

## Gene-Hull VE Dinghy 2.42\_User Guide\_English version

The upgraded version 2,42 just includes a new sheet « Offsets x,y,z » where are gathered all the geometrical data necessary for a transfer to a 3D modeller. Consequently, the sub-section 5. of the Gene-Hull, initially dedicated to that task, is erased. There is no any modification of the input data as previously upgraded in the 2,41 version.

The upgraded version 2,41 of the application includes more specifically :

- the option of an additionnal shaping of the hull body sections,
- the hull with any load can be studied within its hydrostatic equilibrium, upright or with a given heel angle, given that the load (i.e. the crew weight) is a major factor of a dinghy design,
- A perspective view, in complement to the traditionnal 3 views 2D, , and still :
- an early stage Sailplan can be defined for the cat-boat configuration, from which the « lead » is computed (>>> the optimal relative position of the mast and the daggerboard) and also various ratios involving the sail surface.
- an early stage Mass spreadsheet can be defined, from which the light boat weight and CdG coordinates are computed and automatically reported in the Gene-hull sheet for the hull with load study.

Gene-Hull VE Dinghy makes possible the generation of hulls with their 2D views, a perspective view and their hydrostatic characteristics as output, daggerboard and rudder included. It is based on a spreadsheet application (Open Office Calc 4.0.1) involving fit for purpose formulations of the polynomial type, able to generate the hull fairing lines. It needs a relatively small number of data to enter : basic geometrical data and adimensional parameters used in the formulations. This User Guide gives all definition and information on the role and influence of each data, with illustrations. Moreover, the User has the input data of a reference hull allowing him to start his own project step by step, and a « Hulls storage » sheet where other examples of inputs are archived and can be copy/paste.

For each new data introduced, all the computations and the drawings are updated automatically. Proposed parameters allow an infinity of combinations, so as many possible variants of a hull. Drawings and hydrostatic data, including ratios usually considered by naval architects, make possible to judge the hull and to converge towards the desired one. In section 5. of the results, the computation of the hull-daggerboard-rudder with heel angle is also proposed, in hydrostatic condition, at iso-displacement and with control of the longitudinal center of buoyancy thanks to iteration on height and trim parameters. It provides the transversal offset of the center of buoyancy and so the righting moment, and 2D drawings (sections and floatation waterline) which can help assess the relevance of the hull with heel.

Produced data allow either to continue the project with a 3D modeller (for that option, all necessary data are provided in sheet « Offsets x,y,z ») or, for amateurs in particular, to draw at scale one any sections and frames needed for a building (data are provided in section 6.).

The apprenticeship should be light thanks to this User Guide, the hull of reference and a lot of other examples (of which input data are in the Hulls storage sheet) given to initiate a new project.

The application wants to be easy and even fun to create a great number of hulls within just few clicks, up to test unusual values of parameters to find out new style or shape of hulls : combinations are infinites and sometimes unpredictable (it is also a way to test the limits of this software). Of course at the end, the final choice is up to the User, taking into account his experience as naval architect.

It is a free and open source spreadsheet application, on a support itself free and widespread (Open Office Calc 4.0.1) : if any problem are faced to open and use an ods file, you can download Open Office or Libre office according to : <http://www.openthefile.net/extension/ods>

In the annex, the main formulations involved are detailed, if necessary you can improve the tool yourself and share it with the community of amateurs of naval architecture. Or you can contact me with your remarks and improvement requests.

*Jean-François Masset – January 2020*

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## Summary presentation

The application includes 5 sheets :

- Gene-Hull
- Hulls storage
- Sailplan
- Mass spreadsheet
- Offsets  $x,y,z$

**Gene-Hull** : includes an User space (input & outputs) followed by an Administrator space where the computations are carried out. The User space includes 7 successive sections :

Gene-Hull input :

1. Data to enter

Gene-Hull output :

2. Data sum-up and results of hydrostatic and surfaces calculations
3. The 3 views 2D
4. Curves of control
5. Hydrostatics of the heeled hull with loading
6. Data for hull sections drawing at scale one, inc. hull frames and deck bars

**Hulls storage** : is the storage space for hulls input data

**Sailplan** : includes an User space (with input and outputs) followed by an Administrator space where the computations are carried out

**Mass spreadsheet** : includes an User space (with input and outputs)

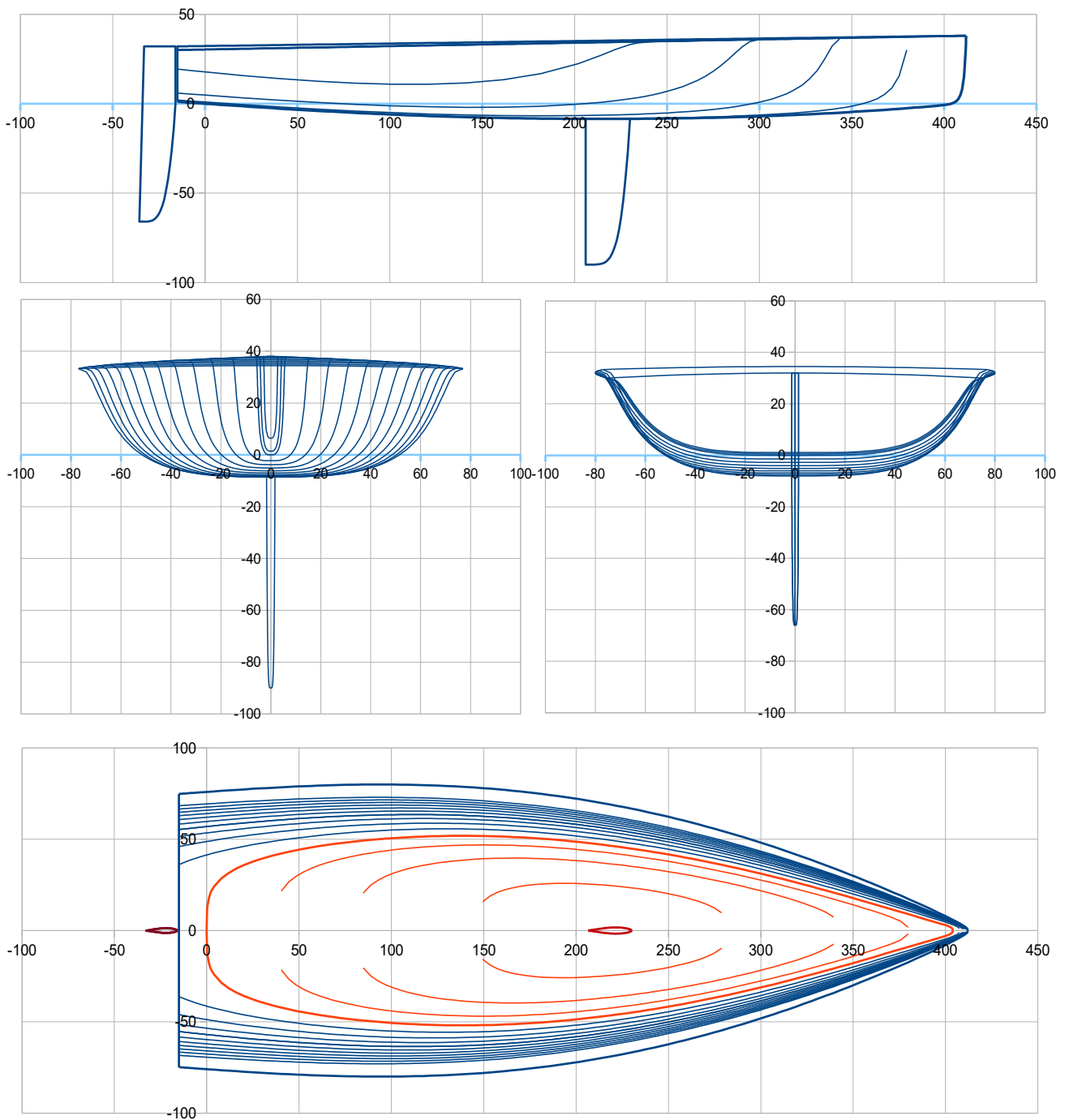
**Offsets  $x,y,z$**  : includes the geometrical data for the hull sections, for the keel, transition (if any), hard chine (if any) and sheer lines, for the daggerboard, for the rudder, for the mainsail (2D)

**+ in annex of the present User Guide** : main formulations involved in Gene Hull

**The coordinates x,y,z used for the views include :**

- Origin 0,0,0 at the cross of the designed waterline surface (« H0 » level) and the perpendicular at the rear point of the waterline (station C0). The perpendicular at the front point of the waterline is station C10.
- x = longitudinal axis (positive towards front),
- y = transversal axis,
- z = vertical axis (positive towards up),

Showed unities on the views are **cm**



Automatic scales are proposed for the views, with a main grid with a fixed pitch. Nevertheless, it is suggested for the User, as long as the main dimensions of the new project are fixed, to put the views at a right scale and to fix it.

## Gene-Hull sheet / Input

## 1. Data to enter for the hull body

Data to enter are in column B (cells B12 to B67), the ones of the hull of reference are in column D, in pink. Simplified views of the hull are showed opposite to the data so that one can see on them, as well as on the complete views some lines below, the effect of each data new value (*sometimes these small views do not update instantly, in that case go directly to the complete views that are in the output space*). **Data are in metric units**, with automatic conversion in Imperial units in column C (*in italic blue in the file*).

1.1 Hull data	metric	>> feet	Hull of ref.
Length of waterline :			
Lwl (m)	4,04	13,25	4,04
Maximum draft of the hull body :			
Tc (m)	0,0850	0,28	0,0850
X Tc (%Lwl)	53,00		53,00
Hull bow :			
Xbow (m)	4,12	13,52	4,12
Zbow (m)	0,38	1,25	0,38
Shape coefficient of the bow :			
Cet	80,0		80,0
Polynomials of the keel line, front part and rear part :			
Pui q av	2,2		2,2
Pui q ar	2,2		2,2
Rear end of the transom :			
X tab ar (m)	-0,15	-0,49	-0,15
Z tab ar (m)	0,0110	0,04	0,0110
Sheer line, in horizontal projection xy :			
Bg (m)	0,56	1,84	0,56
X Bg (% Lwl)	55,0		55,0
Alfa (°)	11,84		11,84
Pui liv y	2,00		2,00
Cor Pui liv	0,020		0,020
Pui Cor Pui	2,00		2,00
Scow	0,07		0,07
Option Hard Chine line, in vertical projection xz :			
Type	0		0
1,2 Zhc av (m)	0,15	0,49	0,15
2 Zhc m (m)	0,20	0,66	0,20
1,2 Zhc ar (m)	0,10	0,33	0,10
Pui hc z	3		3
Sheer line, in vertical projection xz :			
Z liv m (m)	0,35	1,15	0,35
Z liv ar (m)	0,30	0,98	0,30
Pui liv z	1		1
Deck / central line rear end			
Z p m (m)	0,38	1,25	0,38
Z p ar (m)	0,32	1,05	0,32
Pui deck z	1,0		1,0
Sections : as a combination of « V » shape and « E » shape			
Sections V :			
C Hv av	3,00		3,00
C Hv m	6,00		6,00
C Hv ar	5,00		5,00
Pui Hv	3,00		3,00
Pui V av	20,00		20,00
Pui V ar	12,00		12,00
Pui Pui V	1,00		1,00
Sections E and combination VE :			
Pui E1	0,30		0,30
Pui E2	8,67		8,67
mix VE av	0,25		0,25
mix VE ar	0,15		0,15
Pui mix VE	1,00		1,00
Option additionnal shaping (convex - concav modificatic			
Ky	1,00		1,00
Kz	0,40		0,40
Ksoft	2,00		2,00

### Lenght of waterline

**Lwl (m)** : lenght of waterline at H0 (cell B12)

Rear perpendicular crosses H0 plan at the coordinates origin (0, 0, 0). Front perpendicular crosses H0 at (Lwl, 0,0) point.

### Hull body draft

**Tc (m)** : maximum draft of the hull body (cell B14)

**X Tc (%Lwl)** : longitudinal position of the maximum draft (in % of Lwl) (cell B15)

### Hull bow end

**Xbow (m)** : should be > Lwl (inverted bow is not possible) (cell B17)

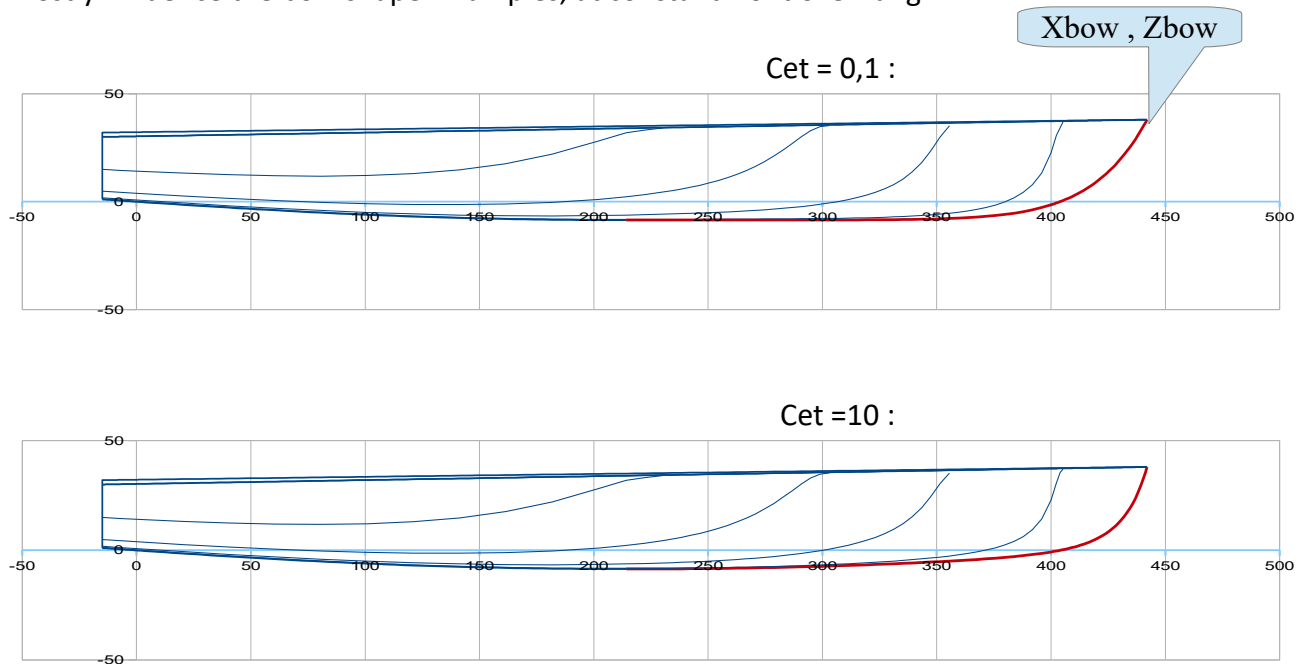
**Zbow (m)** : it is the front freeboard (cell B18)

### Bow coefficient : Cet

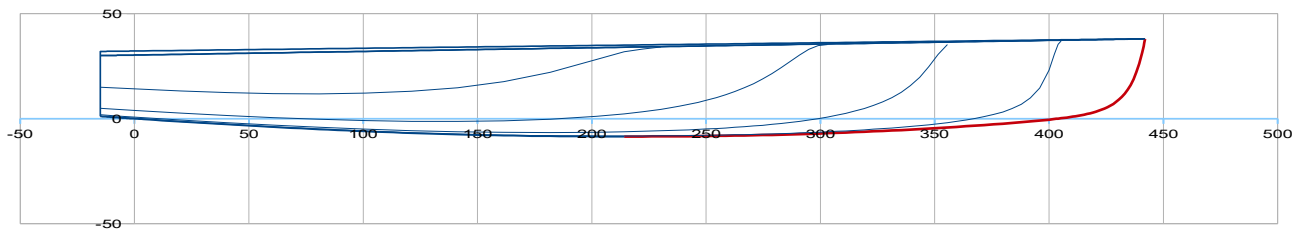
For the bow shape, 3 data are influent and in interaction : **Xbow** (Xbow-Lwl = the front overhang), **Cet** (acting on the bow line) and **Pui q av** (acting on the overall shape of the front keel line).

**Cet** : adimensional coefficient > 0, from 0,1 to 100 typically. (cell B 20)

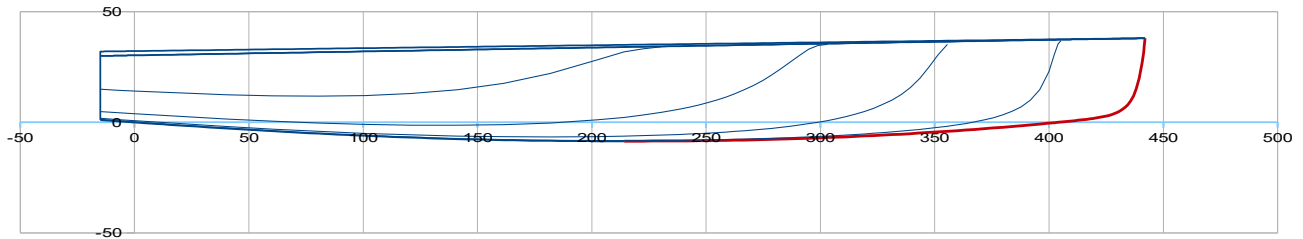
This coefficient is involved in the polynomial formulation of the front part of the keel line and mostly influence the bow shape. Examples, at constant front overhang:



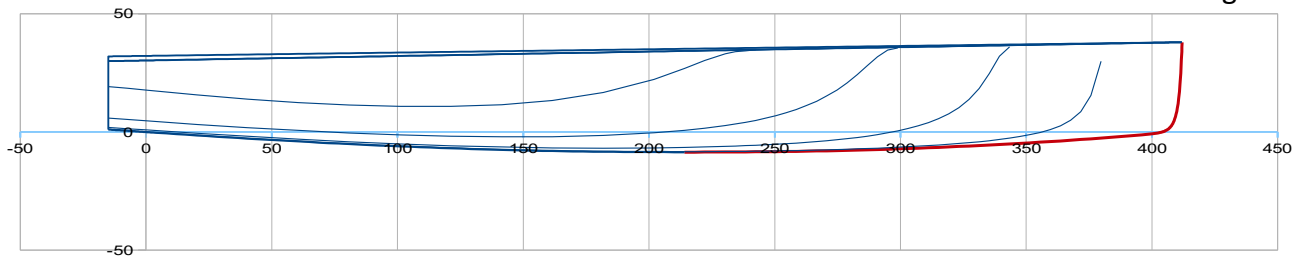
Cet 20 :



Cet 40 :



Cet 80 with a shorter front overhang :

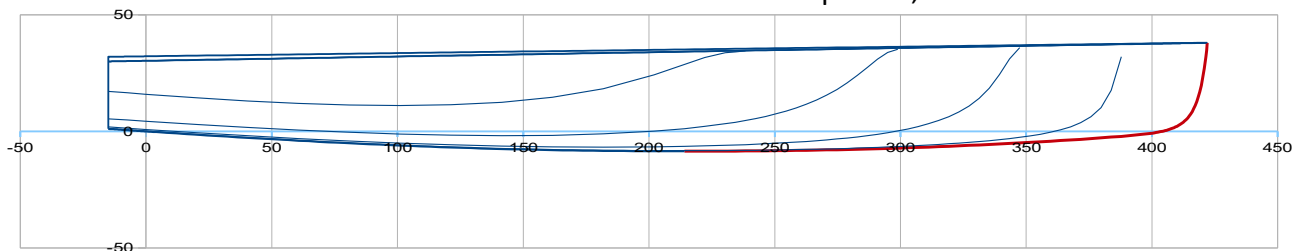


### Keel line polynomial / front part ( $x > X_{Tc}$ ) : Pui q av

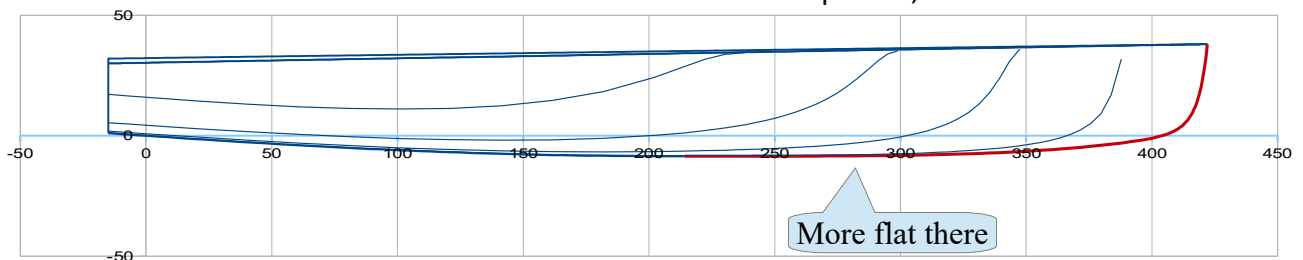
**Pui q av** : adimensional coefficient which figures the power factor of the front polynomial (details of the formulation in the technical appendix on request). (Cell B22)

Should preferably be  $\geq 2$  , some examples :

Pui q av = 2,2 :



Pui q av = 4,0 :



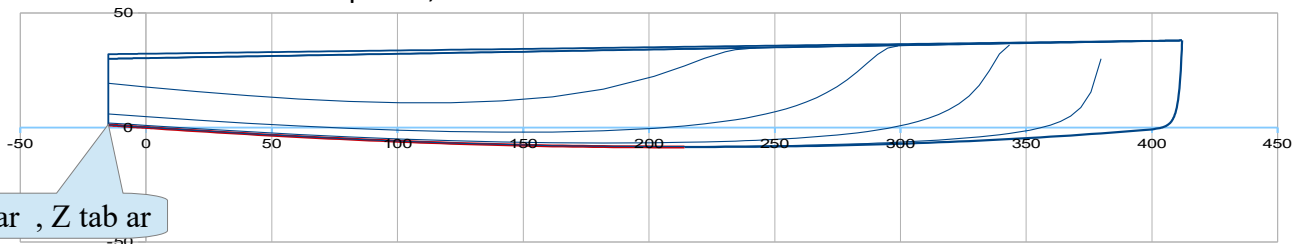
### Keel line polynomial / rear part ( $x < X_{\text{tab ar}}$ ) : Pui q ar

For the rear keel line shape, 3 data are influent and in interaction : **X tab ar**, **Z tab ar** (= the rear point location, X tab ar) and **Pui q ar** (acting on the overall shape of the rear keel line).

