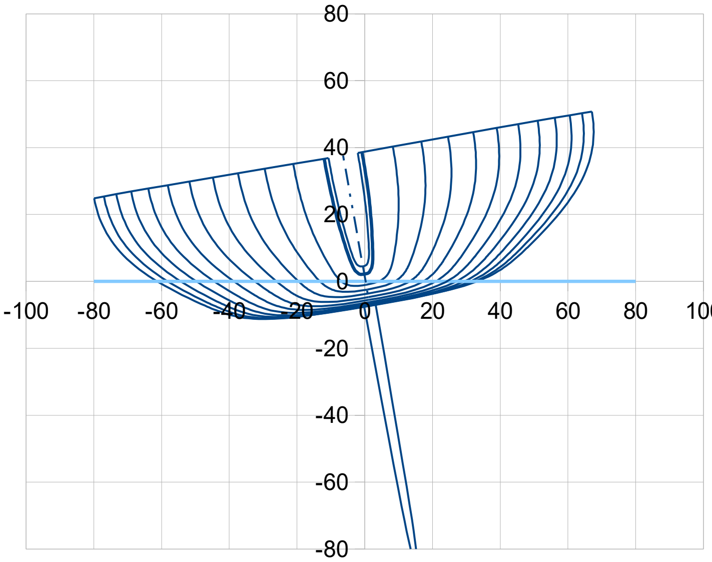
e.g. the helmsman is hiking with its center of gravity estimated at about Y = B/2 + 15 cm and Z = 35 cm (and X still at 150 cm)



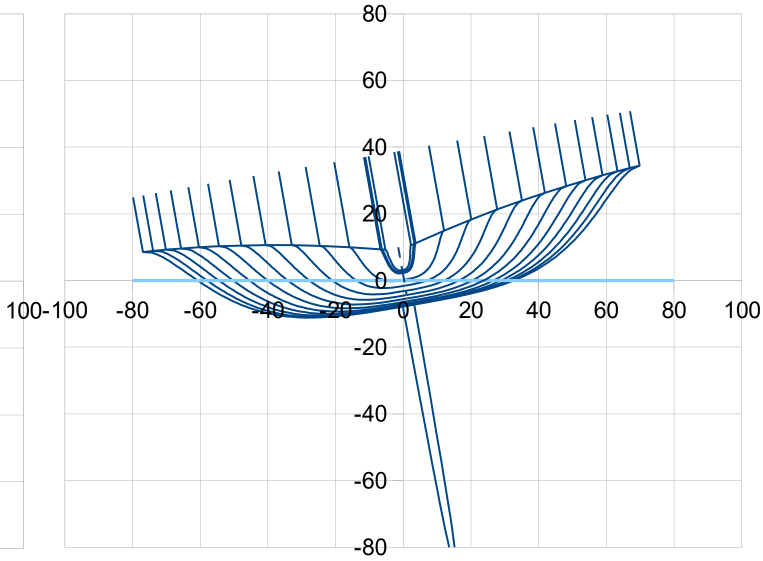
>>> at 10° heel angle, the hull provides + 16% RM : 0,92 kN.m >> 1,07 kN.m

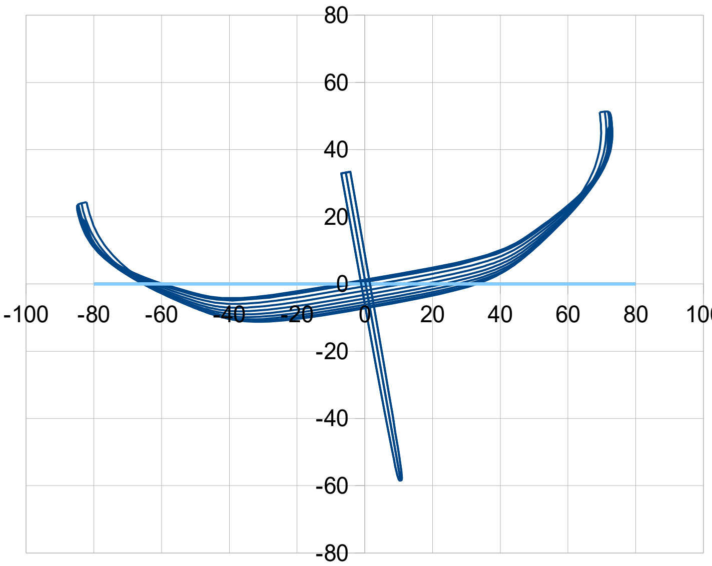
Comparison at 10° heel angle :

