Au 2019-04-22

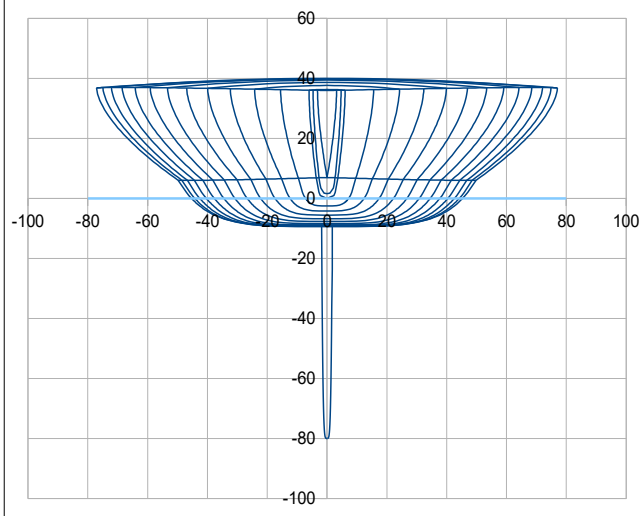
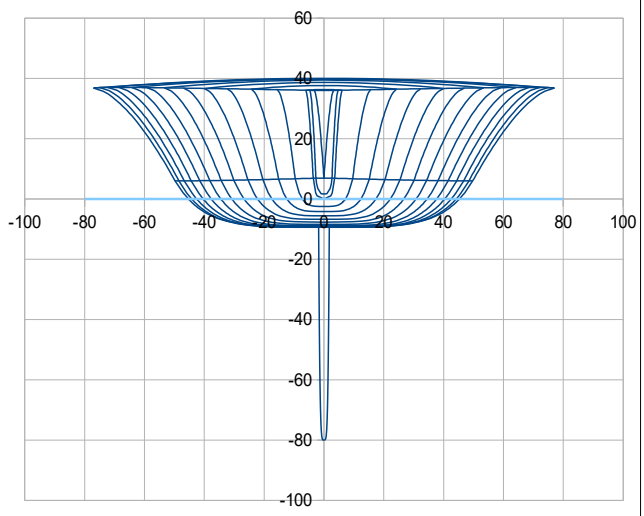
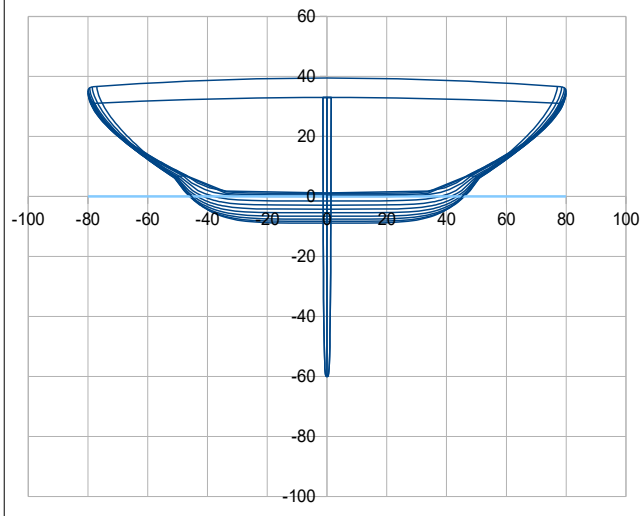
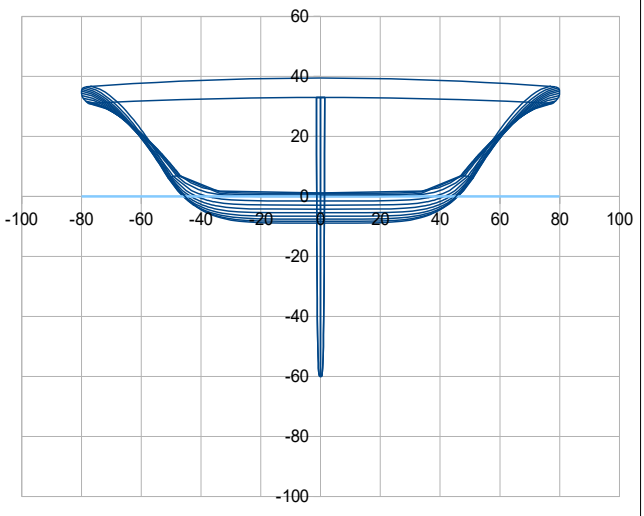
Dinghy 13 hull investigation, for more RM and stability margin