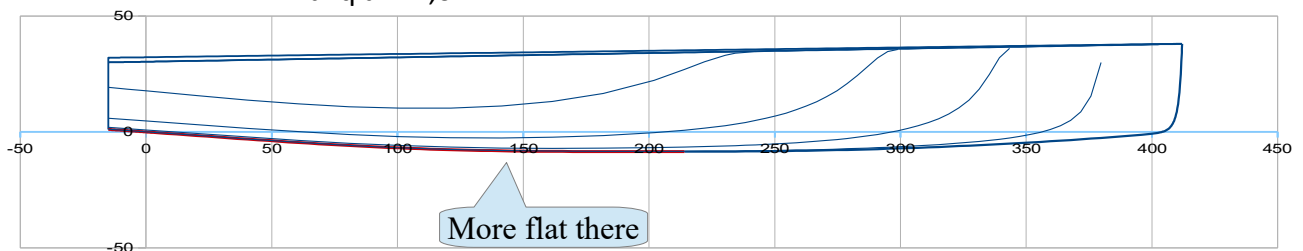
**Pui q ar** : adimensional coefficient which figures the power factor of the rear polynomial (details of the formulation in the technical appendix on request). **(cell B23)**

Should preferably be  $\geq 2$  , some examples :

Pui q ar : 2,2



Pui q ar : 4,0



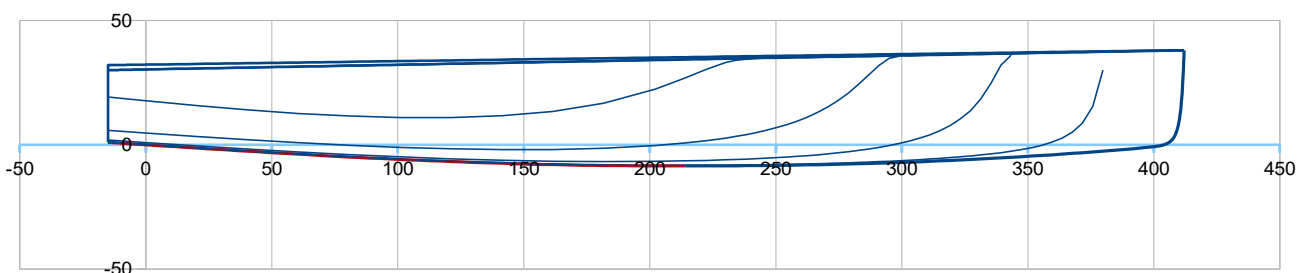
### Rear transom end point

**X tab ar (m)** : X of the rear point overall (i.e. the rear overhang), should be  $< 0$  due to the hull coordiantes **(cell B25)**

**Z tab ar (m)** : Z of the rear point. **(cell B26)**

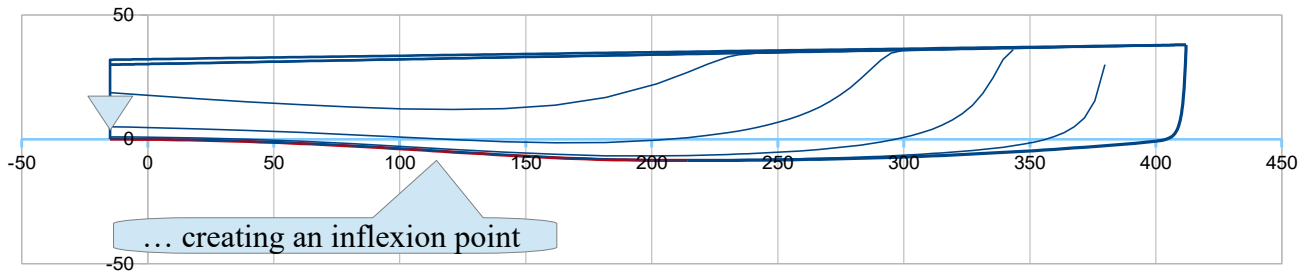
**Important** : in the case of a dinghy hull where the rear overhang **X tab ar** is usually very short, the **Z tab ar** data is a small value very sensitive, a small variation of it (X tab ar and Pui q ar being unchanged) can have a huge influence on the shape of rear half of the the keel line, and so for the rear volume and the LCB of the hull.

Example with **Z tab ar** = 0,01 m >>> LCB = 46,55 % Lwl

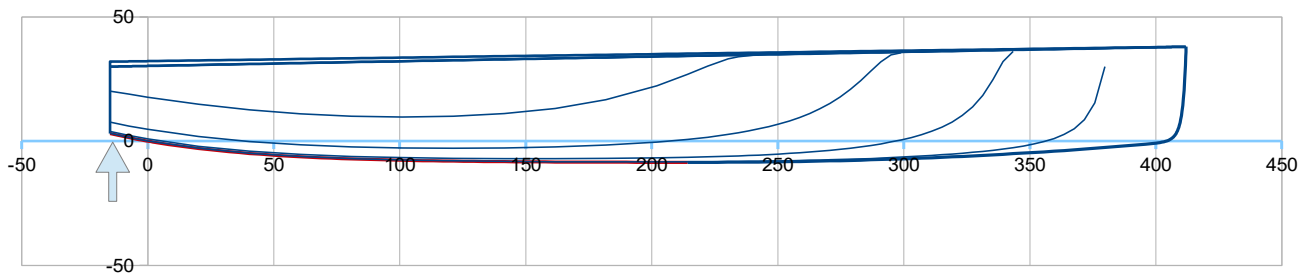




Same with **Z tab ar** lower = 0,001 m >>> LCB = 51,28 % Lwl



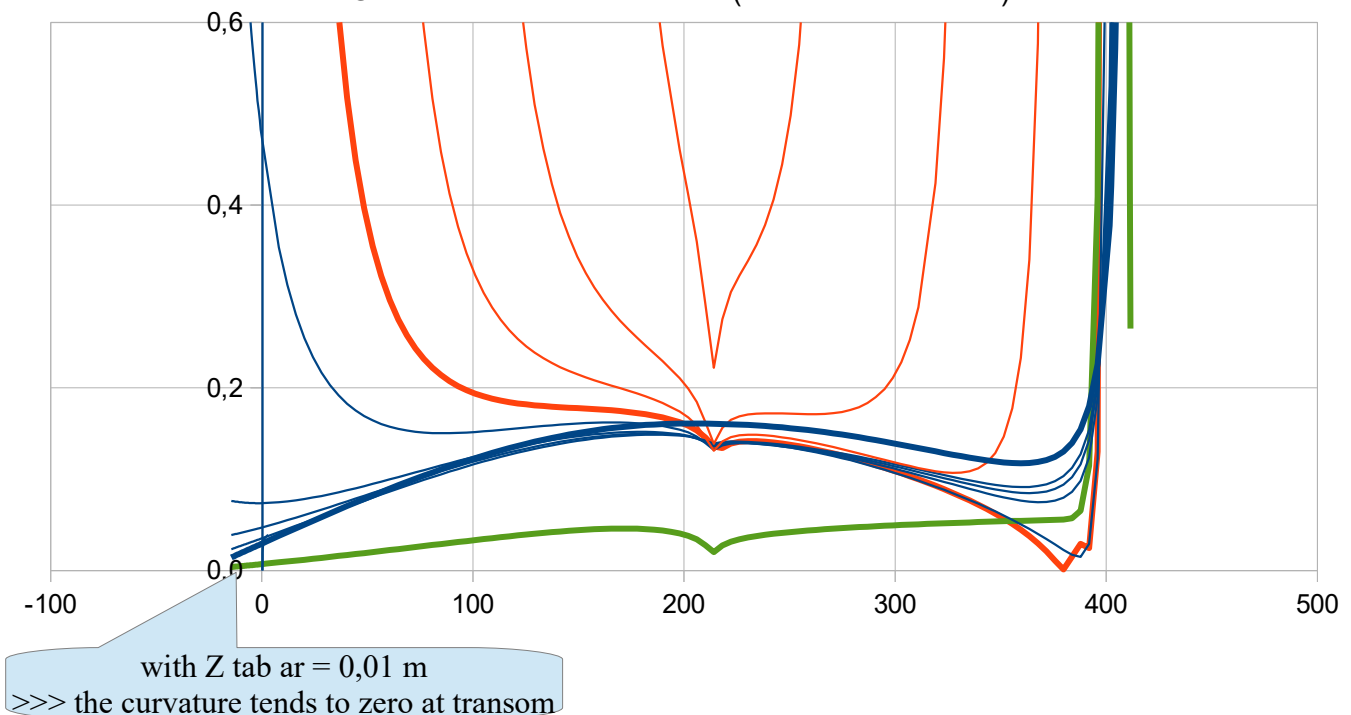
Same with **Z tab ar** higher = 0,03 m >>> LCB = 44,38 % Lwl



>>> so decimals for the value of **Z tab ar** are important to finalise the keel line and the subsequent volume repartition. To perfectly master this point, for each choice of **Z tab ar** you can also have a look at the keel line curvature given in the output, it is the green thick line in the figures below showing the 3 typical cases :

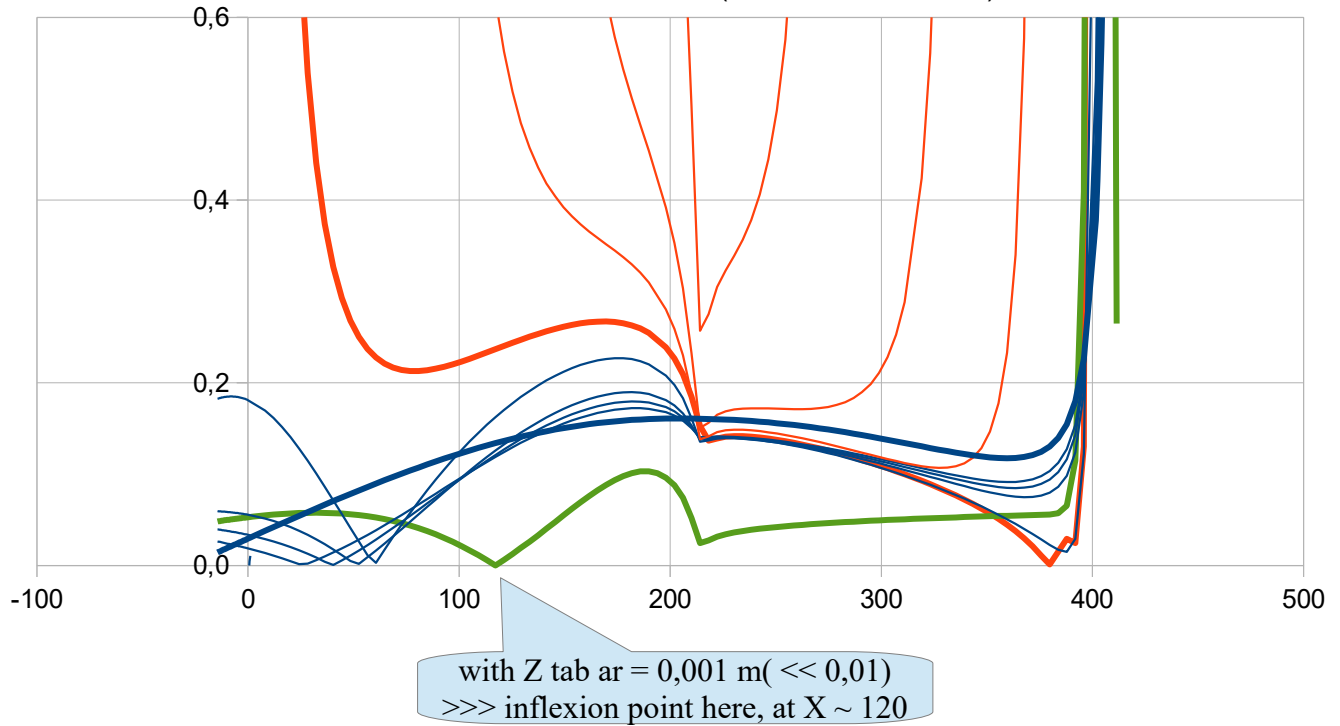
### Waterlines curvatures 1/R

Red : waterlines below H0 (thick line = H0) ; Blue : waterlines above H0 (thick line = sheer line)  
Green : keel and buttock lines (Thick line = keel line)

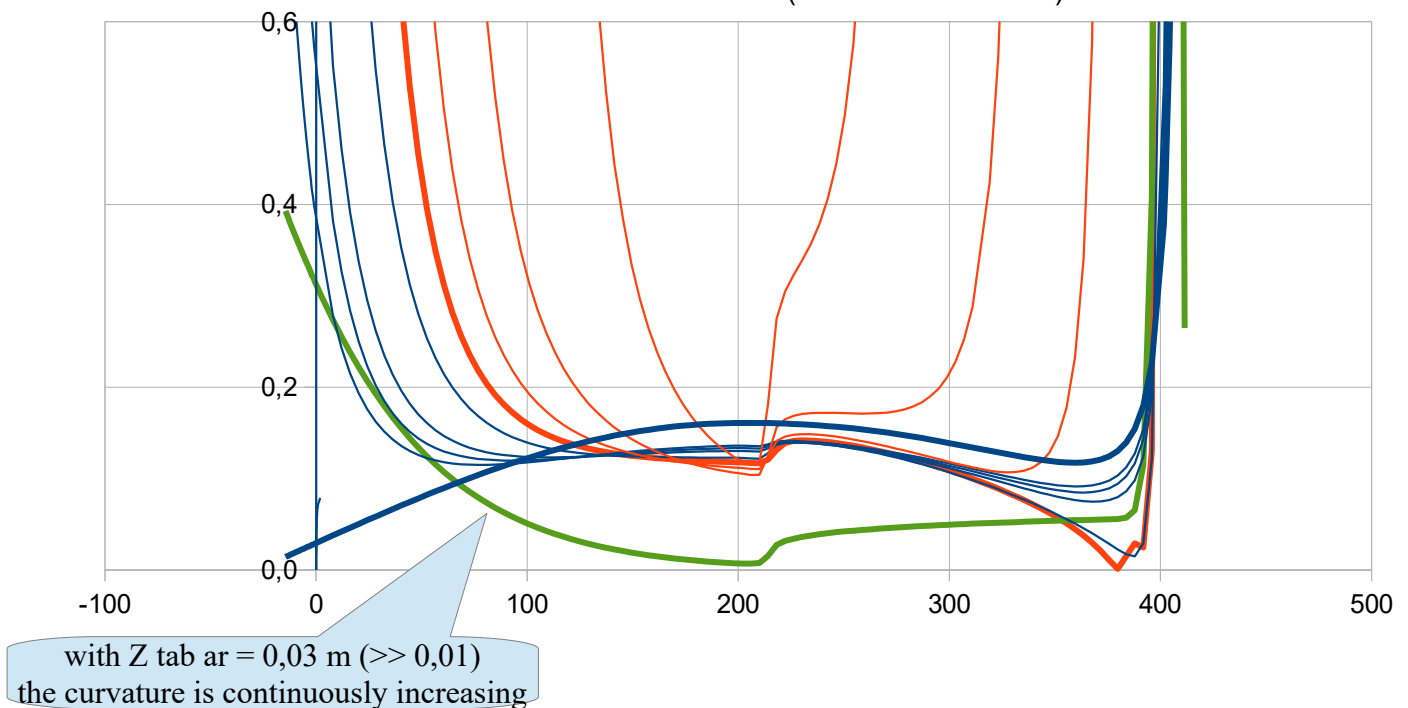


Waterlines curvatures  $1/R$ 

Red : waterlines below  $H_0$  (thick line =  $H_0$ ) ; Blue : waterlines above  $H_0$  (thick line = sheer line)  
 Green : keel and buttock lines (Thick line = keel line)

Waterlines curvatures  $1/R$ 

Red : waterlines below  $H_0$  (thick line =  $H_0$ ) ; Blue : waterlines above  $H_0$  (thick line = sheer line)  
 Green : keel and buttock lines (Thick line = keel line)



### Sheer line in horizontal plan (plan xy)

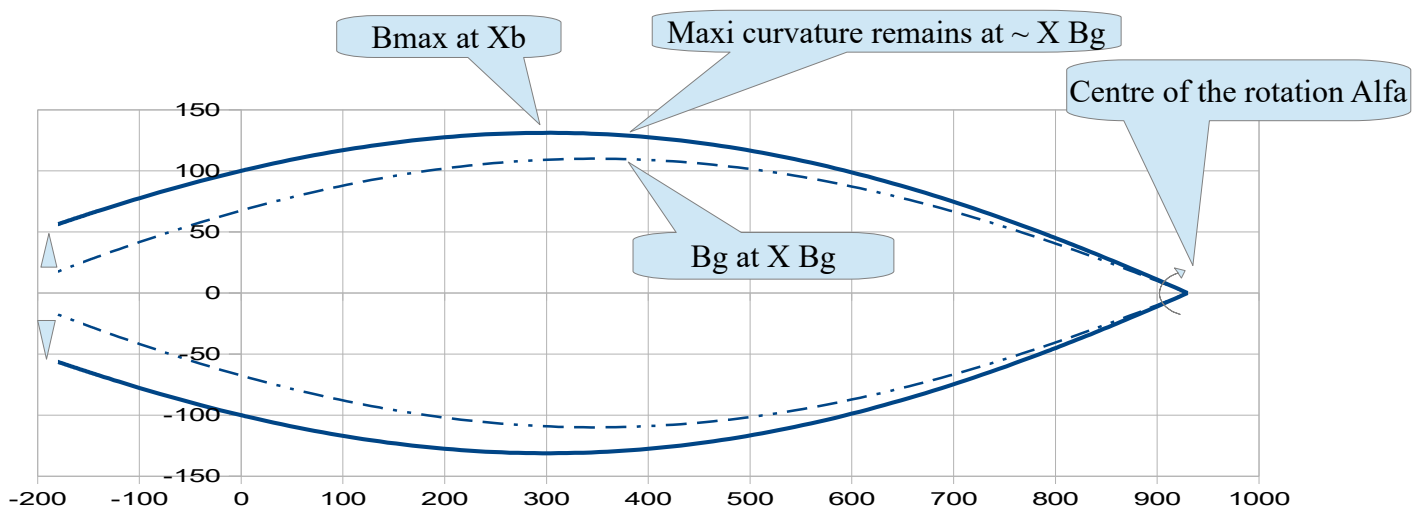
3 data and 4 adimensional parameters are involved :

Bg (m)
X Bg (% Lwl)
Alfa (°)
Pui liv y
Cor Pui liv
Pui Cor Pui
Scow

An indirect approach is proposed to define the sheer line maximum beam  $B_{max}$  and its longitudinal location  $X_b$ , using 3 data : **Bg (m)** , **X Bg (%Lwl)** and **Alfa (°)**. This approach allows both to adjust the rear transom width and to position the maximum beam  $B_{max}$  independently of the sheer line maximum curvature.

At first a « virtual » sheer line (dashed line here below) is defined with as input the maximum « virtual » beam **Bg (m)** (cell B28) positioned in **X Bg (%Lwl)** (cell B29). Then, this line is « open » by rotation of a half-angle **Alfa (°)** (cell B30) with the bow end as center for this rotation (as showed here below), to obtain the real sheer line with a real maximum beam **B<sub>max</sub>** at a real location **X<sub>b</sub>** (B<sub>max</sub> and X<sub>b</sub> being computed by the system and showed in blue opposite to the input data).

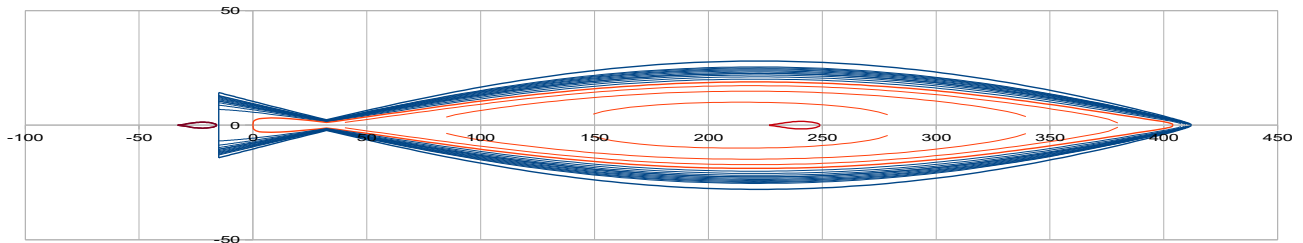
So a set of input values Bg, X Bg and Alfa leads to the real sheer line with maximum beam  $B_{max}$  at a rear position  $X_b$ . By doing so, the sheer line maximum curvature remains close to X Bg and is disconnected to the maximum beam position  $X_b$ .