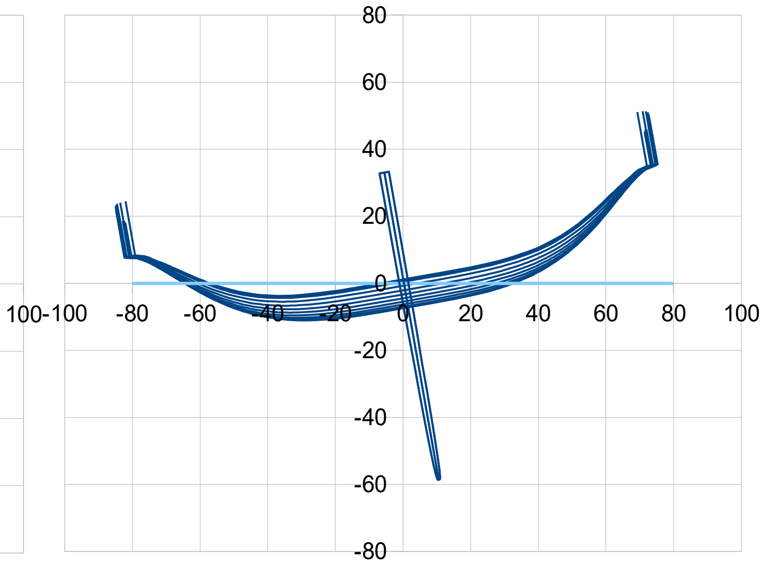
Bi-convex soft



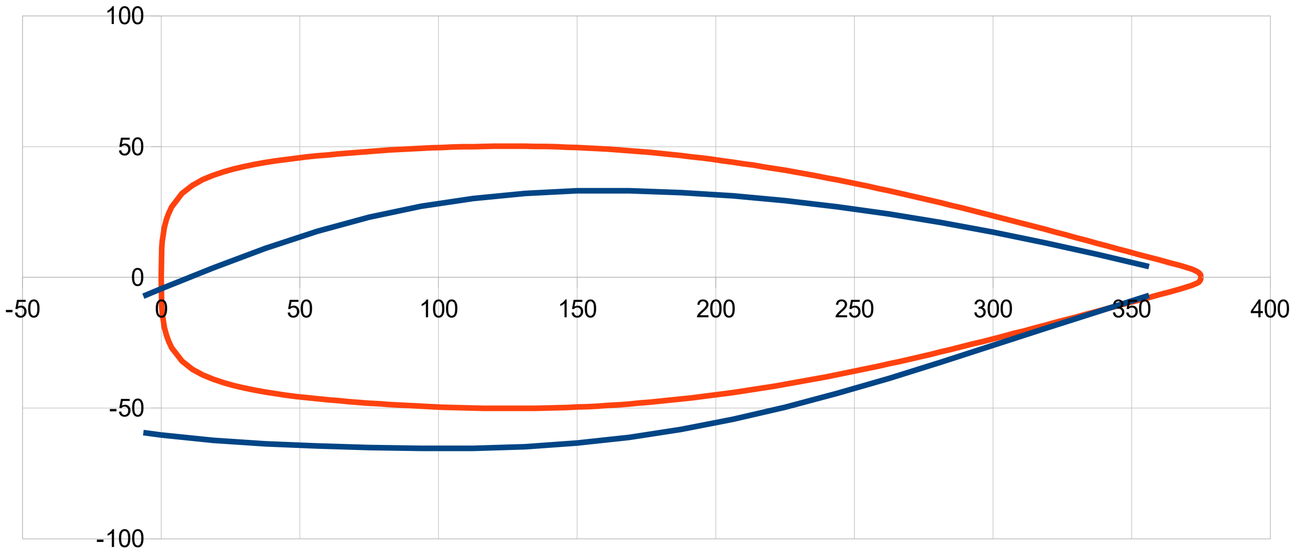
Convex-concav-hard chine