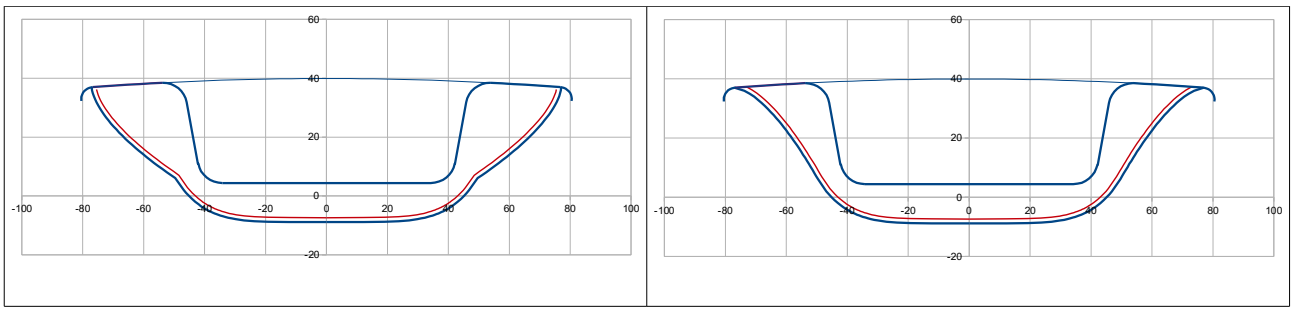
The Bi-convex option, and comparison with a Convex-concav one

A Bi-convex shape 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 option is compared with the convex-concav shape option with the same beams overall and at waterline. The two options share exactly the same dimensions and immerged hull waterlines :

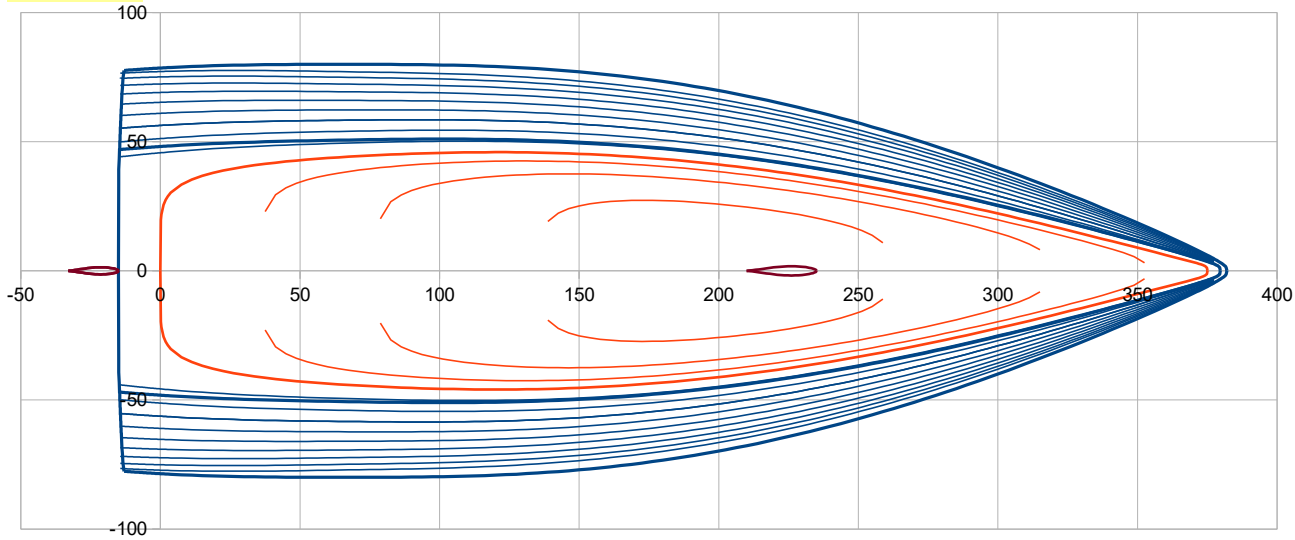
Lhull : 3,97 m (13 ft) ; Bhull : 1,60 m ; Light weight assumed 59 kg (with a 8 m2 sail)