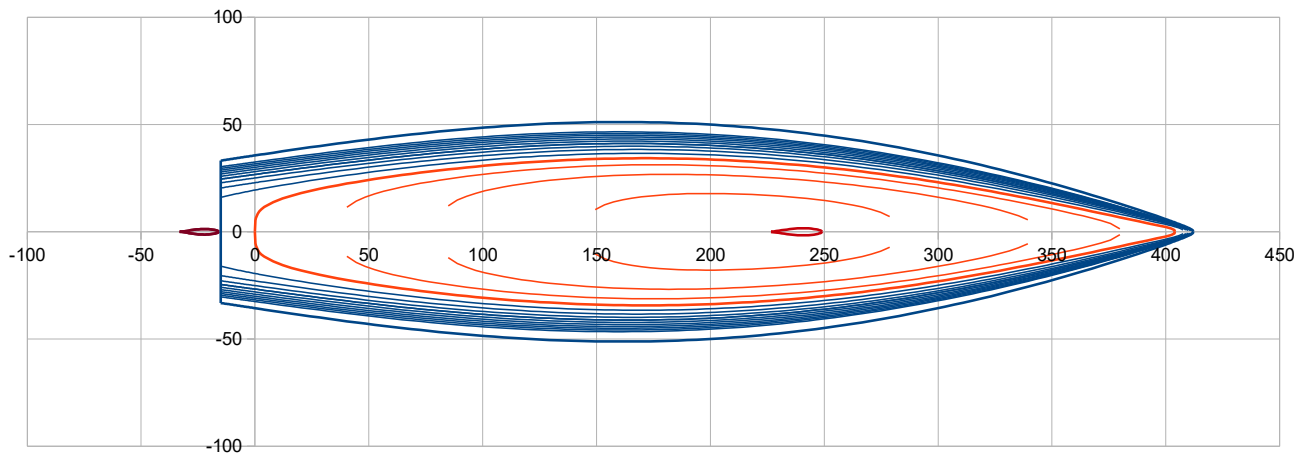
*Nota : this « Alfa » reshaping of the hull is powerful, it can be done at any moment of the hull definition, all the stations and waterlines are automatically updated.*

**Example :**

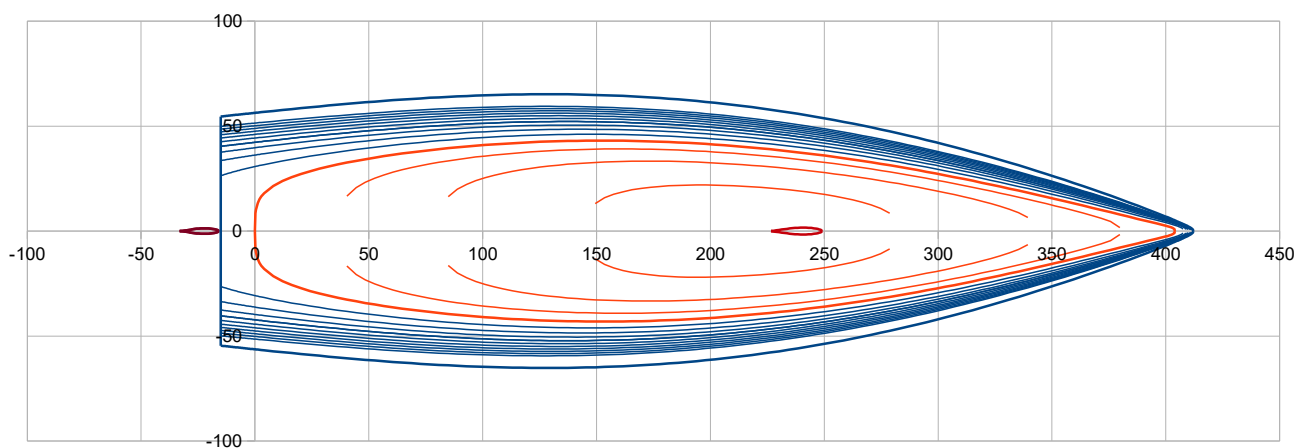
Starting with **Bg = 0,56 m** ; **X Bg = 55 % Lwl** ; **Alfa = 0°** >>> generic hull (« virtual » as can be seen here below, it is not a problem for the following process)



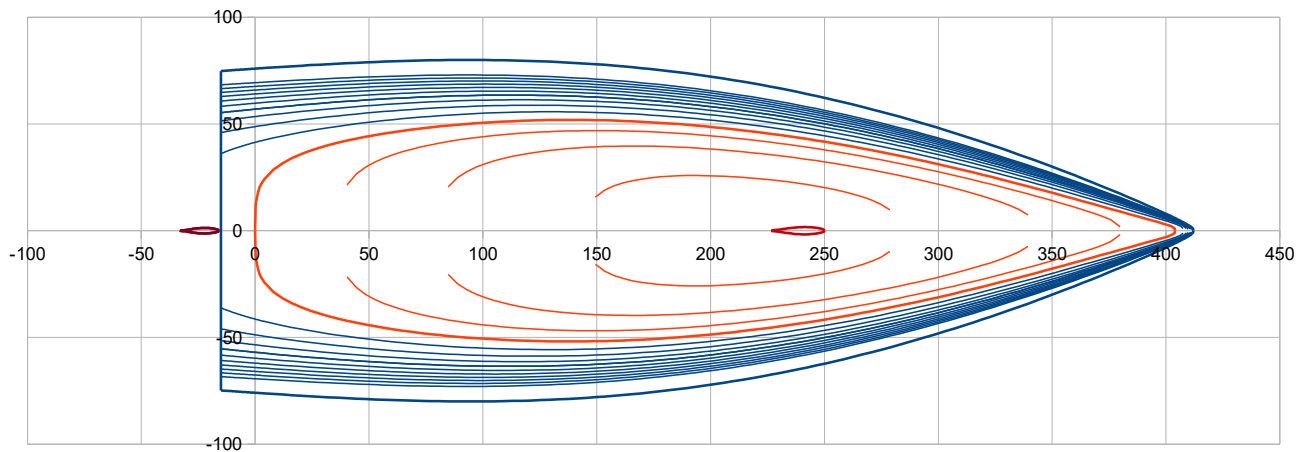
... then opening by rotation **Alfa = 6,00°** >>> real hull with **Bmax = 1,023 m** at **Xb = 40 %Lwl**



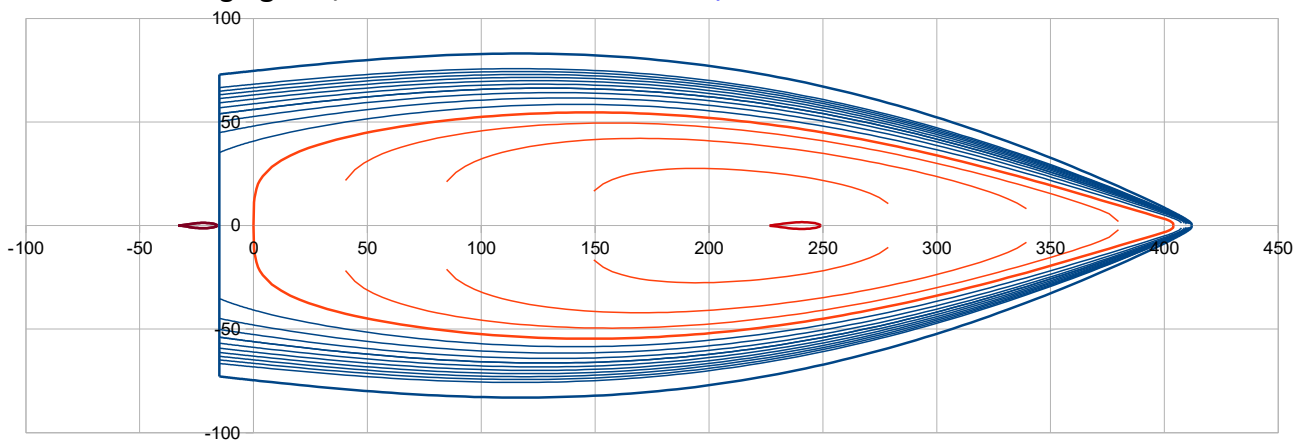
... rotation **Alfa = 9,00°** >>> real hull with **Bmax = 1,304 m** at **Xb = 32 %Lwl**



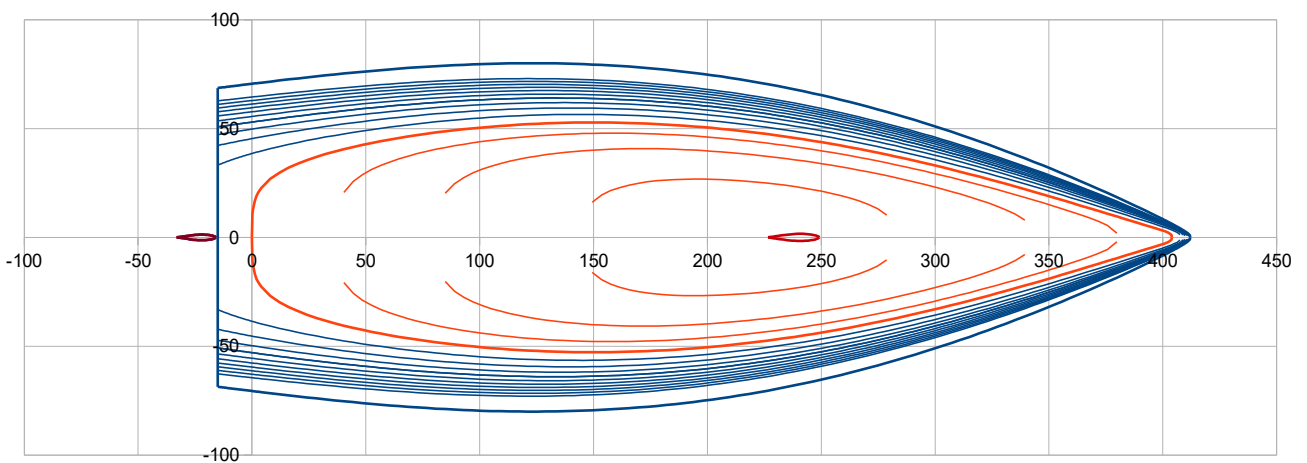
... rotation **Alfa** = **11,84°** >>> Real hull **Bmax** = **1,600 m** at **Xb 23 % Lwl**



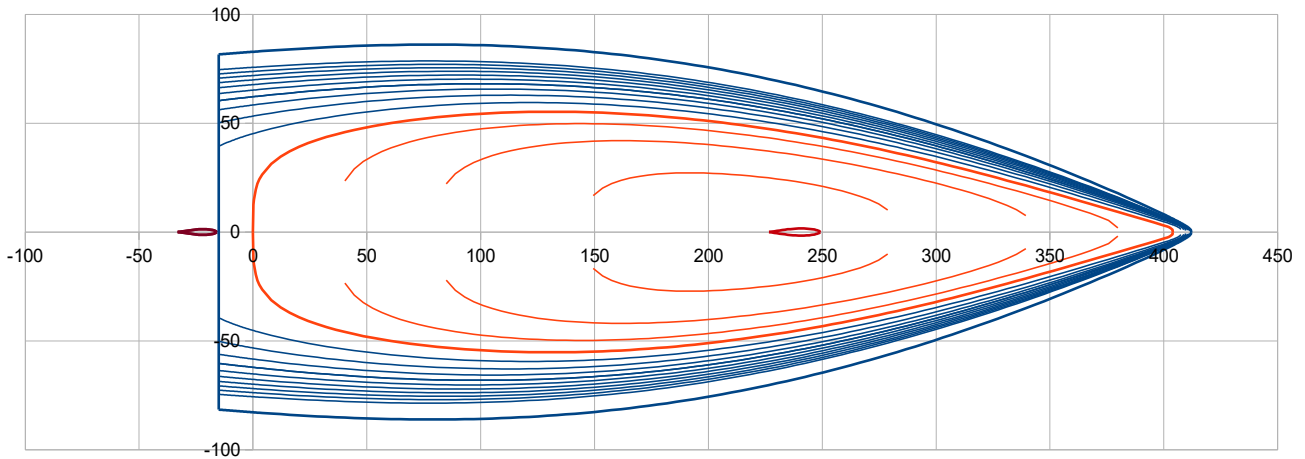
... then increasing **Bg** to **0,66 m** >>> Real hull **Bmax** = **1,661 m** at **Xb 29 % Lwl**



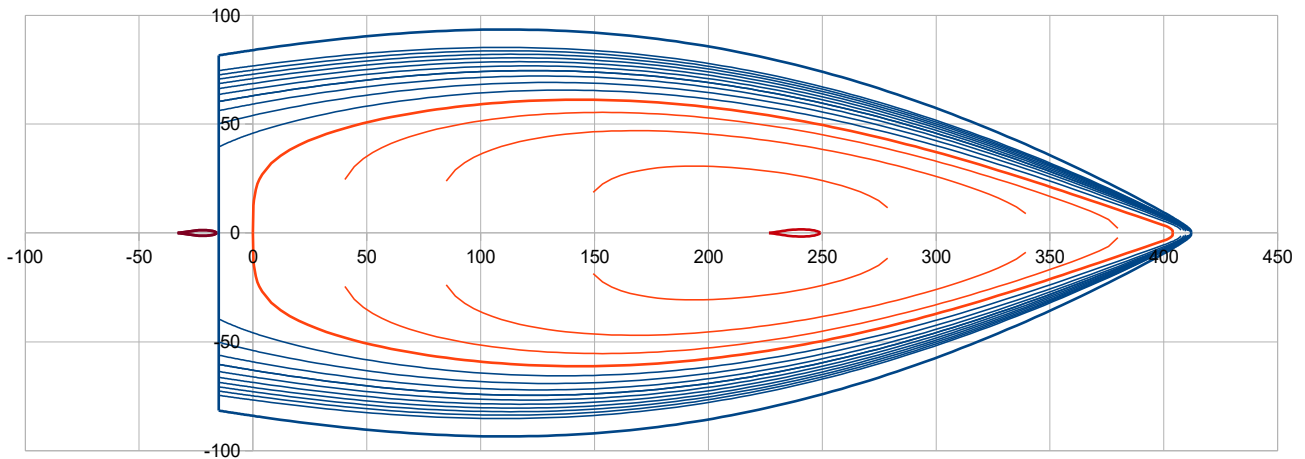
... then reducing the rotation **Alfa** to **11,24°** >>> Real hull **Bmax** = **1,600 m** at **Xb 30 % Lwl**



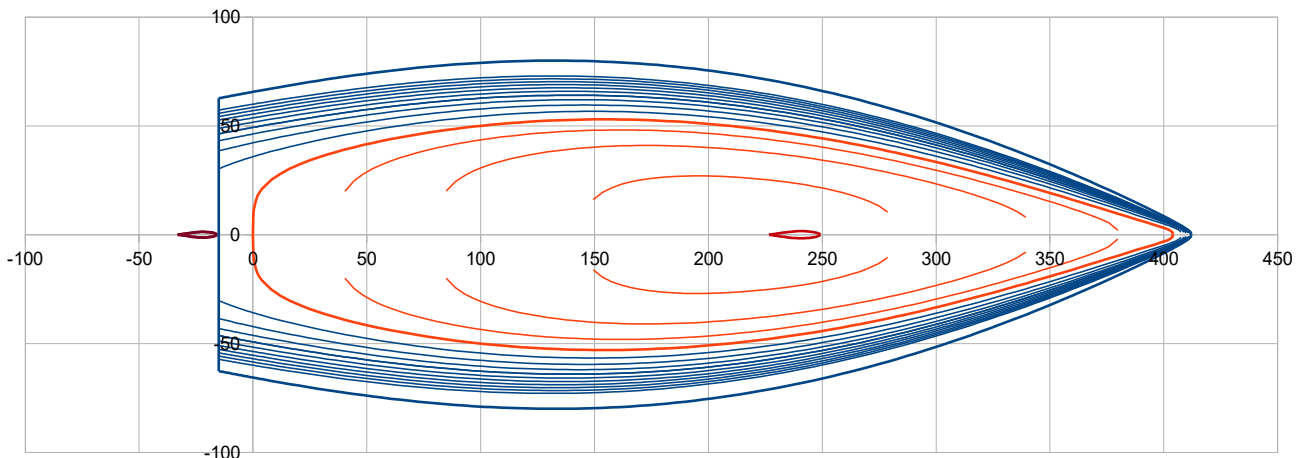
... then moving backward **X Bg to 50 % Lwl** >>> Real hull **Bmax = 1,722 m** at **Xb 20 % Lwl**



... then increasing **Bg to 0,86 m** >>> Real hull **Bmax = 1,870 m** at **Xb 27 % Lwl**



... then reducing **Alfa to 8,59°** >>> Real hull **Bmax = 1,600 m** at **Xb 33 % Lwl**



... etc , in this process example we have generated 3 hulls at Bmax 1,6 m positioned respectively at Xb 27, 30 and 33% Lwl.

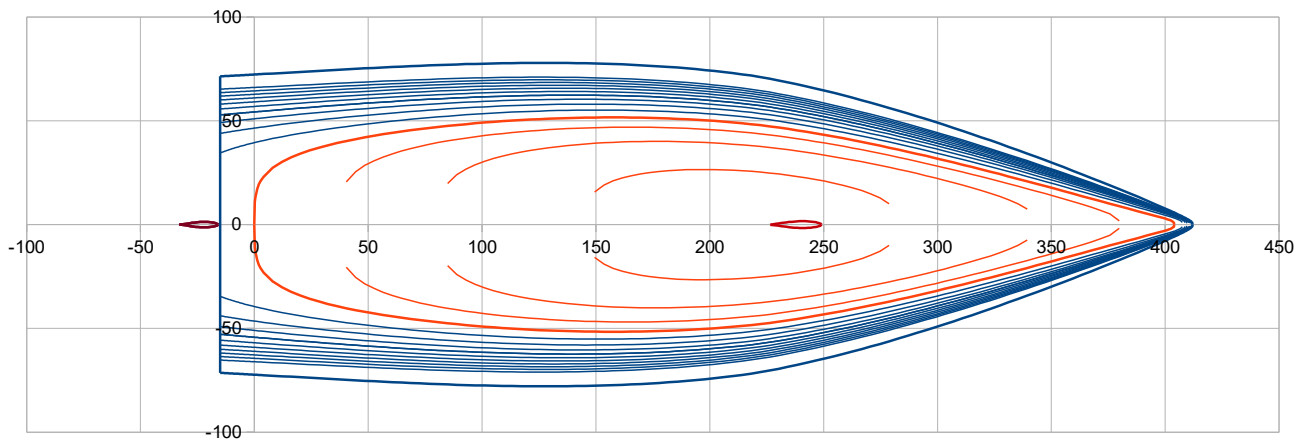
Nota : the « rotation » is explained in the technical appendix, actually concerning only the y values of the sheer line, the x values being unchanged (the rotation matrix is used only for the y values).

**Pui liv y**, **Cor Pui liv** and **Pui Cor Pui** are 3 adimensional coefficients for respectively the power of the sheer line polynomial, its correction along with x and the power of the correction polynomial itself (formulation details in the technical appendix).

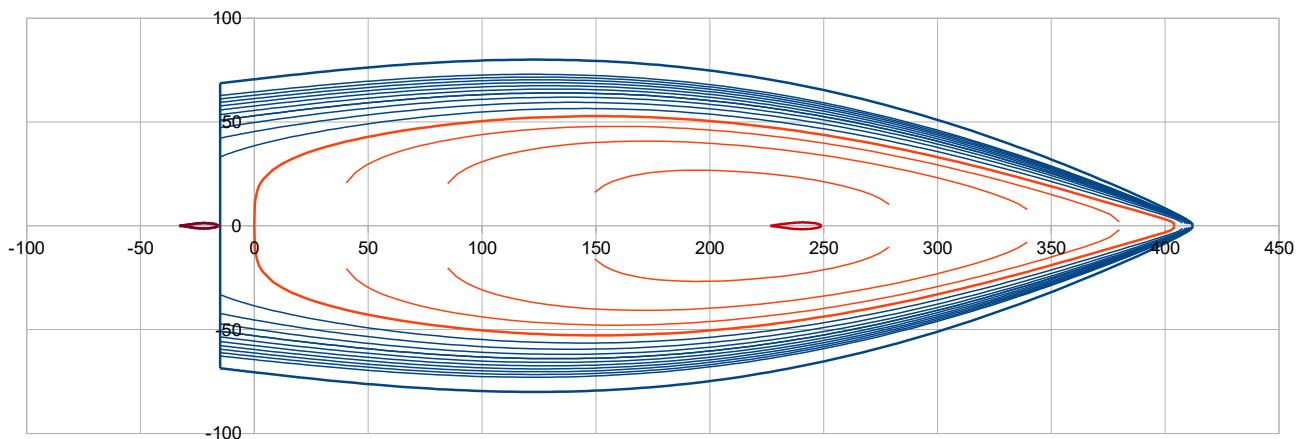
**Pui liv y (cell B31) :**

***Pui liv y = 2 gives the better curvature regularity in the midship zone, it is the recommended value.*** Pui liv y < 2 leads to a more accentuated curvature (up to a folding when Pui liv y < 1,5) and on the other hand a Pui liv y > 2 leads to a flattening in the midship zone. Examples :

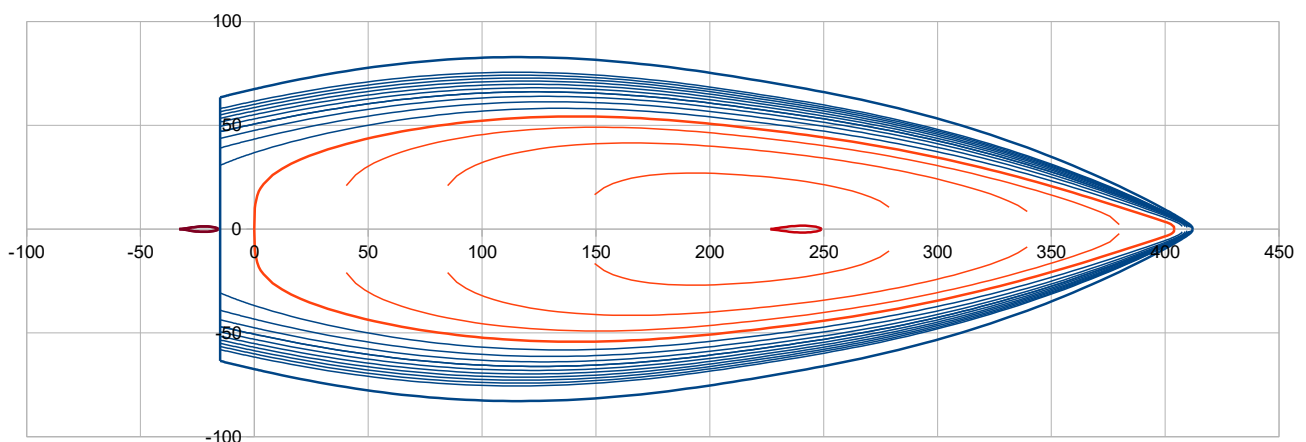
Pui liv y = 1,7 :



Pui liv y = 2 :

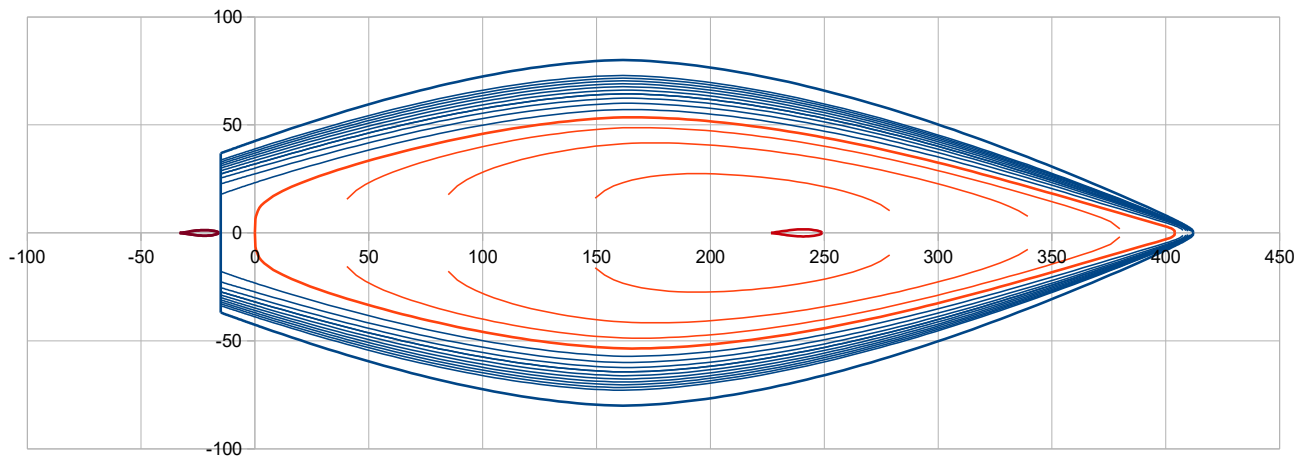


Pui liv y = 2,5 :