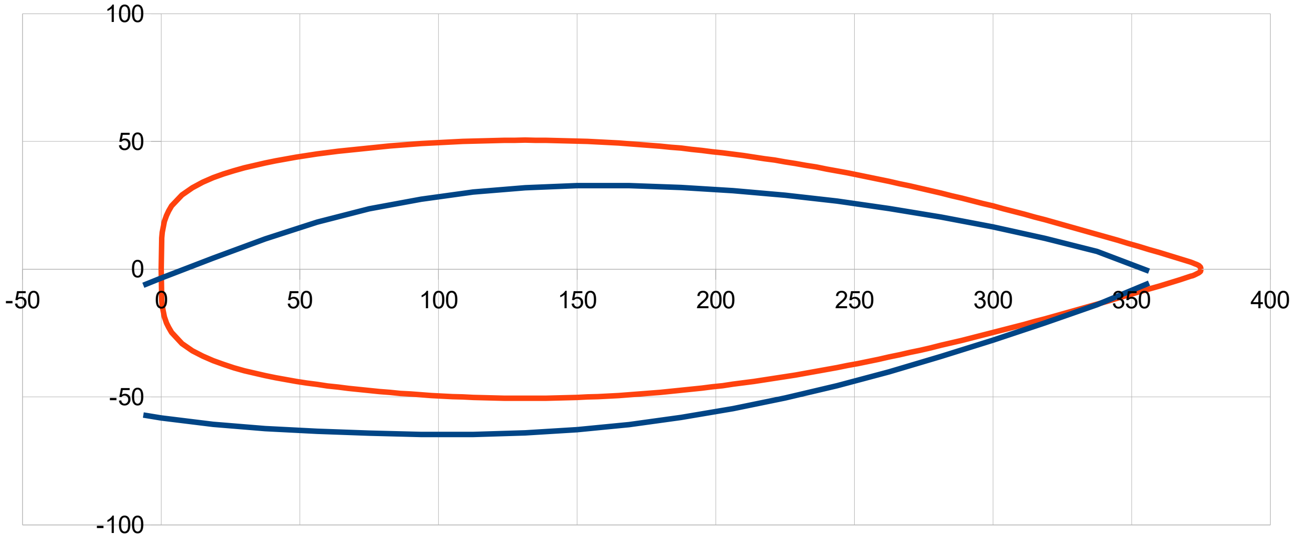




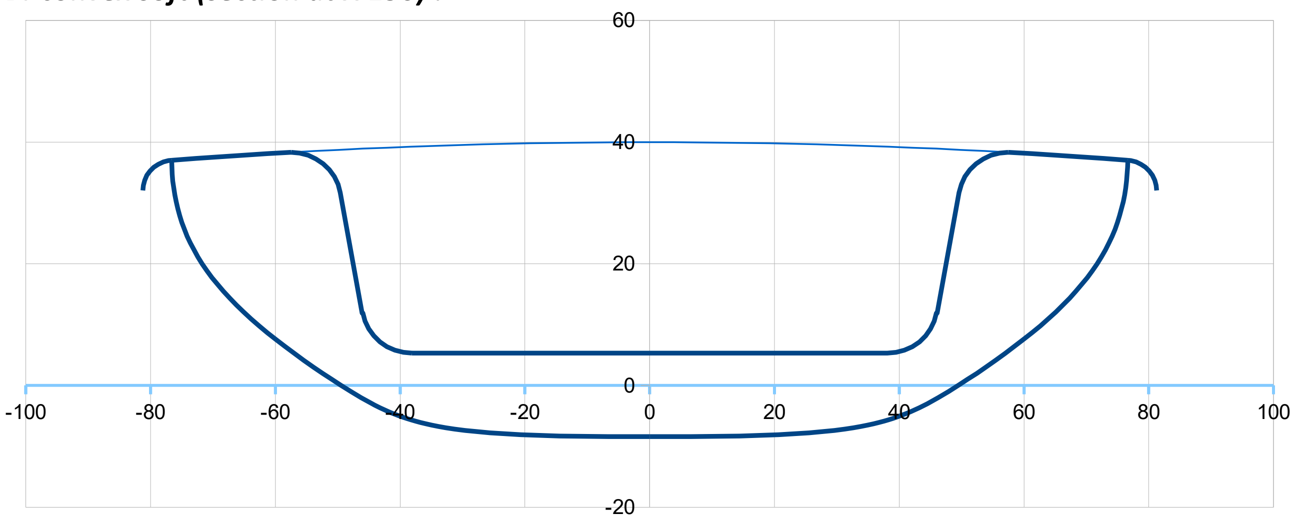
Bi-convex soft