With the design « payload » 95 kg (a heavy helmsman case) :
>>> Lwl : 3,75 m ; Bwl : 0,92 >>> Bwl / Bhull = 0,575

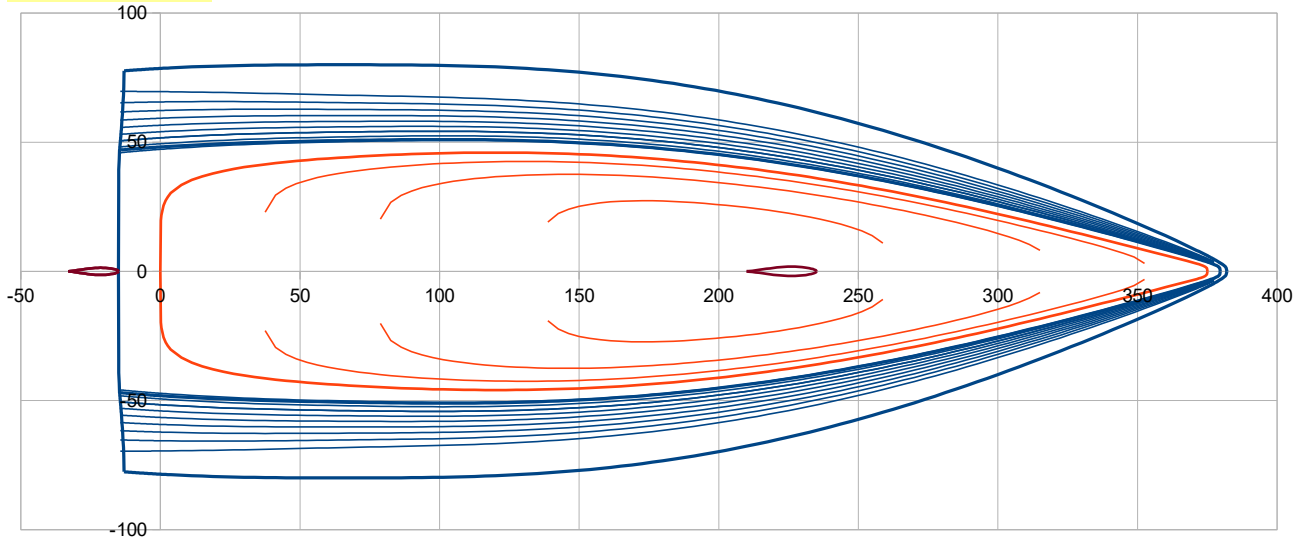
Bi-convex :	**Convex-concav :**
	
	