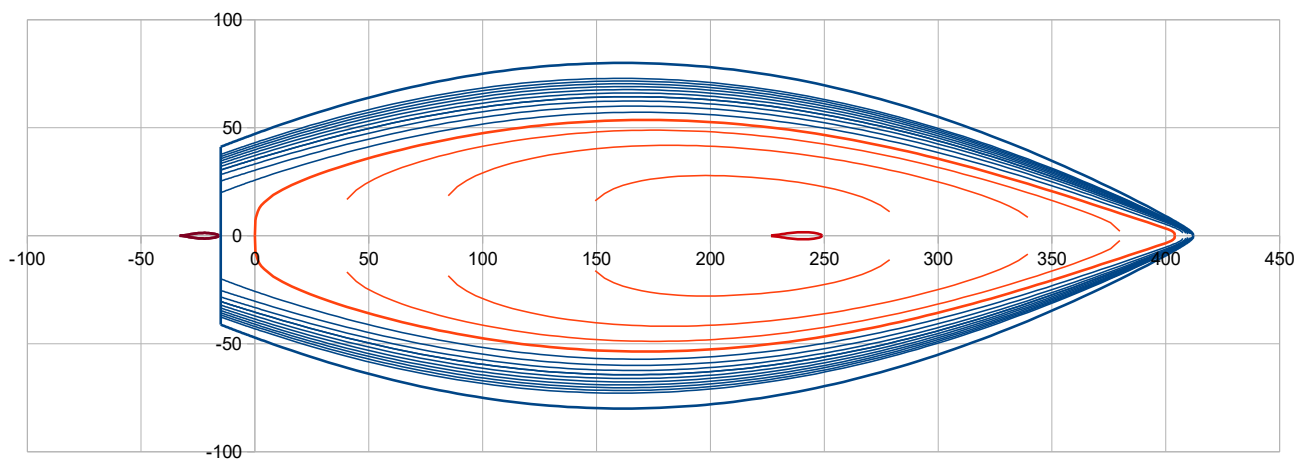


Another example (using another set of the previous parameters  $B_g = 1,6$ ,  $X_{Bg} = 40$  and  $\alpha = 0$ ) :

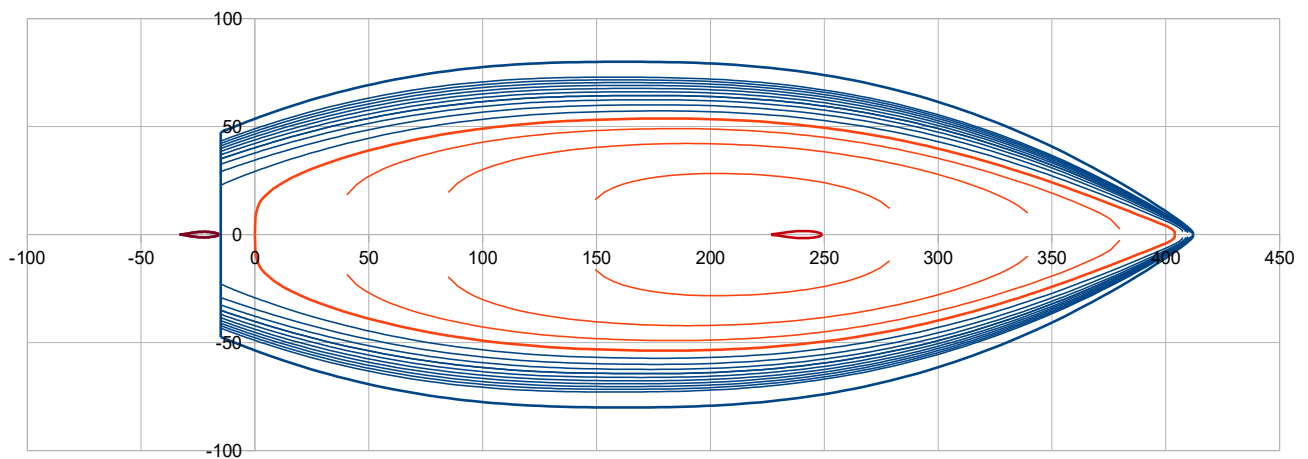
Pui liv  $y = 1,7$  :



Pui liv  $y = 2,0$  :



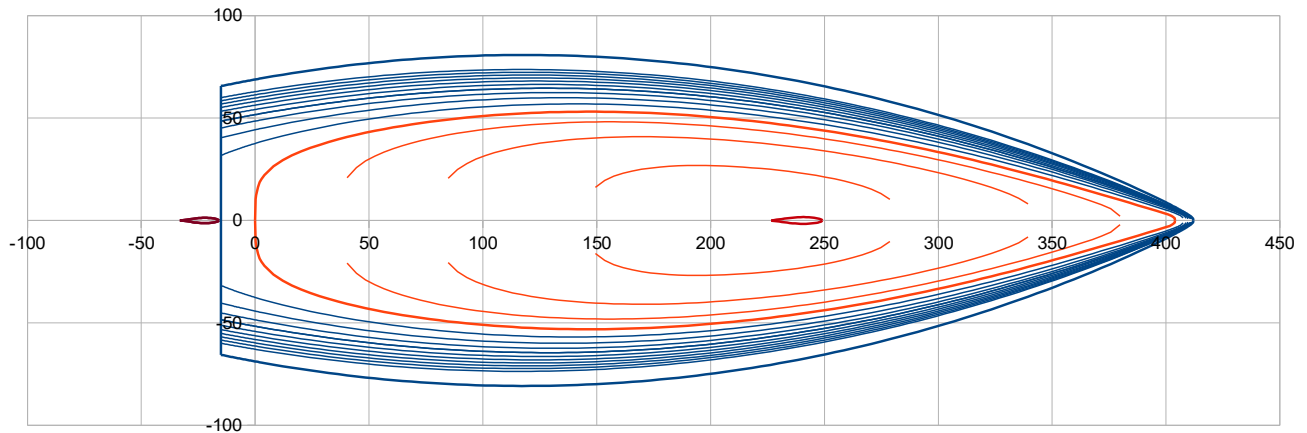
Pui liv  $y = 2,5$  :



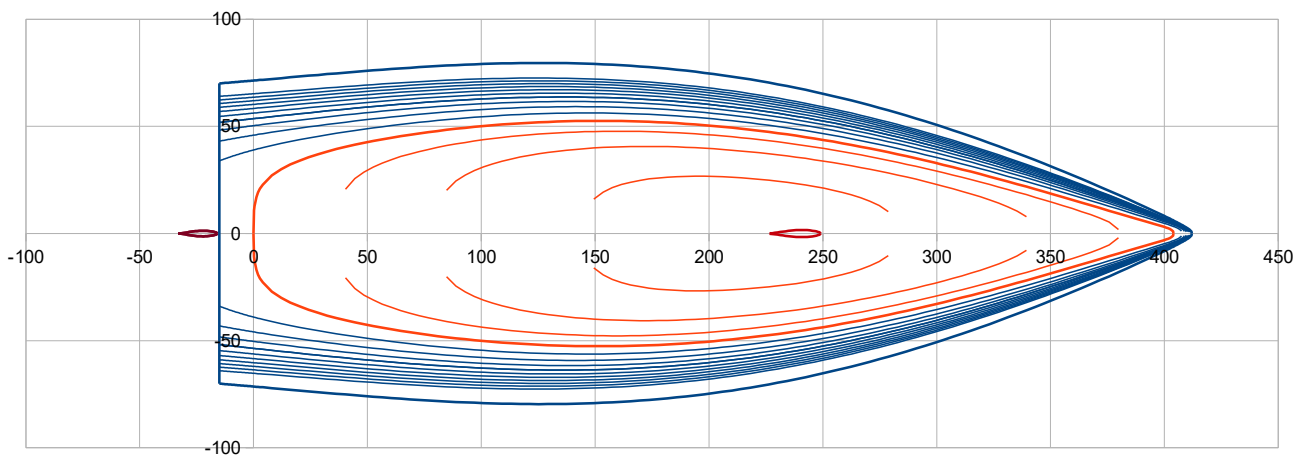


**Cor Pui liv (cell B32)** can add more or less tension towards the front and aft ends of the sheer line, meaning ends steched with less or no curvature. Examples :

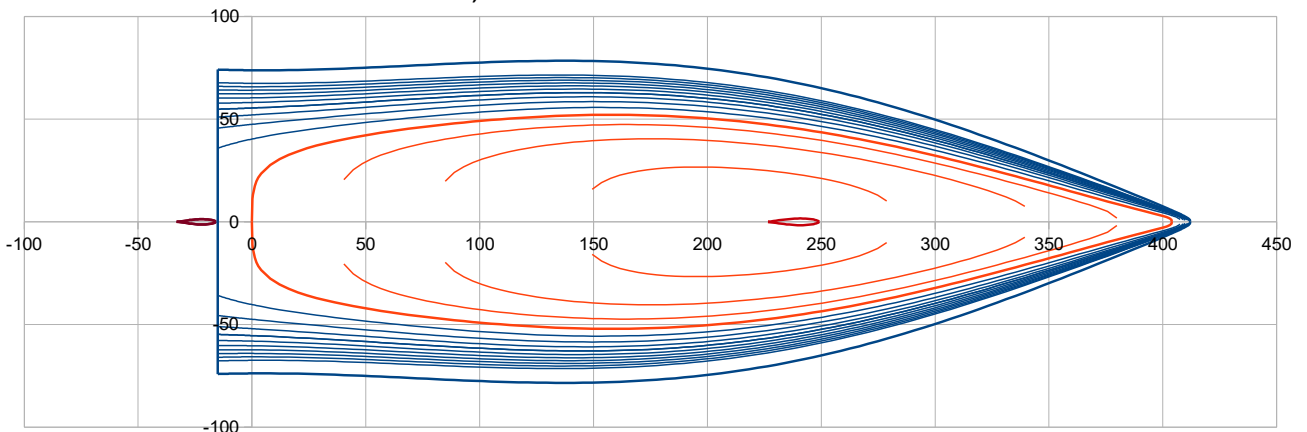
Cor Pui liv = 0



Cor Pui liv = 0,03



Cor Pui Liv = 0,06 :



Negative values of Cor Pui Liv can be tested too, with the inverted effect.

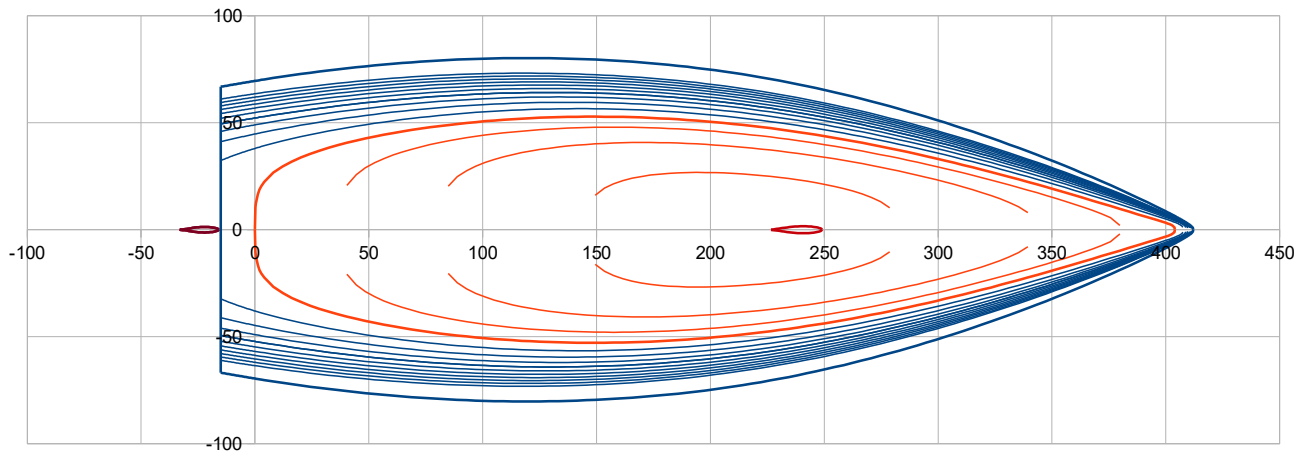
**Pui Cor Pui (cell B33)** acts on the application with x of the correction Cor Pui liv.

Pui Cor Pui = 1 >>> correction application is linear.

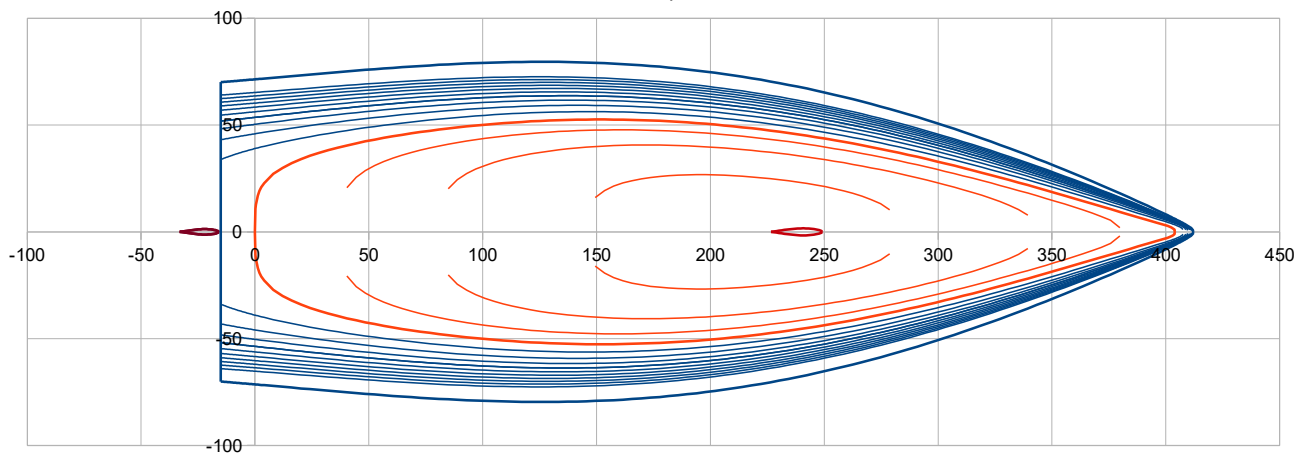
Pui Cor Pui > 1 >>> amplifies the correction application towards the ends. Some examples :

Examples (with Cor Pui Liv = 0,03) :

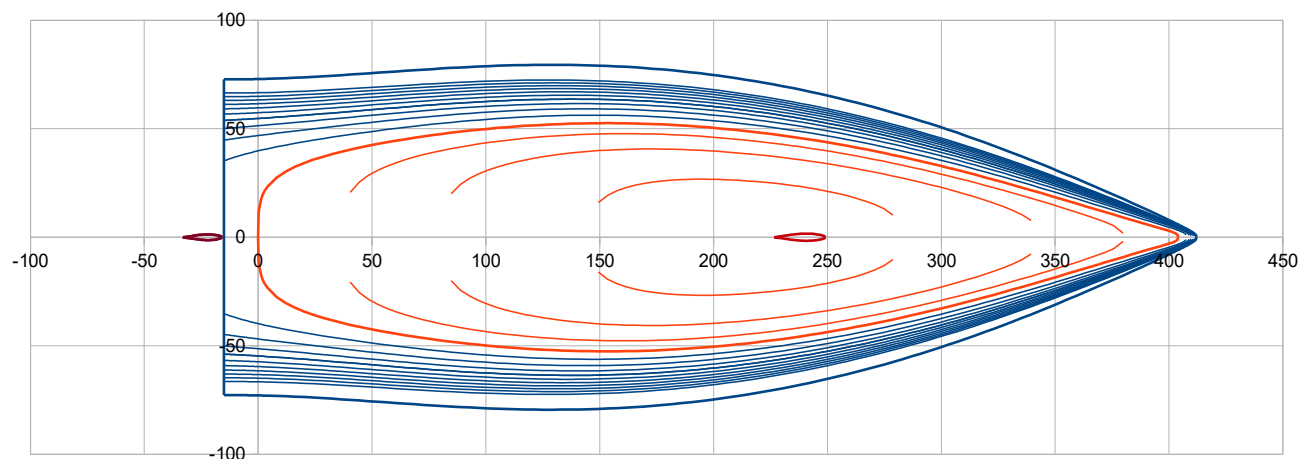
Pui Cor Pui = 0,5



Pui Cor Pui = 2,0



Pui Cor Pui = 3,0

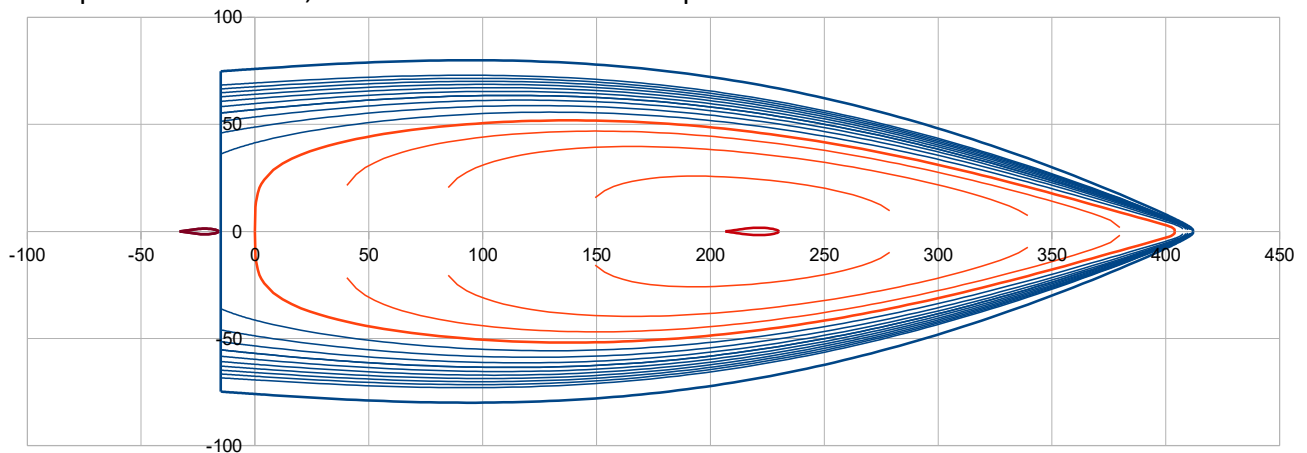


**Nota :** with recommended values of 0,5 to 2, Pui Cor Pui acts as a fine tuning of the tensioning of the ends of the sheer line triggered by Cor Pui liv.

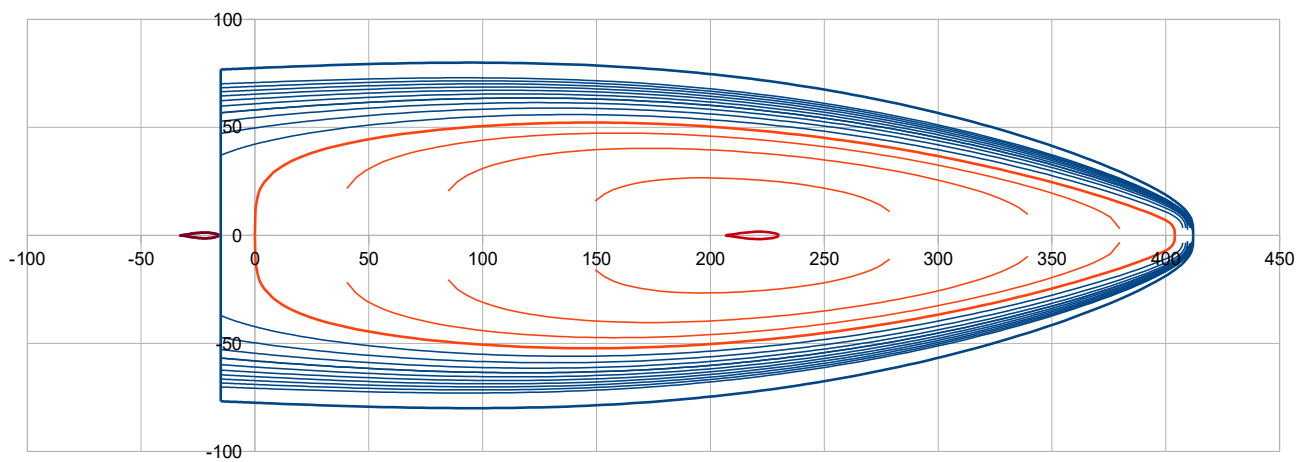
**Scow (Cell B35) :** it is a coefficient introducing a scow influence on the bow shape of the sheer line.