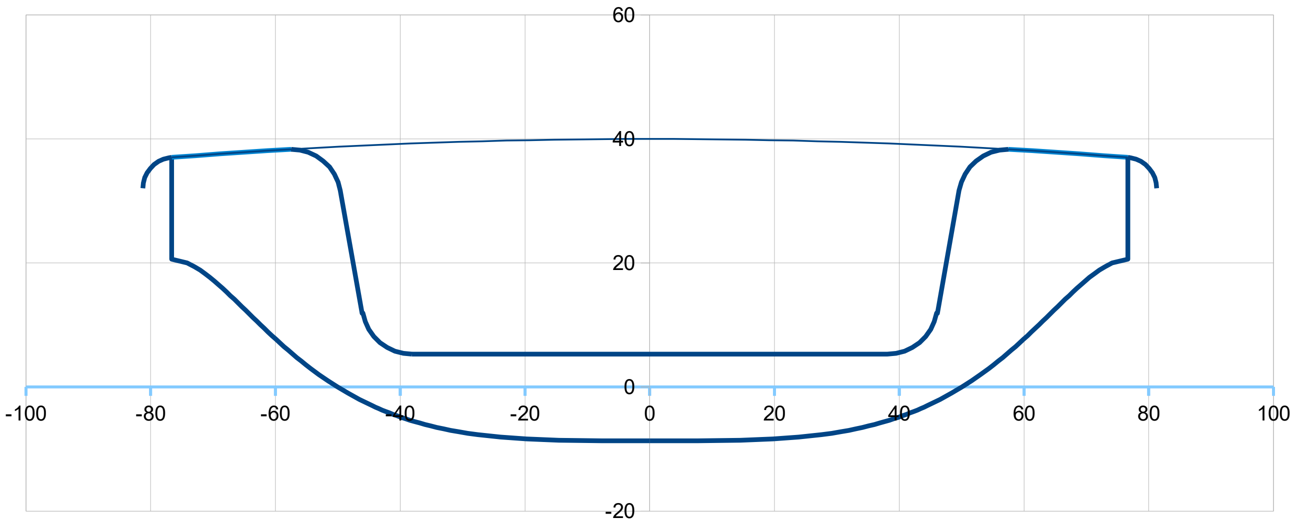
Convex-concav-hard chine



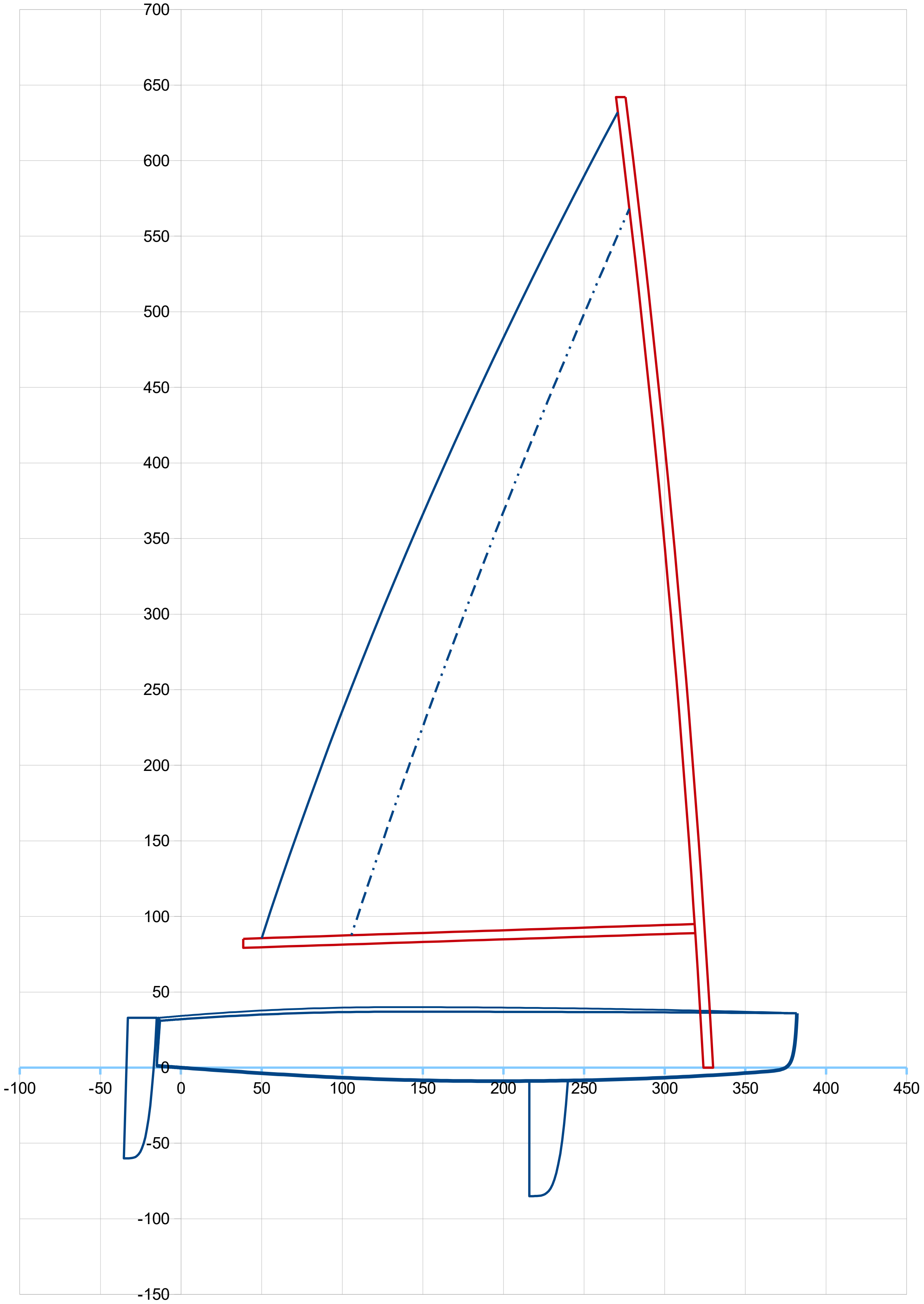