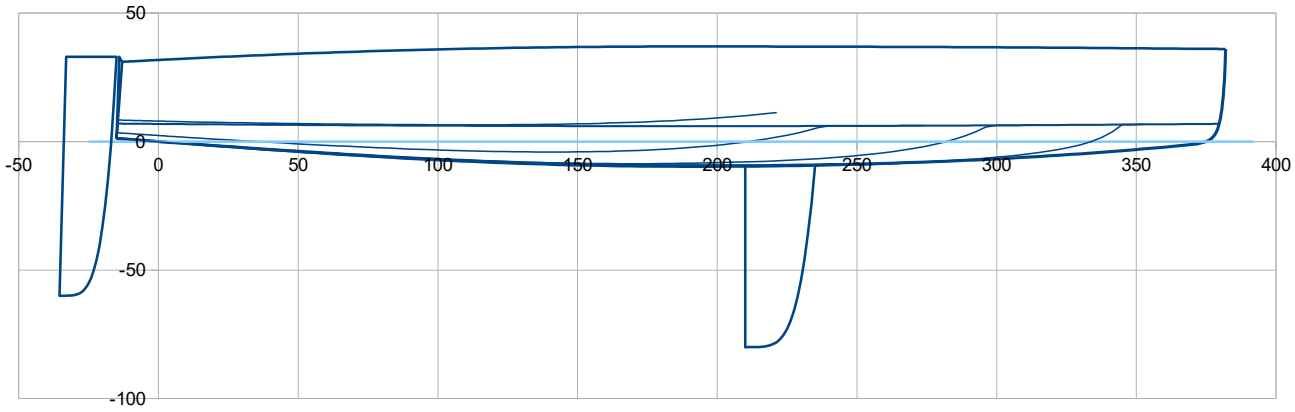
Bi-convex



Convex-concav

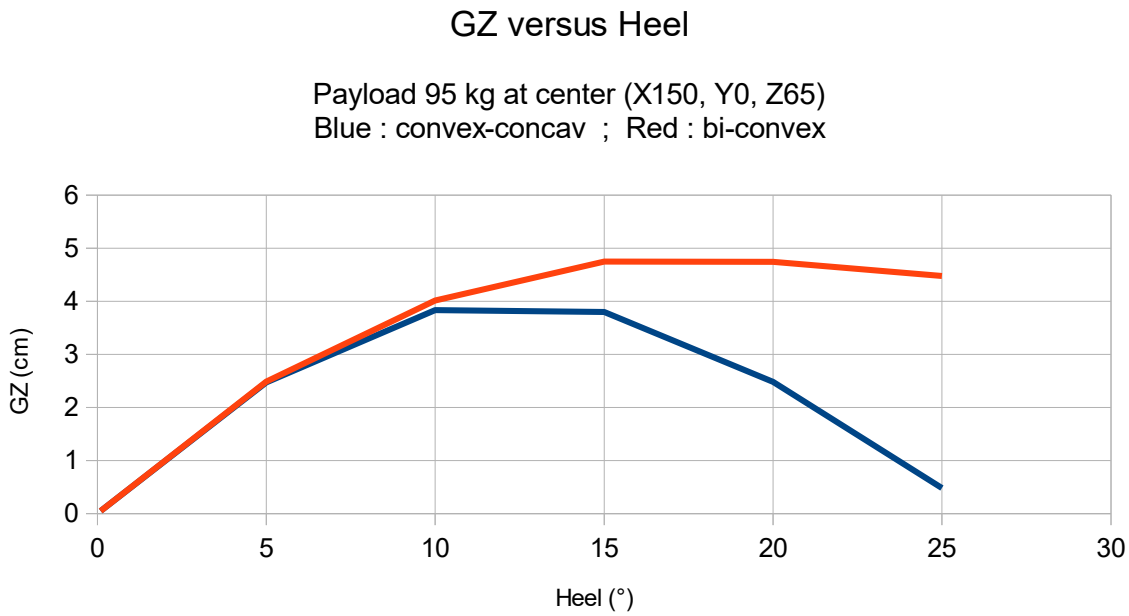


The longitudinal view, common to the 2 options :