Scow = 0 to 1 ; **0 = no scow bow ; 1 = full « rectangular » size scow bow**

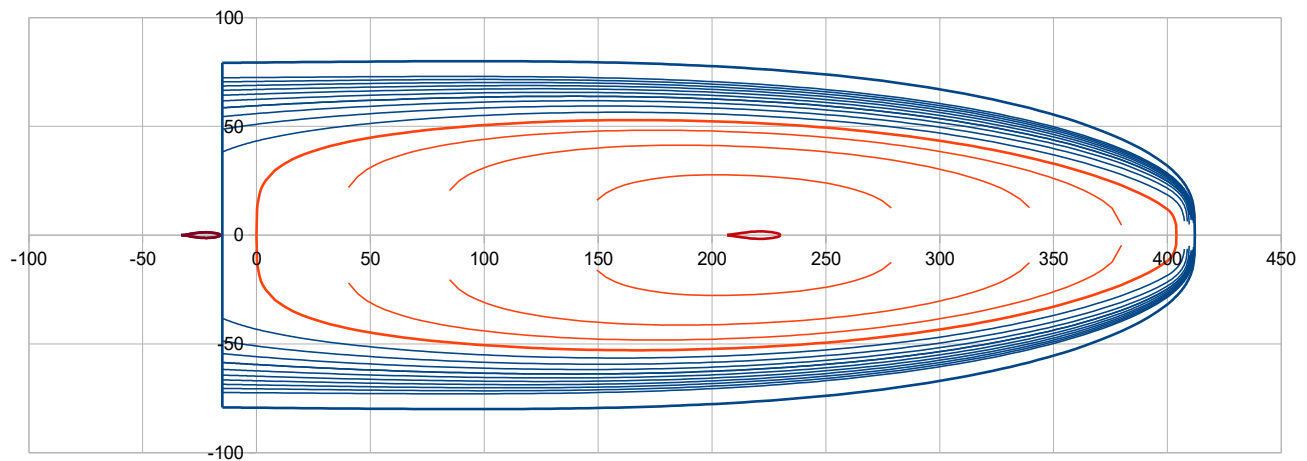
Example with  $Scow = 0,07 \gg \gg$  a small roundness representative of the bow construction



Same with  $Scow = 0,4$

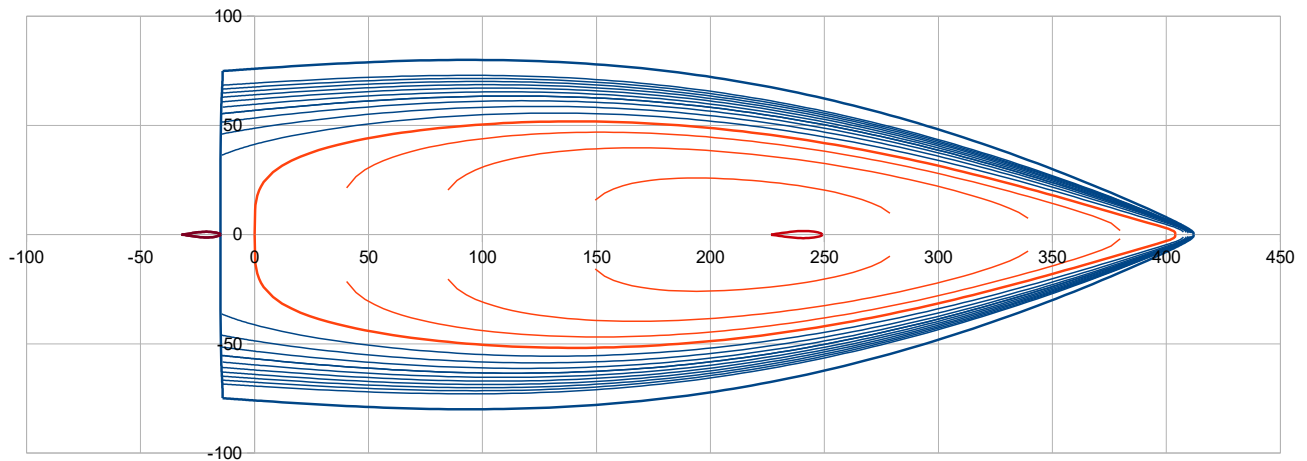


Same with  $Scow = 0,8$

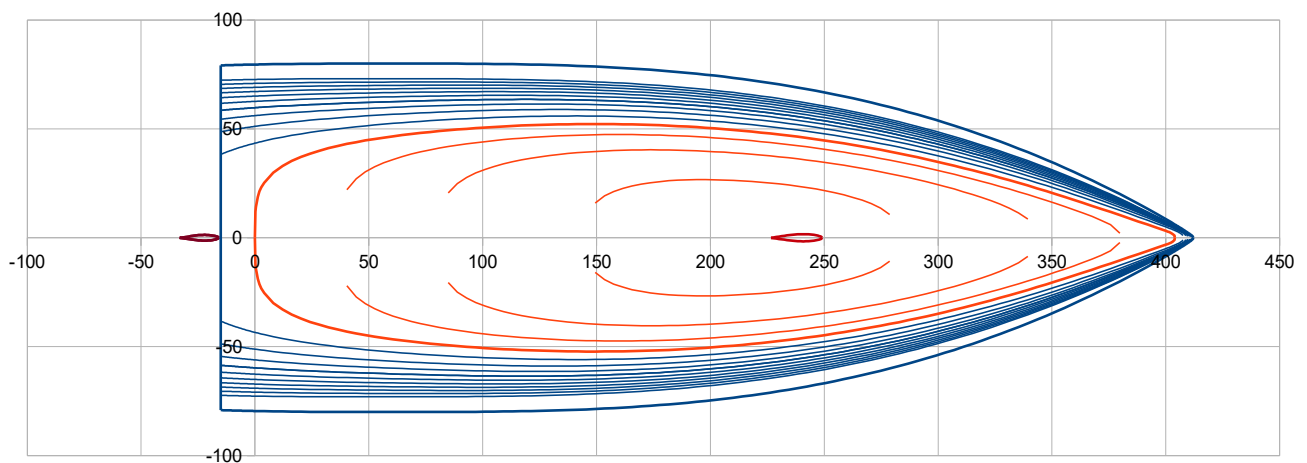


To finish on this sheer line definition, these two examples with very different input data leading to the same the maximum beam  $B_{max} = 1,60$  m :

Bg (m)	0,56	>> Bmax (m)	1,600	at Xb(%Lwl)	23,0			
X Bg (% Lwl)	55,0							
Alfa (°)	11,84							
Pui liv y	2,00							
Cor Pui liv	0,020							
Pui Cor Pui	2,00							
Scow	0,07							



Bg (m)	1,60	>> Bmax (m)	1,600	at Xb(%Lwl)	15,0			
X Bg (% Lwl)	15,0							
Alfa (°)	0,00							
Pui liv y	3,00							
Cor Pui liv	0,020							
Pui Cor Pui	2,00							
Scow	0,04							



**Option Hard chine line, its definition in the vertical projection (xz plan)**

**Type :** 0 = no hard chine ; (cell B36)  
 1 = hard chine defined by 2 heights ;

**2** = hard chine defined by 3 heights ;

When Type = 1 , two data to input :

1,2 **Zhc av (m)**: height of the hard chine line at the bow (cell B37)

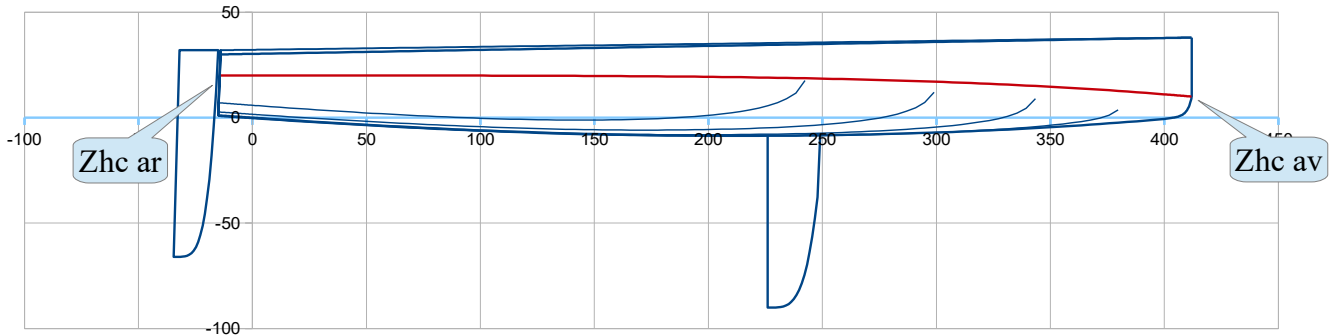
1,2 **Zhc ar (m)** : height of the hard chine line at the aft (cell B39)

When Type = 2, a third height is to input :

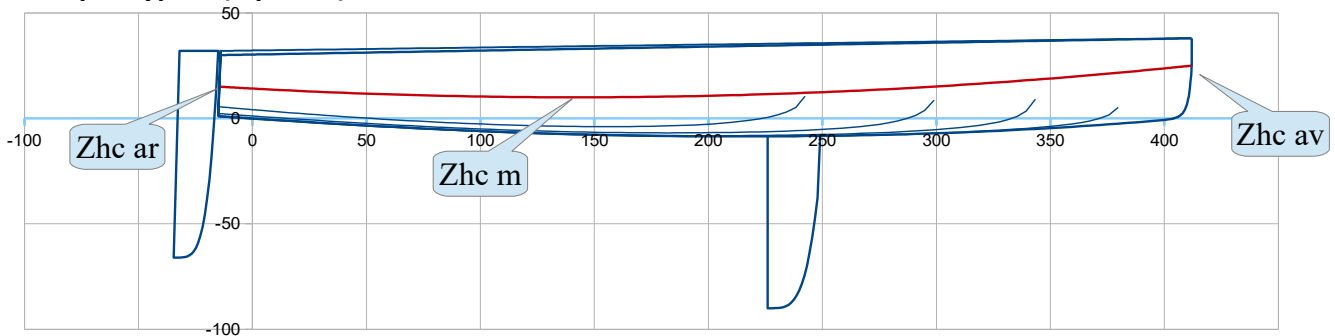
2 **Zhc m (m)** : height of the hard chine line at 35% Lwl (cell B38)

**Pui hc z** : power of the polynomial defining the hard chine line, (cell B40)  
recommended value :  $\geq 1$  (Type 1) ,  $\geq 2$  (Type 2)

**Example Type 1 (2 points)** with Zhc av = 0,05 m ; Zhc ar = 0,20 m ; Pui hc z = 4



**Example Type 2 (3 points)** with Zhc av = 0,25 m ; Zhc m = 0,10 m ; Zhc ar = 0,15 m ; Pui hc z = 2

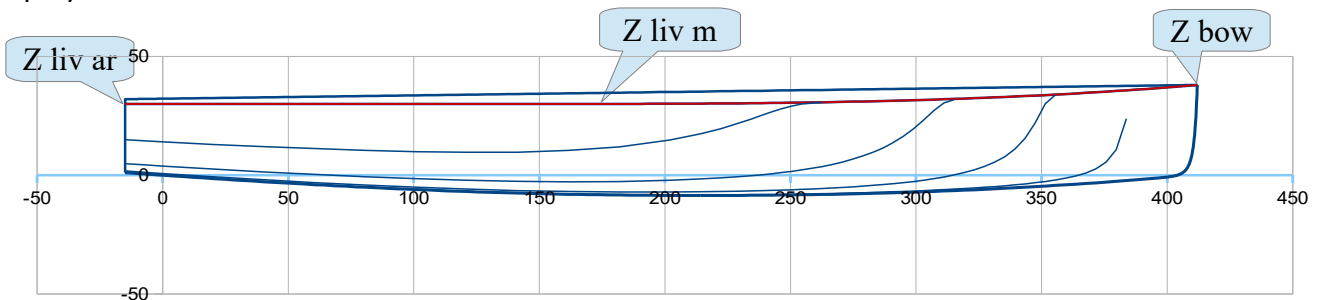


### Sheer line, its definition in vertical projection (xz plan)

**Z liv m (m)** : it is the freeboard at 35% Lwl (cell B42)

**Z liv ar (m)** : it is the aft freeboard, specified at the sheer line aft point. (cell B43)

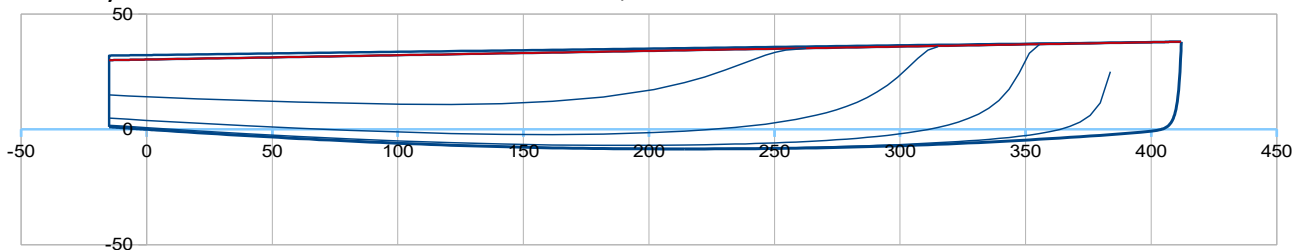
Together with **Z bow** already defined (cell 18) , these are the 3 freeboards on which leans the xz polynomial for the sheer line definition.



**Pui liv z** : it is the power of this polynomial for the fore part of the line. **(cell B44)**

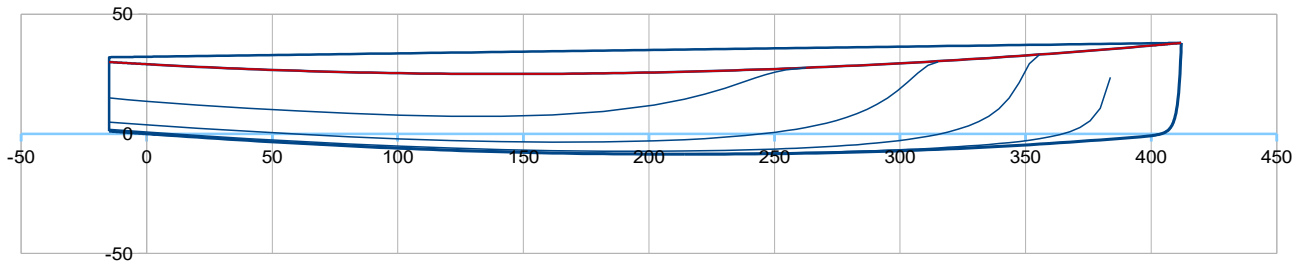
Usual values : either 1 (straight line) , or  $\geq 2$

**Example with Pui liv z = 1** ; in that specific case, the sheer line appears to be a straight line, and only Z liv ar and Z bow are used to define it, Z liv m is not used

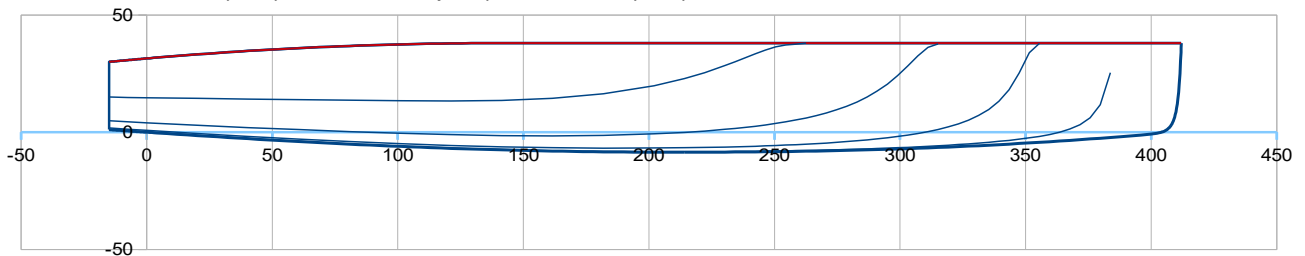


Examples with Pui liv z = 2 and two different values of Z liv m :

Z liv ar : 0,30 ; **Z liv m = 0,25** ; Zbow = 0,38 ; Pui liv z = 2

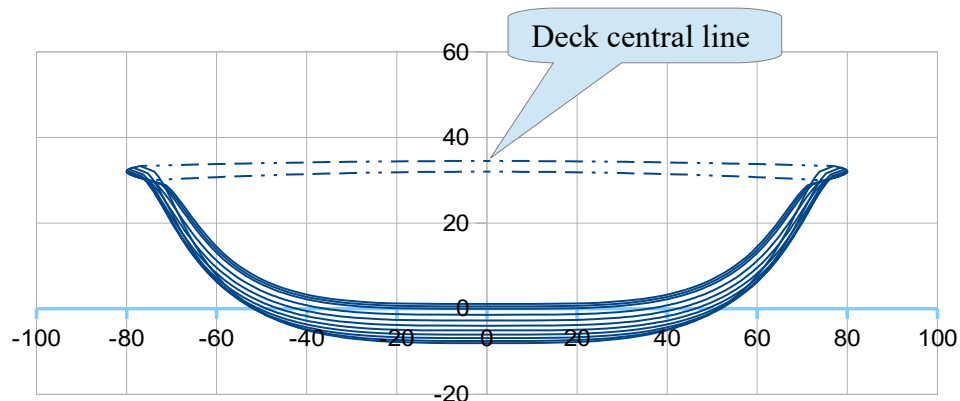


Z liv ar : 0,30 ; **Z liv m = 0,38** ; Zbow = 0,38 ; Pui liv z = 2



### Hull deck / central line of symmetry

A deck surface can be defined, for a dinghy hull this « deck » is of course virtual but the generated curvatures in the sections can be used to define the real fore deck and the benches. Example :

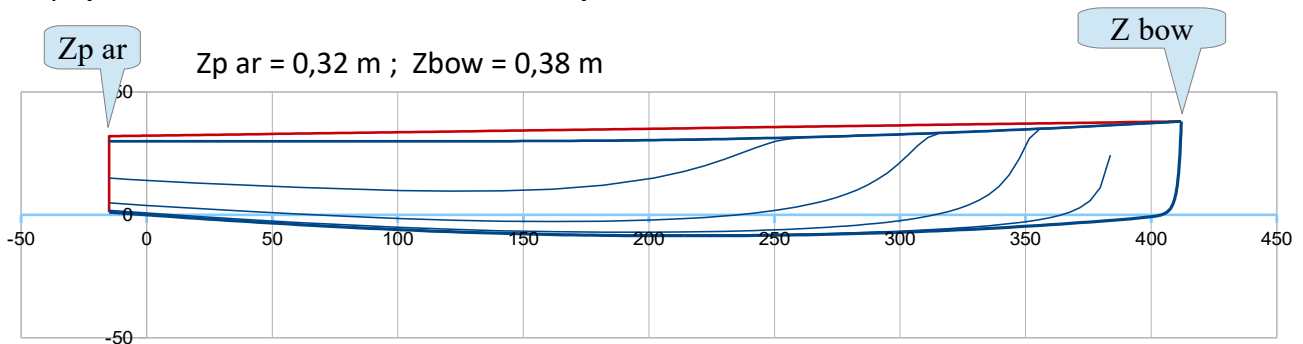


The « deck » is made of transversal circular arcs based on both the sheer line definition and the central line of symmetry (at  $y = 0$ ) going from the front end of the hull (X bow, Z bow) and defined by :

- a point at midship : **Zp m (m)** at  $X = 35\% \text{ Lwl}$  (cell B46) **Zp m** should be  $> \text{Z liv m}$
- a point at the rear transom : **Zp ar (m)** at  $X \text{ tab ar}$  (cell B47) **Zp ar** should be  $> \text{Z liv ar}$

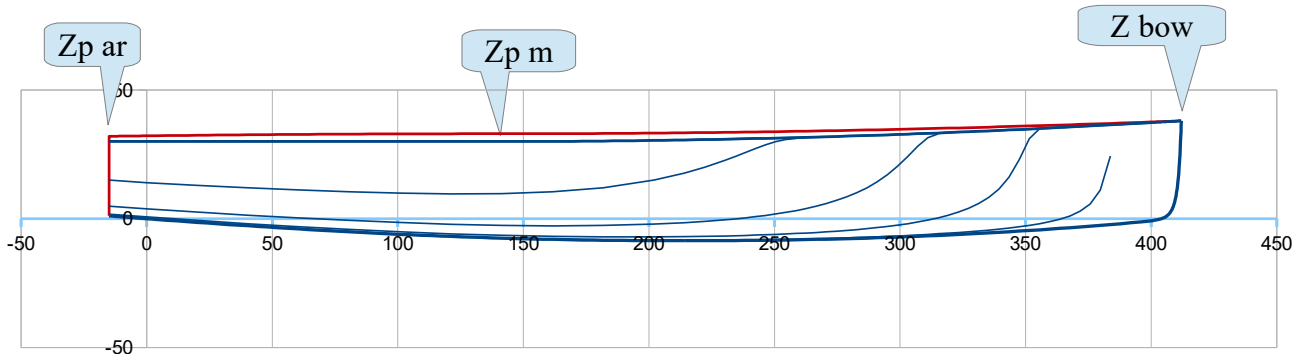
**Pui deck z (Case B48)** : it is the power of the polynomial defining the fore part of this deck central line. Recommended values : either 1 (straight line), or  $\geq 2$ .

**Example with Pui deck z = 1** ; in that specific case, the sheer line appears to be a straight line, and only **Zp ar** and **Z bow** are used to define it, **Zp m** value is not used.



Exemple with Pui deck z = 2

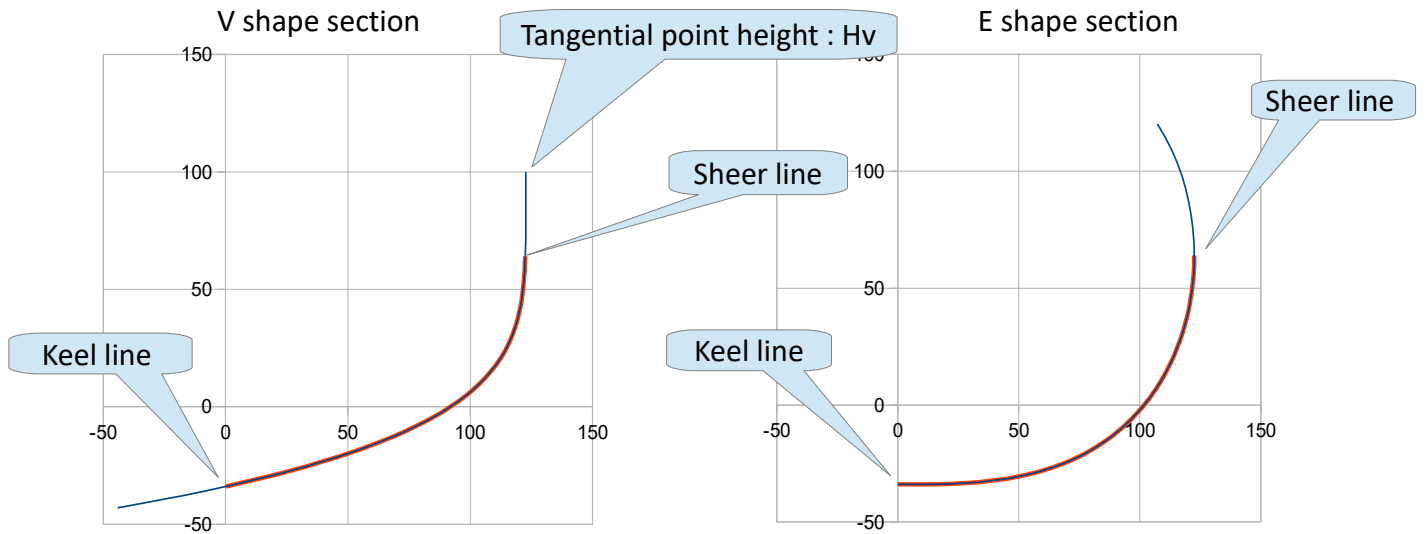
$Z_{p \text{ ar}} : 0,32 \text{ m}$  ;  **$Z_{p \text{ m}} = 0,33 \text{ m}$**  ;  $Z_{\text{bow}} = 0,38 \text{ m}$  ;  $\text{Pui deck } z = 2$



### VE Sections (as a combination of « V » and « E » transversal shapes)

In the « VE » spreadsheet application, the transversal sections are defined as a combination of 2 polynomials, one representative of a V shape section and another one representative of a E shape section (E for Elliptic). Before describing each input parameters (all adimensional), some more explanations and illustrations of these combinations are probably useful.