Bi-convex soft (section at X 150) :



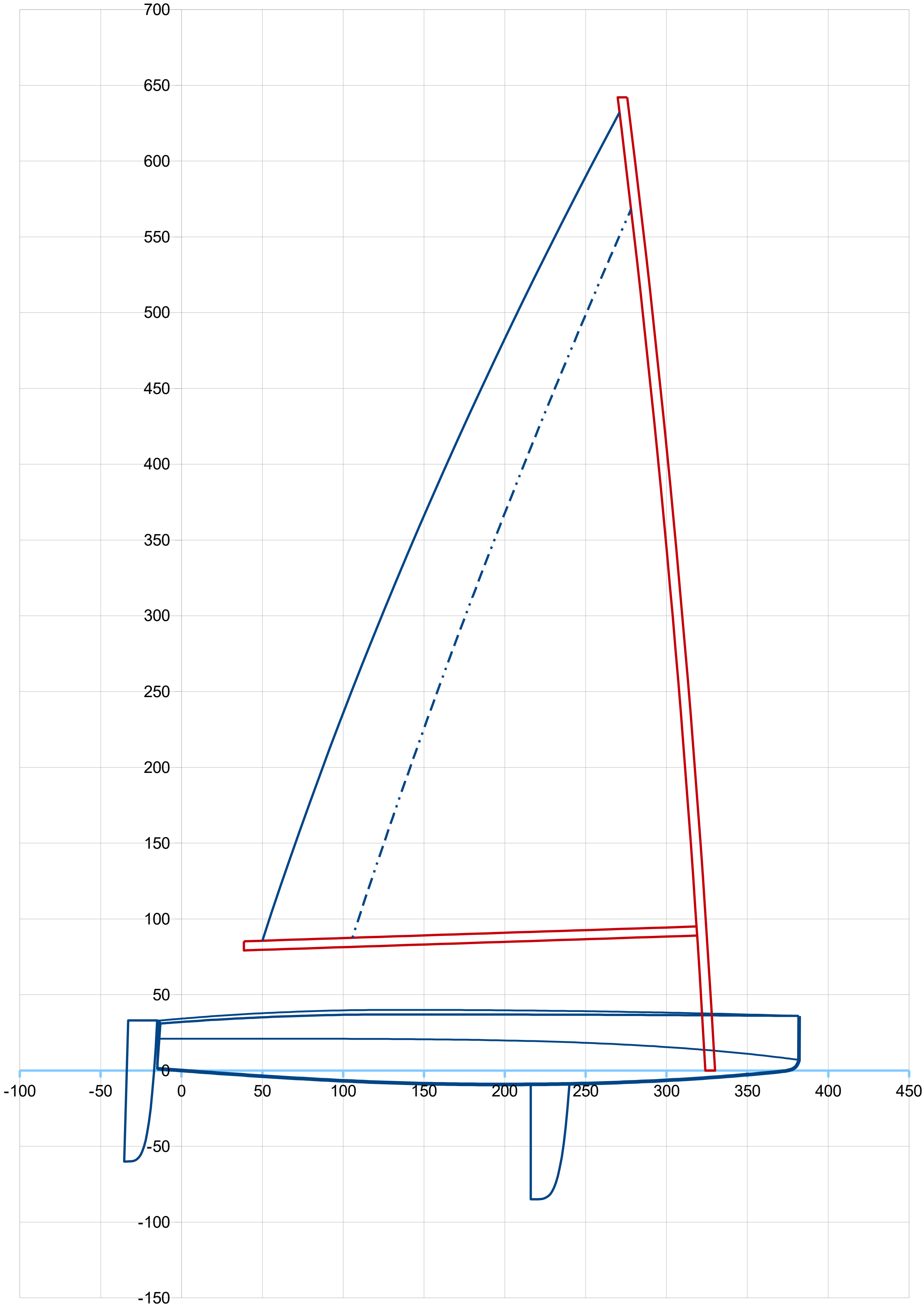
Convex-concav-hard chine (section at X 150) :