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

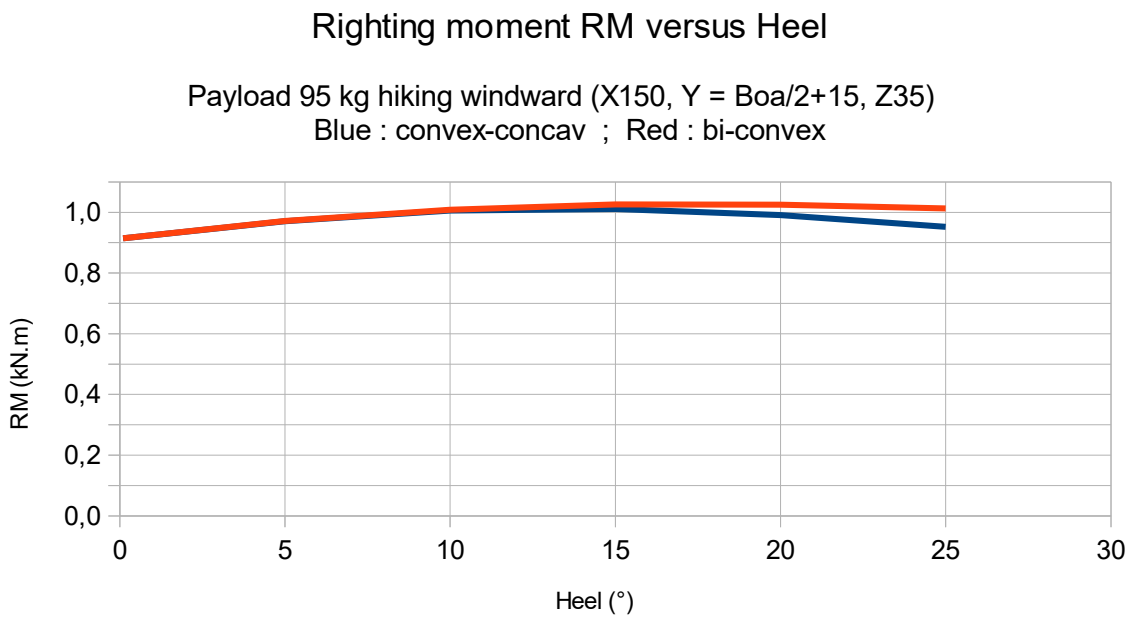
e.g. the helmsman squatted in the boat center under the boom, with his center of gravity at Z +65 cm. It is typically the tack or gybe configuration. Here for the stability comparison it is assumed that the helsman is (temporarly) fixed like a statue in the center of the boat. and we look at the righting 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 :



>>> It is the illustration of the stability margin searched for the bi-convex option, when the helmsman is temporarly in the center under the boom in rough seas.

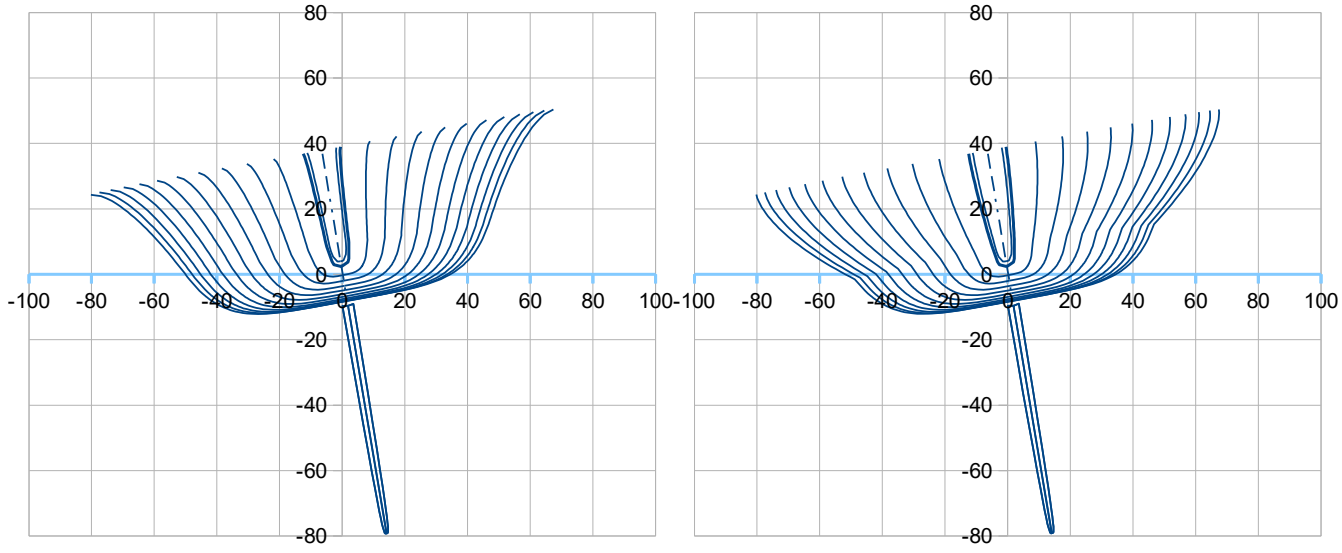
>>> If we translate the result into possible transversal offset dY of the 95 kg payload : at 25° heel angle we have an offset margin of ± 4,9 cm with the bi-convex option but only ± 0,5 cm with the convex-concav one.