« VE » sections are combination of two shapes as sketched here below. Adimensionnal parameters to enter concern the height of the tangential point  $H_v$ , the degree and the coefficients of the polynomials V and E, their variation with x.



Overview of the parameters to input :

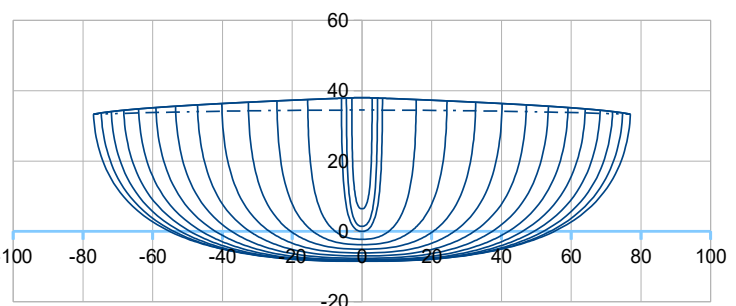
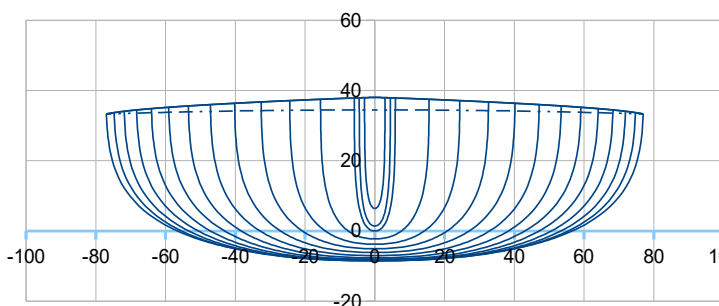
C Hv av	3,00
C Hv m	6,00
C Hv ar	5,00
Pui Hv	3,00
Pui V av	20,00
Pui V ar	12,00
Pui Pui V	1,00
Sections E and combination	
Pui E1	0,30
Pui E2	8,67
mix VE av	0,25
mix VE ar	0,15
Pui mix VE	1,00
Option additional shaping (	
Ky	1,00
Kz	0,40
Ksoft	2,00



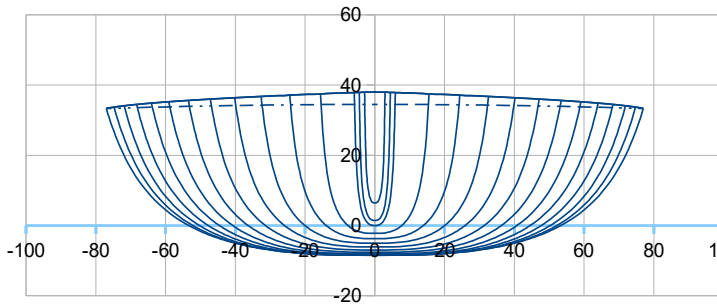
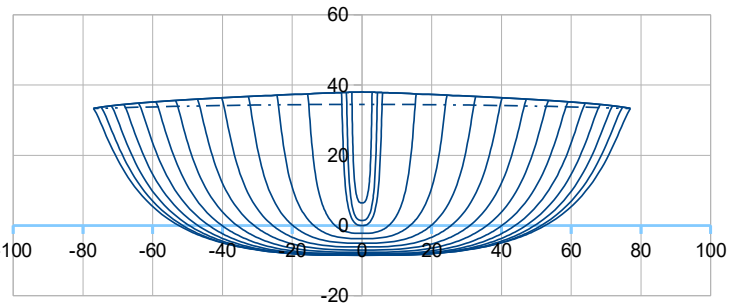
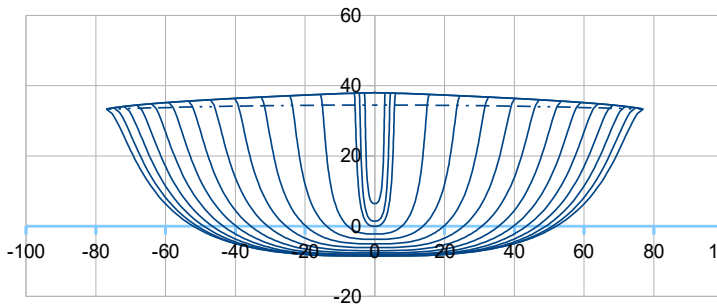
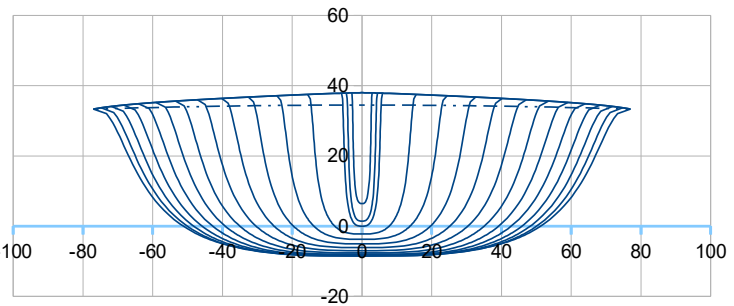
**Suggestion for the beginner :** at first you can play with just various values of **Pui E1** and **Pui E2**, keeping the other values constant as set above, you can still have a wide variety of hull relevant for a dinghy. Then, in a second stage of your learning curve, you can test variants with using the other parameters. Some examples (at same hull displacement) :

**Pui E1 = 3 ; Pui E2 = 3,7**

**Pui E1 = 2 ; Pui E2 = 4,5**





**Pui E1 = 1 ; Pui E2 = 6****Pui E1 = 0,75 ; Pui E2 = 6,5****Pui E1 = 0,5 ; Pui E2 = 7,5****Pui E1 = 0,25 ; Pui E2 = 9,1****V shape adimensional parameters :****C Hv av ; C Hv ar ; C Hv m ; Pui Hv (cells B51, B52, B53, B54)**

These parameters deal with the height Hv of the polynomial tangential vertical point as a function of the x position of the section (formulation details in the technical appendix).

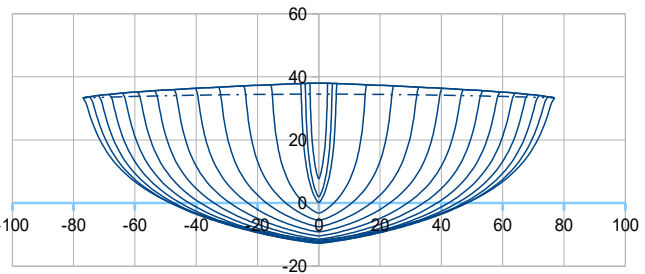
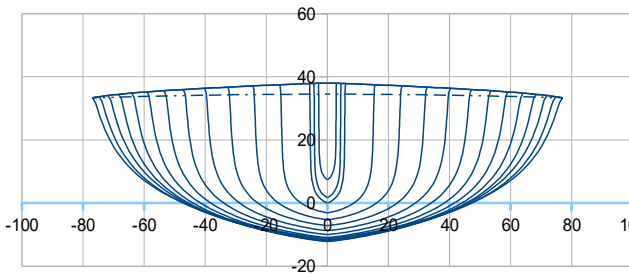
**C Hv av** at bow end , **C Hv m** at midship and **C Hv ar** at rear end, are the relative heights Hv to respectively Z bow, Z liv m and Z liv ar . The larger C Hv, the more the V shape is sharp ; the smaller C Hv, the more the V shape is rounded. C Hv > 1 is recommended (C Hv < 1 can give a tumblehome shape but it is not usual for a dinghy).

**Pui Hv** is the power of the polynomial computing the evolution of C Hv from front to rear of the boat.

Some examples of the C Hv (s) influence :

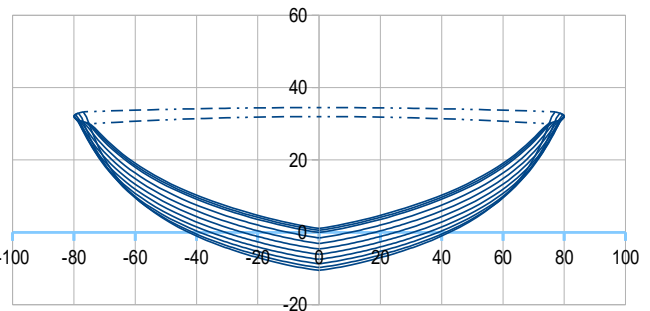
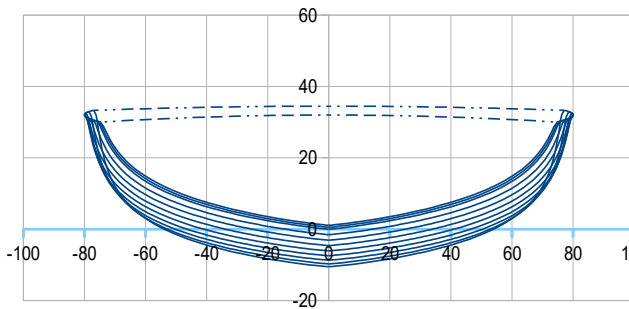
**C Hv av = 1,5 ; C Hv m = 6 ; C Hv ar = 6**

&gt;&gt;&gt;

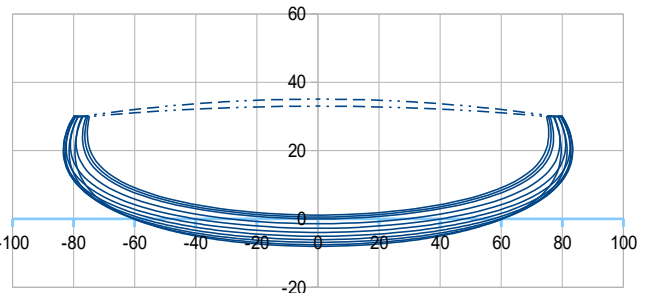
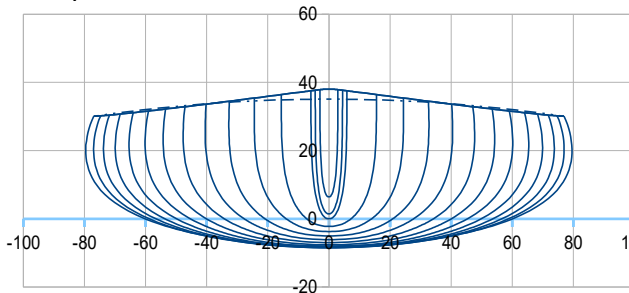
**C Hv av = 6 ; C Hv m = 6 ; C Hv ar = 6**  
more sharp V towards the fore sections

C Hv av = 6 ; C Hv m= 4 ; C Hv ar = 4

>>> C Hv av = 6 ; C Hv m= 7 ; C Hv ar = 7  
more sharp V towards the aft sections



Example with tumblehome : C Hv av = 0,8 ; C Hv m= 0,52 ; C Hv ar = 0,8

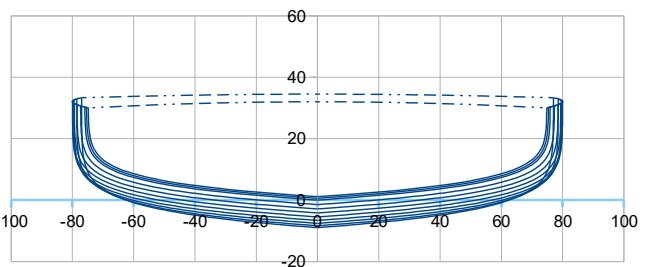
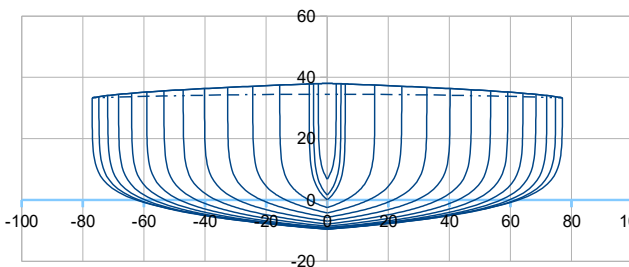


**Pui V av ; Pui V ar ; Pui Pui V ; Cor Pui Pui (cells B57, B58, B59, B60)**

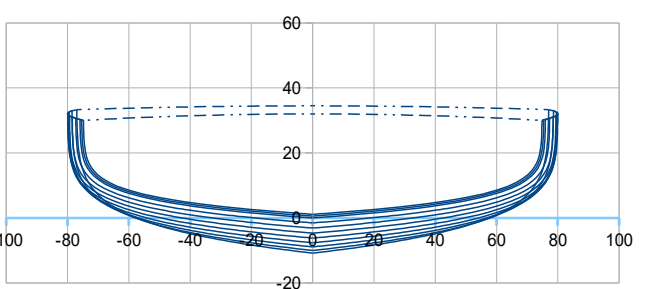
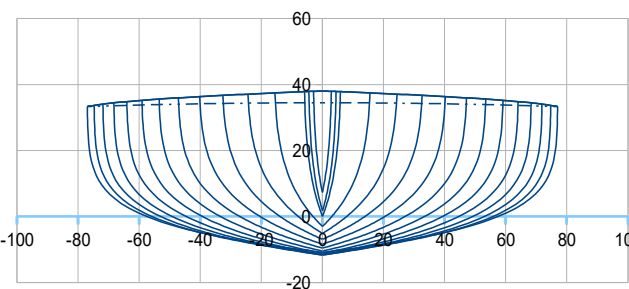
These parameters deal with the power of the polynomial with position  $x$  of the section (formulation details in technical appendix). **Pui V av** is the front power ; **Pui V ar** is the rear power. The larger Pui V, the more the V shape is rounded. **Pui Pui V** is the power of the polynomial computing the evolution from Pui V ar to Pui V av . Some examples (V sections only, without the combination with E sections) :

Example of **Pui V av** influence, mostly towards fore sections :

**Pui V av = 15 ; Pui V ar = 12 ; Pui Pui V = 1**

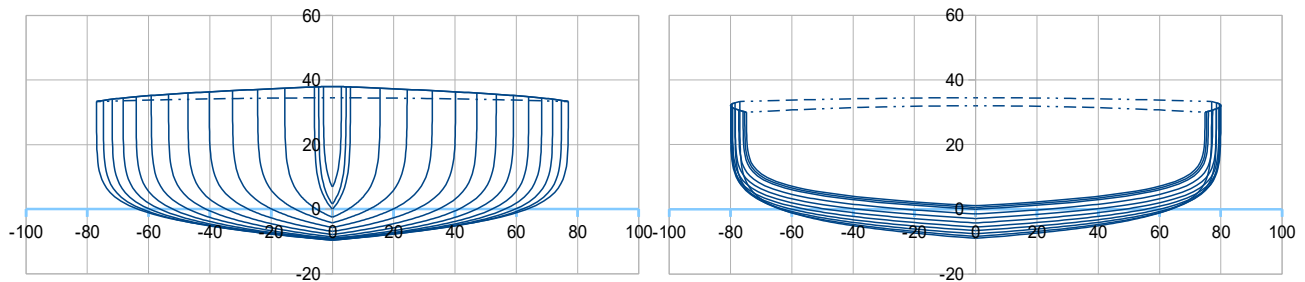


>>> **Pui V av = 5 ; Pui V ar = 12 ; Pui Pui V = 1**

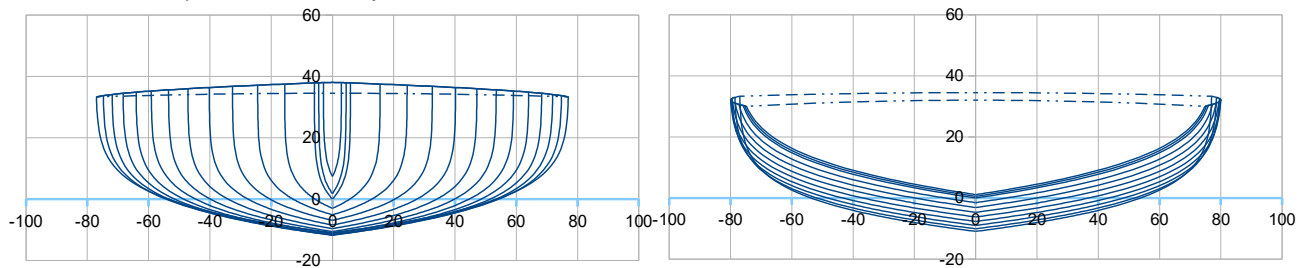


Example of **Pui V ar** influence, mostly towards aft sections :

**Pui V av = 12 ; Pui V ar = 15 ; Pui Pui V = 1**



**Pui V av = 12 ; Pui V ar = 5 ; Pui Pui V = 1**



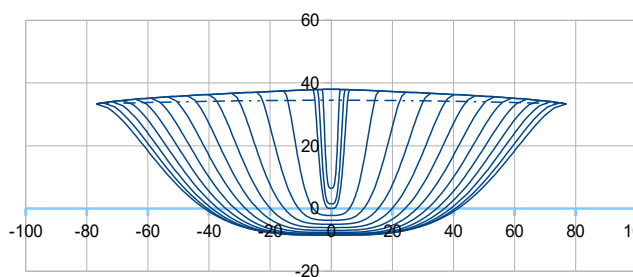
### **E shape adimensional parameters :**

**Pui E1 , Pui E2** : powers of the E generalised function. (cells B62 , B63)

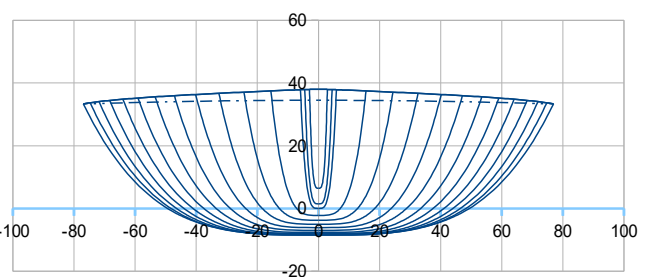
Some examples (E sections only, without combination with V sections). Examples :

**Pui E1 influence :**

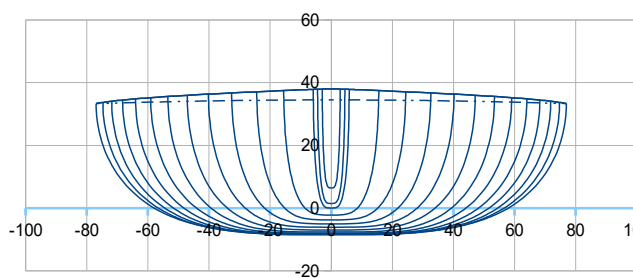
**PE1 = 0,5**



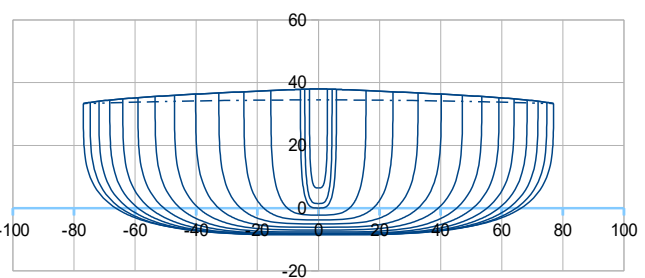
**PE1 = 1**



**PE1 = 2**

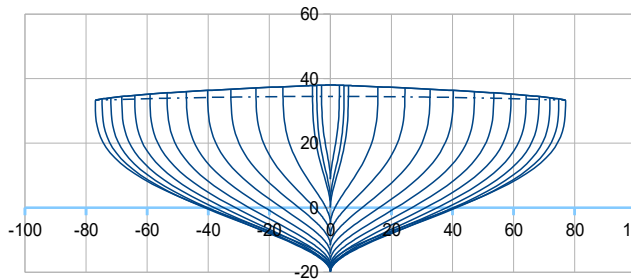


**PE1 = 4**

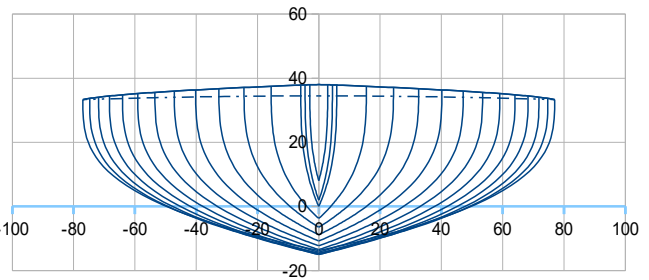


**Pui E2 influence :**

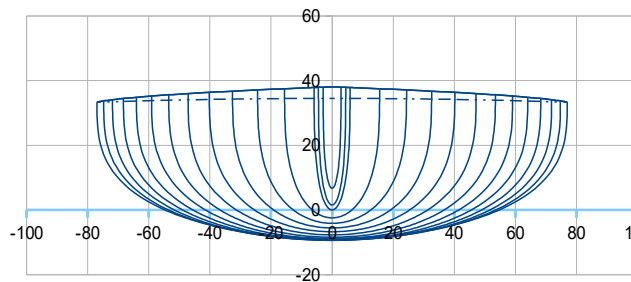
Pui E2 = 0,5



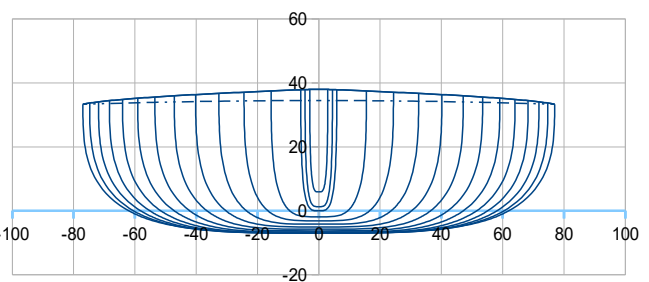
Pui E2 = 1



Pui E2 = 2

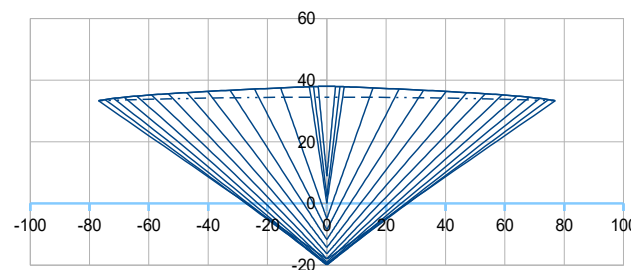


Pui E2 = 6

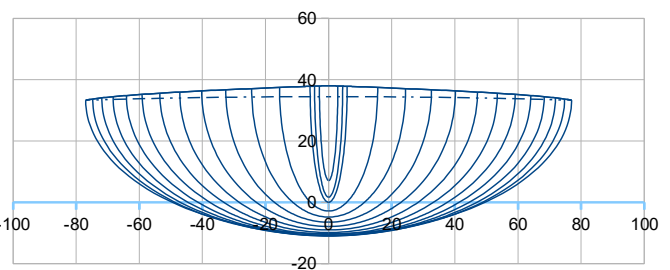


To note also that Pui E1 = Pui E2 = 1 leads to triangle sections, that Pui E1 = Pui E2 = 2 leads to elliptical sections.