Bi-convex soft - Sailplan (with sail 8 m2 and small sail option 6 m2)



Convex-concav-hard chine - Sailplan (with sail 8 m2 and small sail option 6 m2)



***Bi-convex soft* - Hydrostatics** (upright, displacement with payload 95 kg) :

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)	**1,00**	**at X (% Lwl)**	**34,0**	> Bwl / B	0,627			
>> ft	*3,29*				**Freeboards (m) >**	**Aft**	**Midship**	**Fore**
Tc (m)	**0,089**	**at X (%Lwl)**	**50**			**0,31**	**0,37**	**0,36**
>> ft	*0,29*				*>> ft*	*1,02*	*1,21*	*1,18*
Displacement at H0 (m3)		**0,14524**	**at Xc (m)**	**1,739**	**Xc (%Lwl)**	**46,39**	**Zc (m)**	**-0,033**
	>> lbs	*328*	*w. seawater*	*1025*	*kg/m3*		*>> ft*	*-0,11*
Disp at h (cm)	-0,359675757	0,13564	at Xc (m)	1,750	Xc (%Lwl)	46,67	Zc (m)	-0,005
Disp at h (cm)	0,359675757	0,15521	at Xc (m)	1,728	Xc (%Lwl)	46,07	Zc (m)	-0,061
Cp (%)	**57,03**							
Sf (m2)	**2,75**	**at Xf (m)**	**1,564**	**Xf (%Lwl)**	**41,70**		>>> Xc – Xf (%Lwl)	4,69
>> ft2	*29,55*	*>> ft*	*5,13*					
Angle immersed sheer Ii (°)		**25,7**	at section C4 (40% Lwl)					
Sw (m2)	**2,79**	>Sw/D^(2/3)	10,09					
>> ft2	*30,02*							
Shull (m2)	**6,61**	**at X (m)**	**1,614**	**Z (m)**	**0,064**			
>> ft2	*71,13*	*>> ft*	*5,30*	*>> ft*	*0,21*			
Sdeck (m2)	**4,78**	**at X (m)**	**1,451**					
>> ft2	*51,50*	*>> ft*	*4,76*					
2.2 Daggerboard								
Volume (m3)	**0,00280**	**at X (m)**	**2,281**	**X (%Lwl)**	**60,83**	**Z (m)**	**-0,39**	
Draft oa (m)	**0,85**		**Sw (m2)**	**0,31**		**Sxz (m2)**	**0,15**	
>> ft	*2,79*		*>> ft2*	*3,35*		*>> ft2*	*1,61*	
CLR (m)	**2,340**	**CLR (%Lwl)**	**62,40**	method : keel profile extended to the waterline, 25% c at 45% draft oa				
>> ft	*7,68*							
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)		**0,14947**	**at Xc (m)**	**1,731**	**Xc (%Lwl)**	**46,15**	**Zc (m)**	**-0,040**
	Disp. (kg)	**153,2**	*>> ft*	*0,53*			*>> ft*	*-0,13*
	>> lbs	*338*						
	Sw (m2)	**3,28**	>Sw/D^(2/3)	11,64	Lwl/D^(1/3)	7,07		
	>> ft2	*35,29*			*DLR*	*81*		*M(lbs/2240)/(Lwl(ft)/100)^3*
2.5 Data from the mass spreadsheet								
Boat with payload	**M(kg)**	**153,2**	**at Xg (m)**	**1,563**	**Xc (%Lwl)**	**41,68**	**at Zg (m)**	**0,399**
Light boat		58,2		1,665				0,480