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).



>>> Very close values as expected as the beam overall is the same and the righting moment is mostly due to the helmsman in hiking positio, we can just note a slight advantage of the bi-convex at 25° heel angle (+ 6%) , i.e . the heeled situation before a capsize.

Comparison at 10°



Hydrostatics data upright (common to the 2 options) :

2.1 Hull

Loa (m)	**3,97**	**Lwl (m)**	**3,75**	> Lwl/D^(1/3)	7,12				
>> ft	*13,02*		*12,30*						
B (m)	**1,60**	**at X (% Lwl)**	**18,0**						
>> ft	*5,25*								
Bwl (m)	**0,92**	**at X (% Lwl)**	**32,0**	> Bwl / B	0,575				
>> ft	*3,02*				**Freeboards (m) >**		**Aft**	**Midship**	**Fore**
Tc (m)	**0,094**	**at X (%Lwl)**	**50**				**0,31**	**0,37**	**0,36**
>> ft	*0,31*					*>> ft*	*1,02*	*1,21*	*1,18*
Displacement at H0 (m3)	**0,14600**	**at Xc (m)**	**1,733**	**Xc (%Lwl)**	**46,23**		**Zc (m)**	**-0,036**	
>> lbs	*330*	*w. seawater*	*1025*	*kg/m3*			*>> ft*	*-0,12*	
Cp (%)	**56,94**								
Sf (m2)	**2,56**	**at Xf (m)**	**1,555**	**Xf (%Lwl)**	**41,47**	>>> Xc – Xf (%Lwl)		4,75	
>> ft2	*27,53*	*>> ft*	*5,10*						
Angle immersed sheer li (°)	**30,4**	at section C4 (40% Lwl)		Angle at bi-convex point (°)		**33,7**		at C3	
Sw (m2)	**2,62**	>Sw/D^(2/3)	9,46						
>> ft2	*28,24*								
Shull (m2)	**6,47**	**at X (m)**	**1,622**	**Z (m)**	**0,071**				
>> ft2	*69,68*	*>> ft*	*5,32*	*>> ft*	*0,23*				
Sdeck (m2)	**4,72**	**at X (m)**	**1,433**						
>> ft2	*50,79*	*>> ft*	*4,70*						

2.2 Daggerboard

Vol. keel(m3)	**0,00282**	**at X (m)**	**2,226**	**X (%Lwl)**	**59,36**	**Z (m)**	**-0,37**	
Mass keel(kg)	**1,41**	*>> ft*	*7,30*			*>> ft*	*-1,22*	
>> lbs	*3*							
Draft oa (m)	**0,80**		**Sw (m2)**	**0,30**		**Sxz (m2)**	**0,14**	
>> ft	*2,62*		*>> ft2*	*3,24*		*>> 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)**	**-0,05**	
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)	**0,15024**	**at Xc (m)**	**1,724**	**Xc (%Lwl)**	**45,97**	**Zc (m)**	**-0,04**
Disp. (kg)	**154,0**	*>> ft*	*5,66*			*>> ft*	*-0,14*
>> lbs	*340*						
Sw (m2)	**3,10**	>Sw/D^(2/3)	10,98	Lwl/D^(1/3)	7,05		
>> ft2	*33,39*			*DLR*	*81*	*M(lbs/2240)/(Lwl(ft)/100)^3*	

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