Pui E1 = Pui E2 = 1 &gt;&gt; triangle

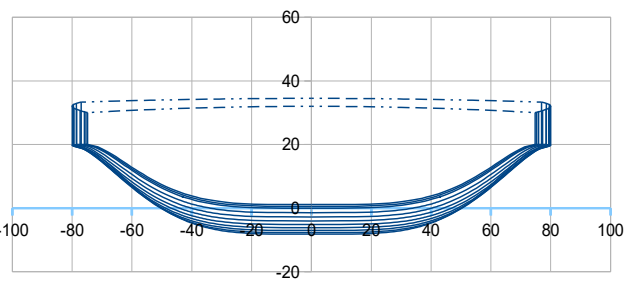
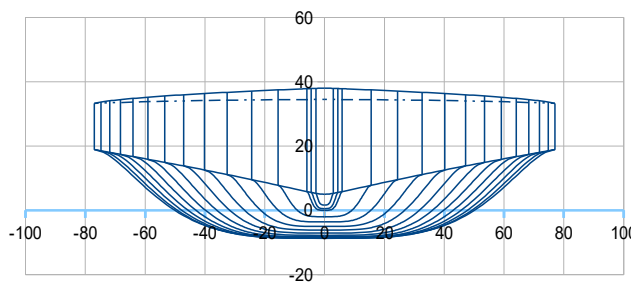


Pui E1 = Pui E2 = 2 &gt;&gt; ellipse



A Pui E1 < 1 combined with the hard chine option can lead to that kind of step / spray rail :

Example : Pui E1 = 0,55 ; Pui E2 = 4



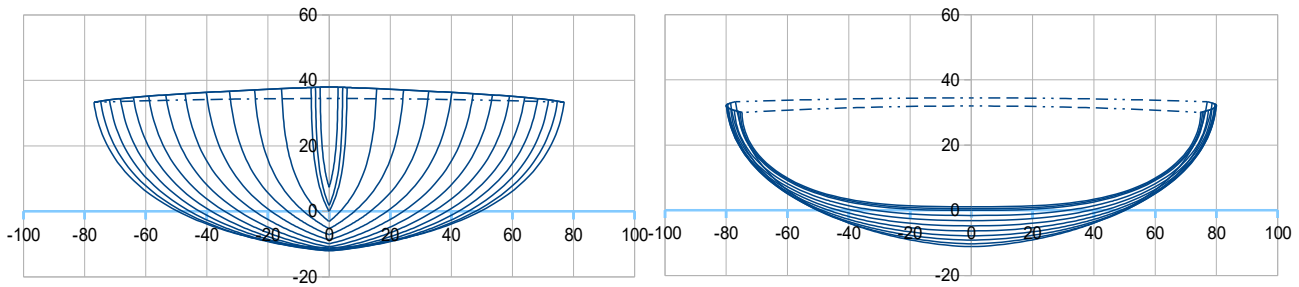
**V and E sections combination :**

V et E sections are combined in function of x, with :

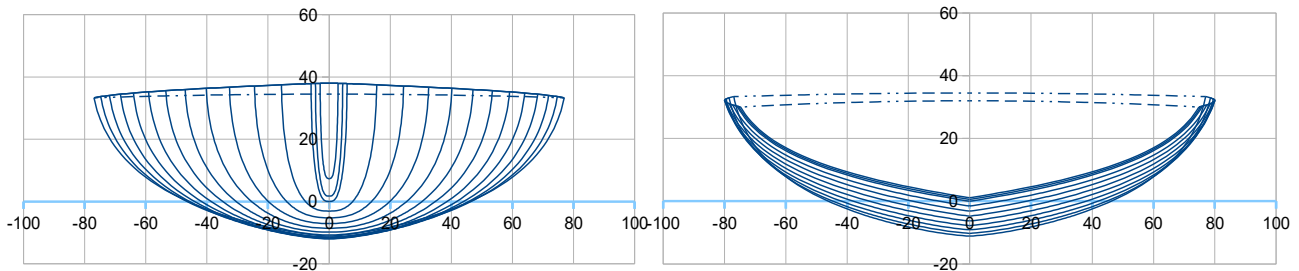
**mix VE av ; mix VE ar** : adimensionals between 0 to 1. (cells B61 and B62)

1 means 100% V shape and 0 means 100% E shape.

**mix VE av = 1 and mix VE ar = 0** >>> Evolution from V sections at the front to E sections at the rear of the hull.



**mix VE av = 0 et mix VE ar = 1** >>> It is the exact contrary, evolution from E sections at the front to V sections at the aft of the hull.



*Nota : all intermediate cases, i.e. to put mix VE av and mix VE ar between 0 and 1, are also possibles and usual.*

**Pui mix VE (cell B63)** : adimensional, it is the power of the polynomial function with x wich pilots the evolution from **mix VE av** at front end to **mix VE ar** at rear end of the hull.

**Option additionnal shaping (triggered only if  $K_y \neq 1$ ) :**

3 new adimensional parameters were added to shape the sections by introducing convex (up to a bump) or concav (up to an hollow) deformation, and with a soft or hard transition :

**Ky (cell 65) :**

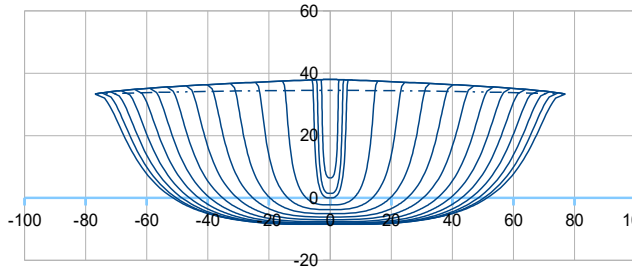
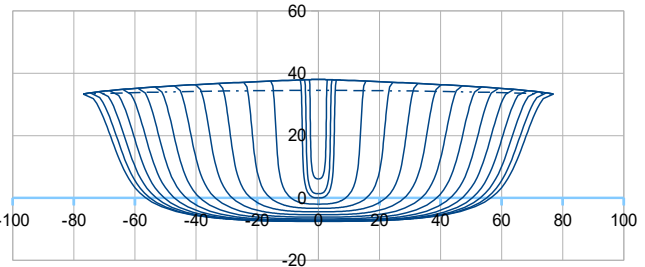
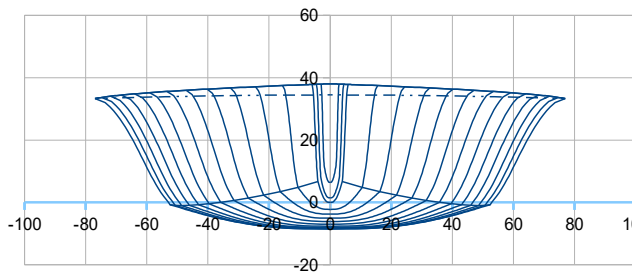
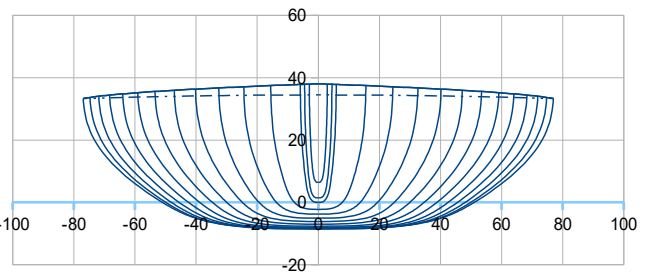
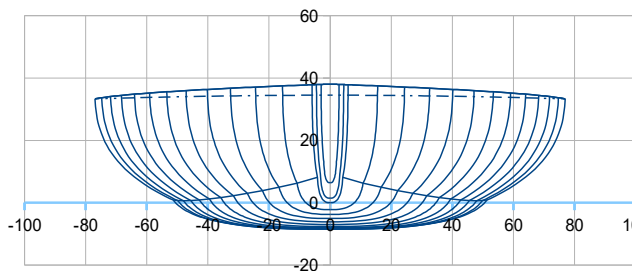
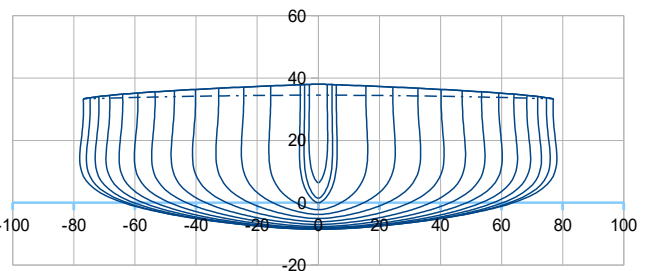
- = 1 : no modification, that neutralizes the effect of the two other parameters
- >1 : creates more convexity (up to a bump)
- <1 : creates a flattness (up to an concavity)

**Kz (cell 66) :**

acts on the height of the protuberance or the hollow

**Ksoft (cell 67) :**

acts on the transition, either soft (when  $\geq 2$ ) or hard (when  $\leq 1$ )

**Examples :****Ky = 1 (no modification)**>>> **Ky = 1,2; Kz = 0,2 ; Ksoft = 2****Others examples :****Ky = 1,235 ; Kz = 0,4 ; Ksoft = 0,85****Ky = 1,2 ; Kz = 0,2 ; Ksoft = 2****Ky = 0,85; Kz = 0,45 ; Ksoft = 1****Ky = 1,3 ; Kz = 0,4 ; Ksoft = 2****A last recommendation about the input data for the hull :**

Probably that the use of the adimensional parameters are not always very intuitive at the beginning :

- the ones of hull of reference data are there to guide in your first steps,
- you can first test the effect of each parameter, including by testing a priori very low or very high values so that to better see the effects, and this « learning by testing » process will help you to progress rapidly.
- then input the geometrical data of your project and go ahead ...

## 1.2 Daggerboard data

Data to enter are in column B , cells B69 to B77 :

Xq ar (m)	2,06
C root (m)	0,24
C roundness	5,00
t/c (%)	14,00
F angle (°)	90,00
Draft oa (m)	0,90
naca 00xx	0
naca 63-0xx	1
naca 65-0xx	0

Rear point of the root chord

Root chord length

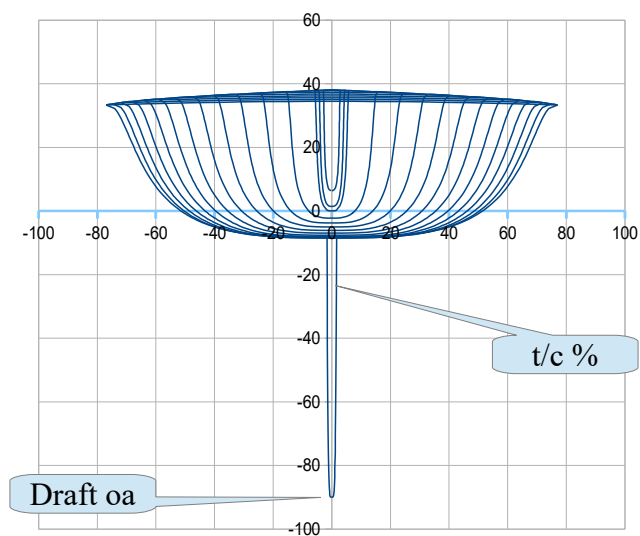
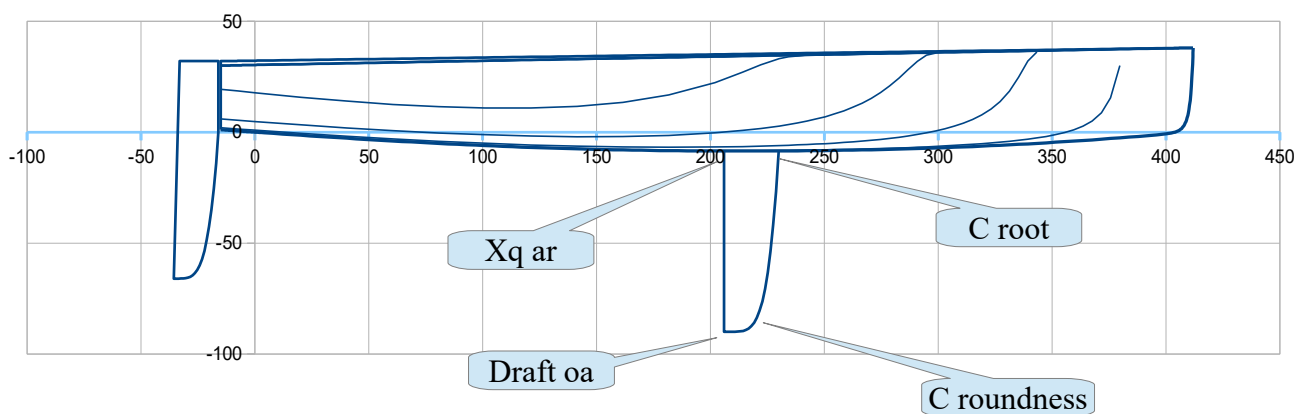
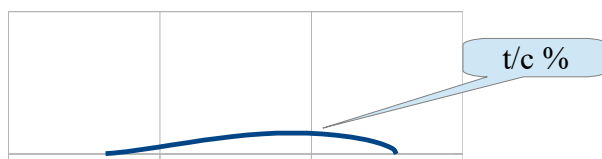
Roundness of the profile lower part ; should be usually 3 to 6

Max thickness of the daggerboard

Daggerboard front angle, could be fixed to 90° for a dinghy  
should be > hull draft Tc

Type of profile (in the horizontal plans)

**Put 1 for the profile used, 0 for the others**

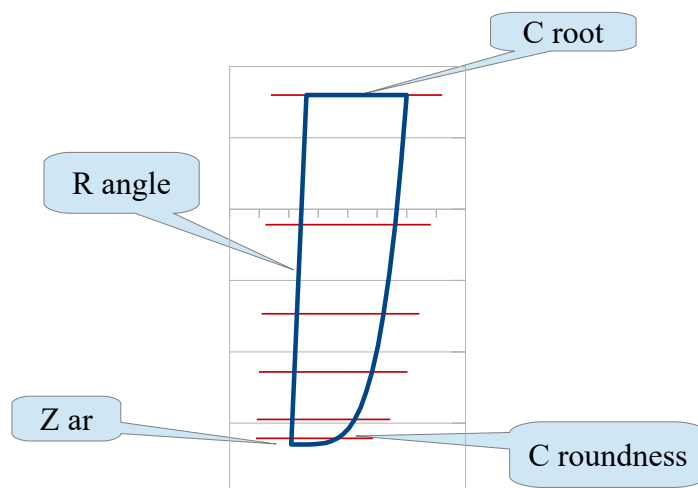


### 1.3 Rudder data

Data to enter are in column B , cells B79 to B89 :

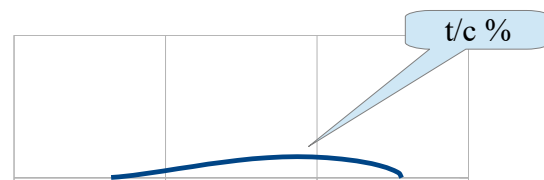
<b>C root (m)</b>	<b>0,170</b>	Root chord length
<b>t/c (%)</b>	<b>15,00</b>	Relative thickness of the profile
<b>R angle (°)</b>	<b>88,50</b>	Rudder rear angle, usually 85 to 90
<b>Z ar (m)</b>	<b>0,66</b>	Rudder rear span end
<b>C roundness</b>	<b>4,40</b>	Roudness of the profile lower part ; should be usually 3 to 6
<b>naca 00xx</b>	<b>0</b>	Type of profile (in the horizontal plans)
<b>naca 63-0xx</b>	<b>1</b>	<b>Put 1 for the profile used, 0 for the others</b>
<b>naca 65-0xx</b>	<b>0</b>	
<b>Nb of rudders</b>	<b>1</b>	1 or 2 rudders ; usually 1 for a dinghy
<b>Offset y (m)</b>	<b>0,00</b>	'put 0 when 1 rudder ; offset 'y' when 2 rudders
<b>Angle (°)</b>	<b>0,0</b>	'put 0 when 1 rudder ; Angle of the rudder with vertical when 2 rudders

As for the keel, data to enter allow the geometrical definition of the longitudinal profile of the rudder and the naca profiles used at various horizontal sections.



Naca 00xx	Naca 63-0xx	Naca 65-0xx
0	1	0

Ex : Profil Naca 63-0xx with Th max at 35% c >>>



Nota : daggerboard and rudder profiles are calculated and drawn with a cut-off at 97,5% c so to avoid trailing edges too tapered and unfeasible. Computed chord c are equal to  $C/0,975$ , C being the geometrical chords.



**Storage of Gene-Hull input data** : the spreadsheet includes a second sheet called « **Hulls storage** » where you can store by copy/paste the input data in column B, for your various projects or variants of a hull during the iteration process. The input data of the hulls given as examples are stored here too.

### Gene-Hull sheet / output

A hull with fairing lines and hydrostatic characteristics is automatically produced as long as all data are fulfilled with consistent values. Modification of one value leads in real time to an updated version of the hull (drawings and other output computations).

These output are divided into several sections 2 to 7, the User should act in some of them for either change and fix the scale of the views or introduce some complementary data for specific study (the hull with heel angle, etc ...)

### 2. Data sum-up and results of hydrostatic and surfaces calculations

These data and results are automatically produced, no intervention by the User.

They include parameters and ratios usually considered by naval architects to judge the consistence of the hull design, like :

- $Lwl / D^{(1/3)}$  (in metric units), its translation in DLR (in lbs,feet units)
- $Lwl/Bwl$
- The so-called hull speed, based on Froude( $Lwl$ ) = 0,4
- Displacements for 3 waterlines :  $H0$ ,  $H0-h$  cm,  $H0+h$  cm, (h depending of the hull size)
- $Xc$  (= LCB) and  $Zc$  positions of the center of buoyancy,
- $Cp$  (Prismatic coefficient) of the hull
- $Sf$  (floatation area) and its longitudinal center
- $Sw$  (hull wetted surface)
- Daggerboard and rudder volume, lateral surface and wetted surface
- .....

... + the curve of the sections areas,

... + to contribute to the mass balance data :

- Shull (surface of the hull) , its center of gravity position  $X,Z$
- Sdeck (surface of the deck, its center of gravity position  $X$   
(although here for a dinghy, it is a virtual deck)

...+ center of lateral resistance CLR (according to Larsson-Eliasson method for fin keel).

...+ the recopy of the weights and CoG coming from the 6.1 section here after (« mass spreadsheet with input of a load »),

Example :

**2.1 Hull**

Loa (m)	4,27	Lwl (m)	4,04	> Hull speed	4,9	(at Fn 0,4)		
>> ft	14,01		13,25					
Bsheer (m)	1,60	at X (% Lwl)	23,0	Boa (m)	1,60			
>> ft	5,25							
Bwl (m)	1,04	at X (% Lwl)	34,0	> Bwl / B	0,649			
>> ft	3,40							
Tc (m)	0,085	at X (%Lwl)	50	Freeboards (m) >		Aft	Midship	Fore
>> ft	0,28					0,30	0,33	0,38
Displacement at H0 (m3)	0,15199	at LCB (m)	1,881	LCB (%Lwl)	46,55	at ZCB (m)	-0,031	
(kg)	155,8	>> ft	6,17			>> inch	-1,23	
>> lbs	343,5	with water mass / vol. of	1025	kg/m3				
Cp (%)	56,68							
Sf (m2)	3,03	at X (m)	1,715	X (%Lwl)	42,45	>>> Xc – Xf (%Lwl)	4,10	
>> ft2	32,63	>> ft	5,63					
Angle immersed sheer li (°)	23,4	at section C4 (40% Lwl)						
Sw (m2)	3,06	>Sw/D^(2/3)	10,76					
>> ft2	32,97							
Shull (m2)	6,93	at X (m)	1,768	Z (m)	0,063			
>> ft2	74,62	>> ft	5,80	>> ft	0,21			
Sdeck (m2)	5,17	at X (m)	1,576					
>> ft2	55,65	>> ft	5,17					

**2.2 Daggerboard**

Volume (m3)	0,00308	at X (m)	2,182	X (%Lwl)	54,01	Z (m)	-0,41	
Draft oa (m)	0,90	Sw (m2)	0,34			Sxz (m2)	0,16	
>> ft	2,95	>> ft2	3,65			>> ft2	1,75	
CLR (m)	2,240	CLR (%Lwl)	55,45	method : profile extended to the waterline, then 25% c at 45% draft oa				
>> ft	7,35							

**2.3 Rudder(s)**

Number	1							
Volume (m3)	0,00162	at X (m)	-0,247	X (%Lwl)	-6,11	Z (m)	-0,108	
Sw (m2)	0,21	>> ft	-0,81			Sxz (m2)	0,10	per rudder
>> ft2	2,23					>> ft2	1,07	

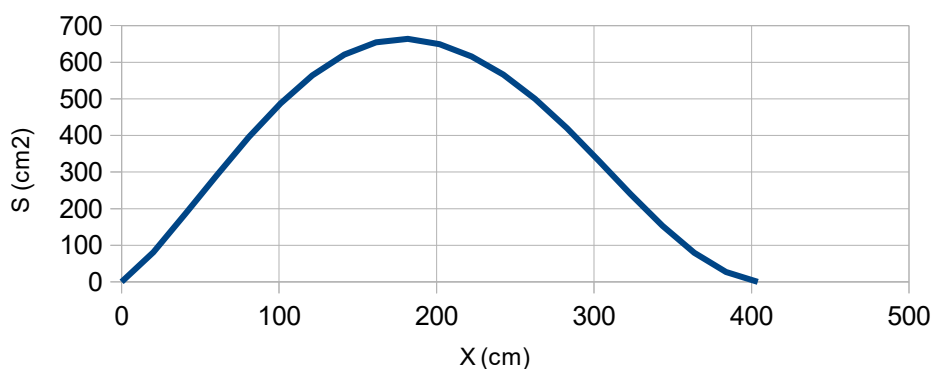
**2.4 Hull + Daggerboard + Rudder(s)**

Displacement at H0 (m3)	0,15669	at LCB (m)	1,865	LCB (%Lwl)	46,15	ZCB (m)	-0,040	
Disp. (kg)	160,6	>> ft	0,57			>> ft	-0,13	
>> lbs	354							
Sw (m2)	3,61	>Sw/D^(2/3)	12,42	Lwl/D^(1/3)	7,49			
>> ft2	38,85			DLR	68	M(lbs/2240)/(Lwl(ft)/100)^3		

**2.5 Data from the mass spreadsheet**

Dinghy with payload	M(kg)	160,6	at Xg (m)	1,666	Xg (%Lwl)	41,24	at Zg (m)	0,590
Light boat		60,6		1,743				0,454

Areas of sections (waterline at H0)



The « Boat with payload » data here shown are coming from the section 6.1 here after (6.1 Mass spreadsheet with input of a load ) where the user should input the data of the load, i.e. mostly the Crew mass and position ( $X_g$ ,  $Z_g$ ,  $Y_g$ ).