***Convex-concav-hard chine* - Hydrostatics** (upright, displacement with payload 95 kg) :

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)	**1,01**	**at X (% Lwl)**	**35,0**	> Bwl / B	0,631			
>> ft	*3,31*				**Freeboards (m) >**	**Aft**	**Midship**	**Fore**
Tc (m)	**0,092**	**at X (%Lwl)**	**50**			**0,31**	**0,37**	**0,36**
>> ft	*0,30*				*>> ft*	*1,02*	*1,21*	*1,18*
	Displacement at H0 (m3)	**0,14590**	**at Xc (m)**	**1,744**	**Xc (%Lwl)**	**46,51**	**Zc (m)**	**-0,034**
	>> lbs	*330*	*w. seawater*	*1025*	*kg/m3*		*>> ft*	*-0,11*
Disp at h (cm)	-0,369770396	0,13599	at Xc (m)	1,754	Xc (%Lwl)	46,76	Zc (m)	-0,006
Disp at h (cm)	0,369770396	0,15620	at Xc (m)	1,734	Xc (%Lwl)	46,23	Zc (m)	-0,061
Cp (%)	**56,21**							
Sf (m2)	**2,75**	**at Xf (m)**	**1,591**	**Xf (%Lwl)**	**42,43**		>>> Xc – Xf (%Lwl)	4,08
>> ft2	*29,64*	*>> ft*	*5,22*					
	Angle immersed sheer Ii (°)	**25,7**	at section C4 (40% Lwl)					
Sw (m2)	**2,79**	>Sw/D^(2/3)	10,07					
>> ft2	*30,03*							
Shull (m2)	**6,79**	**at X (m)**	**1,615**	**Z (m)**	**0,067**			
>> ft2	*73,08*	*>> ft*	*5,30*	*>> ft*	*0,22*			
Sdeck (m2)	**4,76**	**at X (m)**	**1,445**					
>> ft2	*51,28*	*>> ft*	*4,74*					
2.2 Daggerboard								
Volume (m3)	**0,00279**	**at X (m)**	**2,281**	**X (%Lwl)**	**60,83**	**Z (m)**	**-0,39**	
Draft oa (m)	**0,85**		**Sw (m2)**	**0,31**		**Sxz (m2)**	**0,15**	
>> ft	*2,79*		*>> ft2*	*3,34*		*>> ft2*	*1,60*	
CLR (m)	**2,340**	**CLR (%Lwl)**	**62,40**	method : keel profile extended to the waterline, 25% c at 45% draft oa				
>> ft	*7,68*							
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)	**0,15012**	**at Xc (m)**	**1,735**	**Xc (%Lwl)**	**46,27**	**Zc (m)**	**-0,040**
	Disp. (kg)	**153,9**	*>> ft*	*0,53*			*>> ft*	*-0,13*
	>> lbs	*339*						
	Sw (m2)	**3,28**	>Sw/D^(2/3)	11,61	Lwl/D^(1/3)	7,06		
	>> ft2	*35,29*			*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)**	**1,563**	**Xc (%Lwl)**	**41,67**	**at Zg (m)**	**0,583**
Light boat		58,9		1,664				0,476