>>> Hull design should be adjusted so that its Displacement (kg) equals the Mass (kg) of the Dinghy with its nominal payload (what we recommend), and LCB (m) equal or close to  $X_g$  (m). Here above : Disp. = 160,6 kg = Mass ; LCB = 1,865 m /  $X_g$  = 1,666 m. You can fully study this loading and others thanks to the section 6.

### 3. The 3 views 2D + a perspective view

The views are automatically redrawn after every input data modification.

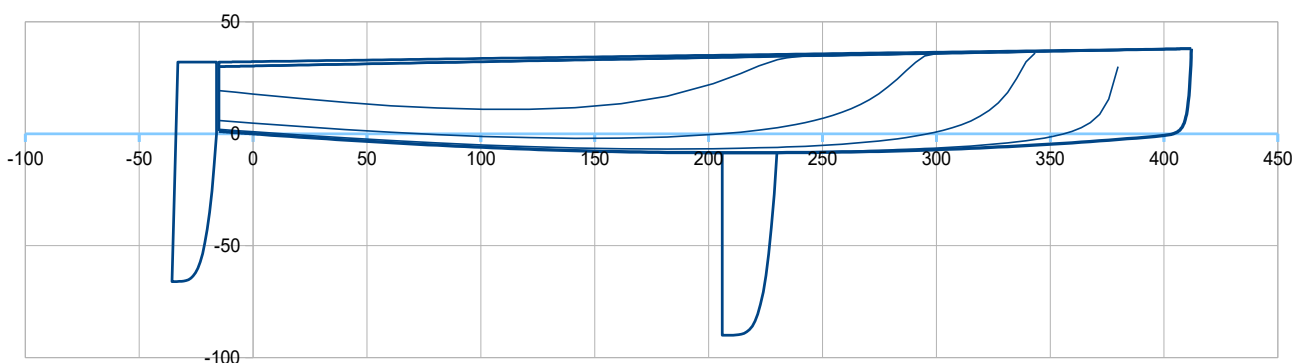
View of the front sections include sections  $\geq C4$  (= 40% Lwl), with a half section pitch : C4, C4,5, C5, .... In front of C10 (Front perpendicular), 2 complementary sections Cav1 and Cav2 are drawn, at 1/3 and 2/3 of the bow overlength.

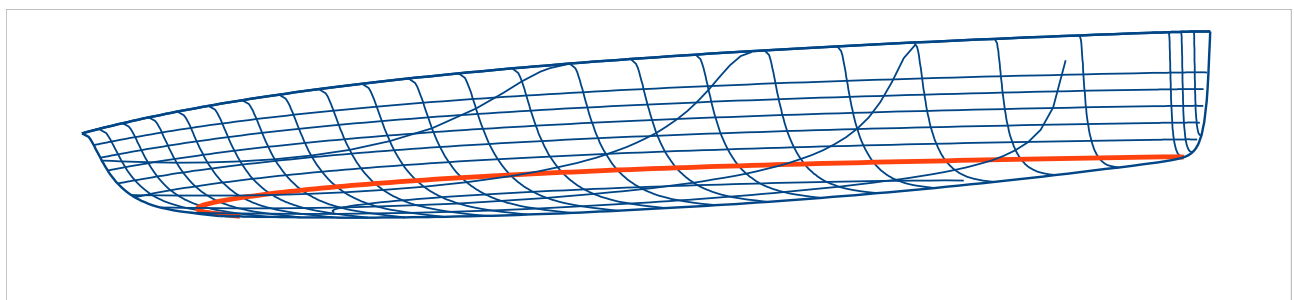
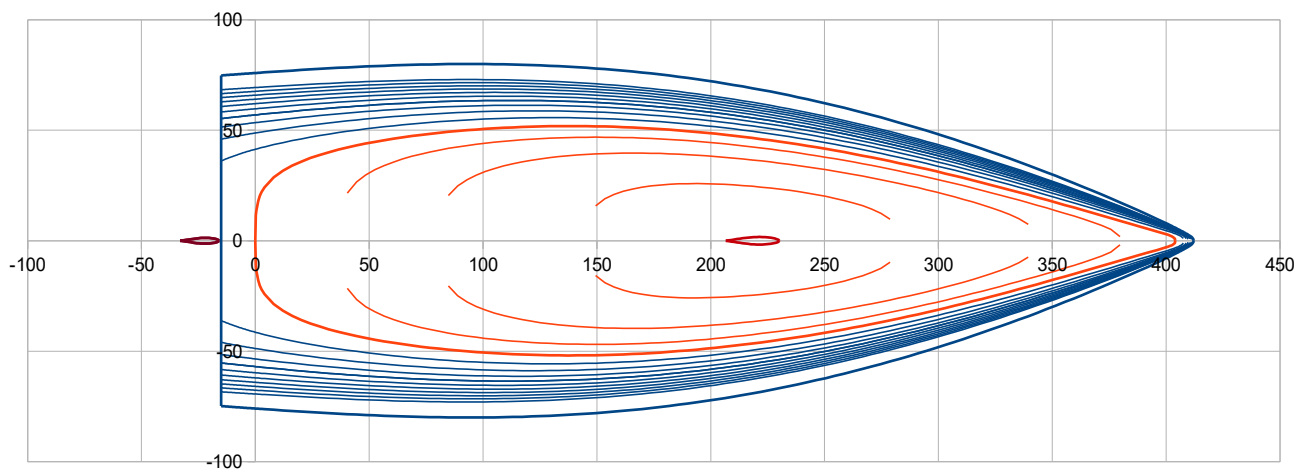
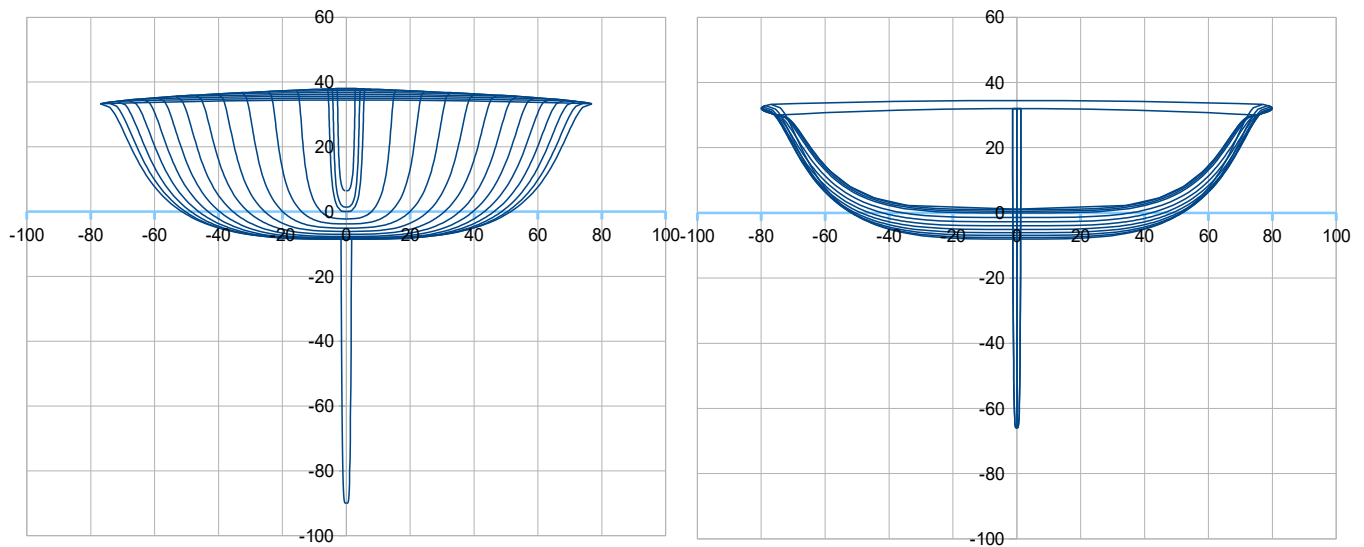
View of the rear sections includes sections  $\leq C4$ , with a half section pitch : C4, C3,5, C3, C2,5, ... Behind C0, 2 complementary sections Car1 and Car2 are drawn, Car2 at the rear end point of the sheer line and Car1 at the middle point between this rear point and C0. And the rear transom is also computed and drawn in this view (as long as it is an inverted one within the condition :  $X_{tab\ ar} < X_{pont\ ar} < X_{liv\ ar} < 0$ ).

In the plan view of the bottom, waterlines in red are the wetted ones, the thick red line being the waterline H0.

**User intervention** : axis scales are proposed automatic, grid pitch fixed and equal for the 2 coordinates. As long as the project dimensions are fixed , it is recommended to modify (if necessary) and to fix the scale of the views for orthonormal views (i.e. square grid).

Example :





#### 4. Curves of control

These curves are proposed to assess some complementary characteristics of the hull :

- Waterlines angles in the horizontal plan  $xy$ , with the same color code blue/red as for the bottom view.
- Curvature  $1/R$  of :
  - Waterlines and sheer line (in the horizontal plan  $xy$ ) with idem color code blue/red,

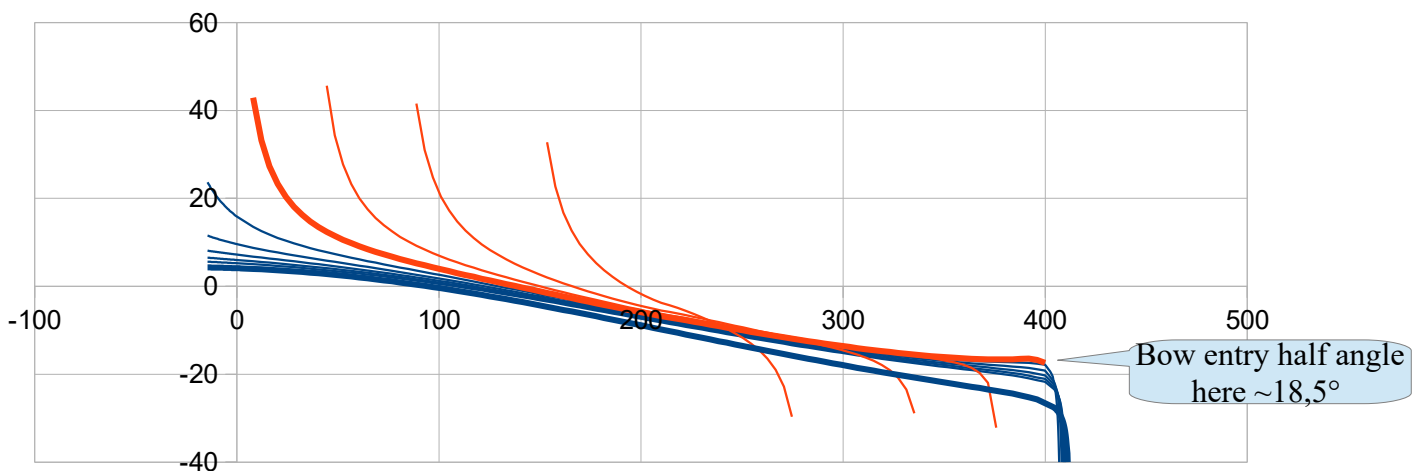
- Keel line and Buttocks lines (vertical longitudinal cuts) in green, keel line being the thick one
- Some parameters curves, H and Pui (for sections V or U) and the combination law (for VE or UE).

**User intervention :** As long as the project length is fixed, it is recommended to fix the scale of the X coordinates in the views.

Example of waterlines angles :

Angles ( $^{\circ}$ ) of the waterlines (in horizontal projection xy)

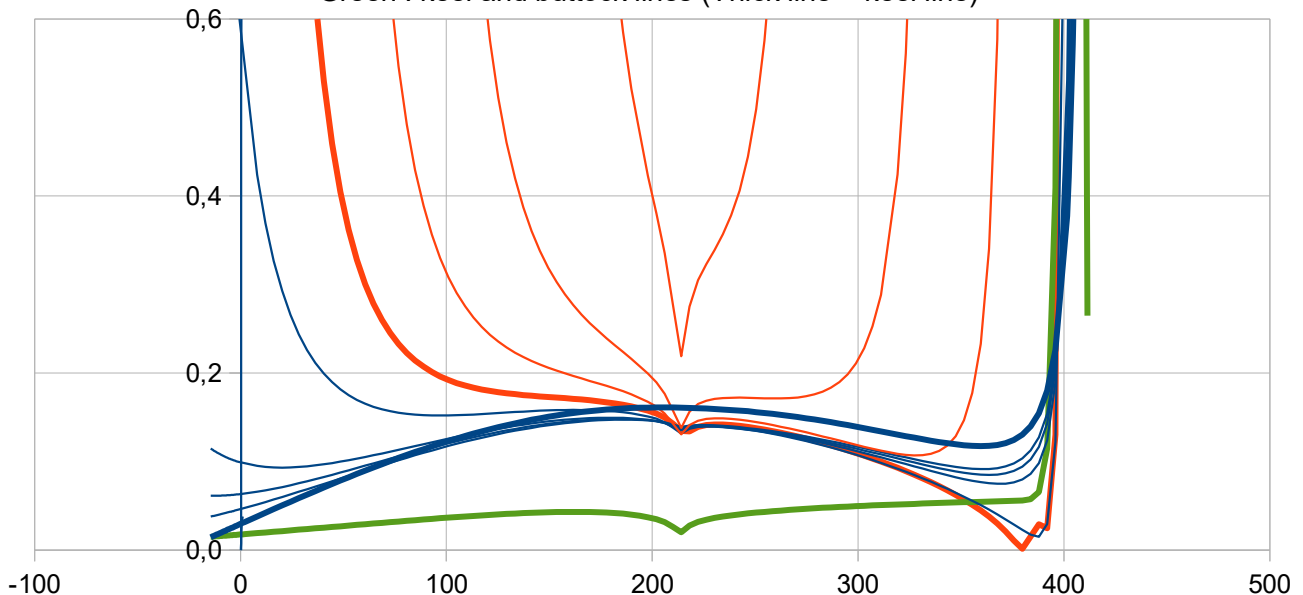
Red : waterlines below H0 (thick line = H0) ; Blue : waterlines above H0 (thick line = sheer line)



Example of waterlines curvatures  $1/R$  :

Waterlines curvatures  $1/R$

Red : waterlines below H0 (thick line = H0) ; Blue : waterlines above H0 (thick line = sheer line)  
Green : keel and buttock lines (Thick line = keel line)



## 5. Hydrostatics of the heeled hull with a loading

This section is for the computation and the drawing of the heeled hull with **in 5.1** the input of a loading and **in 5.2** the input of an heel angle, and iteration on height and trim up to an equilibrium in « hydrostatic » conditions, i.e. at constant displacement (buoyancy = mass) and longitudinal centering ( $X_c$  (LCB) =  $X_g$ ) conditions.

**5.1 :** at first, the user should input the loading data, mostly the crew weight (Mass) and its position ( $X_g$ ,  $Z_g$ ,  $Y_g$ ) in the 2 typical postures for the stability issue : Crew at center (lowered under the boom during a tack change), Crew at hiking. To input data in the yellow cells >> example :

### 5.1 Mass spreadsheet with input of a load

Data to enter : yellow cells	Mass (kg)	$X_g$ (m)	$Z_g$ (m)	$Y_g$ (m)	(in the coordinates of the 2D plan views above)
Dinghy light weight (kg)	60,62	1,743	0,454	0	from the mass spreadsheet
Load >> Crew (kg)	100,00	1,62	0,65	0	Crew at center
			0,35	0,95	Crew at hiking
Total >>> Mass (kg)	160,62	1,666	0,576	0,000	Crew at center
Disp. (m3)	0,15671		0,390	0,591	Crew at hiking

The data of the dinghy light weight (in grey cells) comes from the mass spreadsheet (see here after). The resulting data (in red) are used in the following computation of the heeled hull.

**5.2** The User should introduce 3 data :

- **Heel angle (°)** (typically 0 to 30°) (cell B284)
- **Height (cm)** : the small elevation (few cm) which help maintain constant the hull displacement ; (cell B285)
- **Trim (°)** : which help maintain  $X_c$  (LCB) =  $X_g$ , negative value = nose down (cell B286)

**>>> the user should iterate on both values of Height and Trim up to :**

- Displacement with heel = Displacement from the mass spreadsheet
- $X_c$  heel =  $X_g$

### 5.2 Computation, by input of an Heel angle, and iteration on Height and Trim up to Displacement equality and $X_c$ (LCB) = $X_g$

Data to enter : yellow cells	Results	Specific results
Heel (°) 10,0	Disp. (m3) 0,15671 / Disp. (m3) 0,15671	Relevant only when heel = 0°
Height (cm) 1,4927	Xc heel (m) 1,666 / Xg (m) 1,666	Lwl (m) 3,977
Trim (°) 0,230	Yc heel (m) -0,192 Yg heel (m) 0,512	Bwl (m) 0,940
	Zc heel (m) -0,043 > GZ (m) 0,705	Draft (m) 0,070
	Sw heel (m2) 3,41 RM (kN.m) 1,110	Relevant only when heel = 1°
	Freeboard minimum (cm) 17,30	Yg heel (m) -0,102 with crew at center
	Obliquity (°) 3,81	Gz (m) 0,090
		> GM1° (m) 0,52

Data to enter and to iterate ....

... up to obtain same Displacement and  $X_c = X_g$

**The Heel angle to input depends of the output data you want to have, 3 cases :**

- for the upright data derived from a given loading, you put **Heel = 0°**  
>>> the relevant output data are then : Lwl , Bwl , Draft , Sw , FB mini (the minimum Free-board). Example :

Data to enter : yellow cells	Results	Specific results
Heel (°) 0,0	Disp. (m3) 0,15668 / Disp. (m3) 0,15668	Relevant only when heel = 0°
Height (cm) 0,2385	Xc heel (m) 1,666 / Xg (m) 1,666	Lwl (m) 3,965
Trim (°) 0,598	Yc heel (m) 0,000 Yg heel (m) 0,592	Bwl (m) 1,049
	Zc heel (m) -0,038 > GZ (m) 0,592	Draft (m) 0,083
	Sw heel (m2) 3,76 RM (kN.m) 0,932	Relevant only when heel = 1°
	Freeboard minimum (cm) 28,35	Yg heel (m) 0,000 with crew at center
	Obliquity (°) 0,00	Gz (m) 0,000
		> GM1° (m) #DIV/0 !

- for the initial stability quantified by GM1°, you put **Heel 1°**. Example >> GM1° = 0,68 m

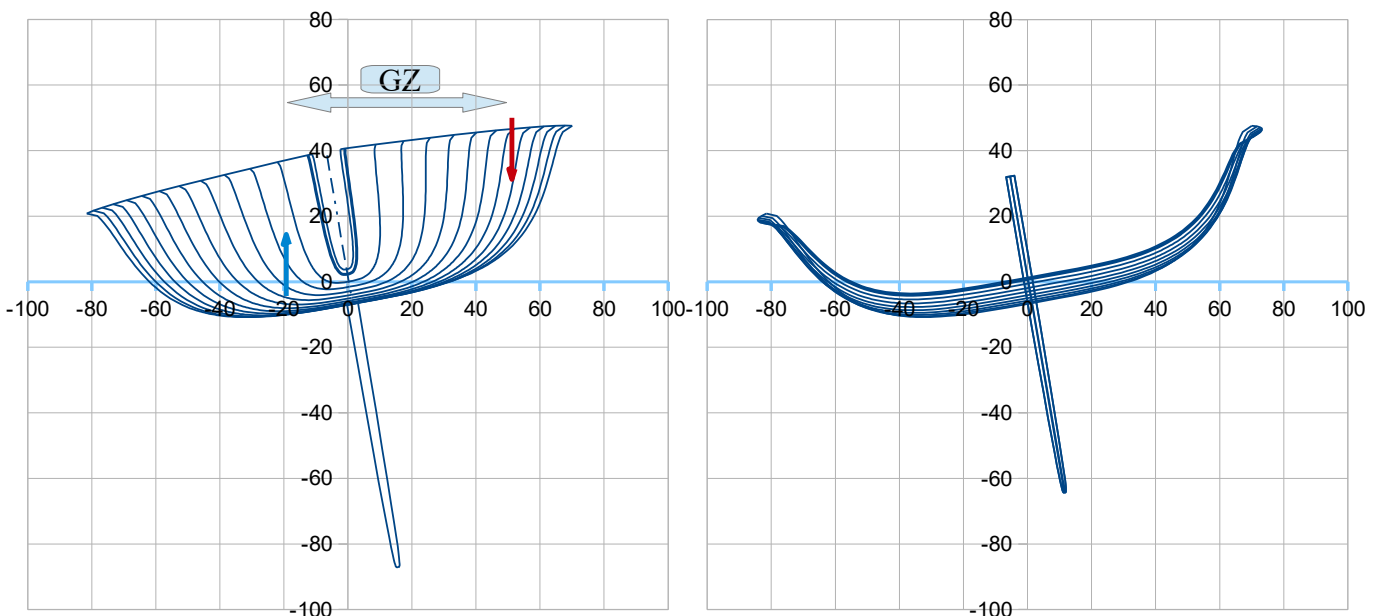
Data to enter : yellow cells	Results	Specific results
Heel (°) 1,0	Disp. (m3) 0,15669 / Disp. (m3) 0,15668	Relevant only when heel = 0°
Height (cm) 0,2503	Xc heel (m) 1,666 / Xg (m) 1,666	Lwl (m) 3,965
Trim (°) 0,594	Yc heel (m) -0,022 Yg heel (m) 0,585	Bwl (m) 1,047
	Zc heel (m) -0,038 > GZ (m) 0,607	Draft (m) 0,082
	Sw heel (m2) 3,75 RM (kN.m) 0,956	Relevant only when heel = 1°
	Freeboard minimum (cm) 27,06	Yg heel (m) -0,010 with crew at center
	Obliquity (°) 0,33	Gz (m) 0,012
		> GM1° (m) 0,68

- to get the righting arm **GZ** and the righting moment **RM** at a given heel angle with crew in hiking posture : you input an heel angle and then you iterate on Height up to have again the displacement balance. Example at 10° heel angle :

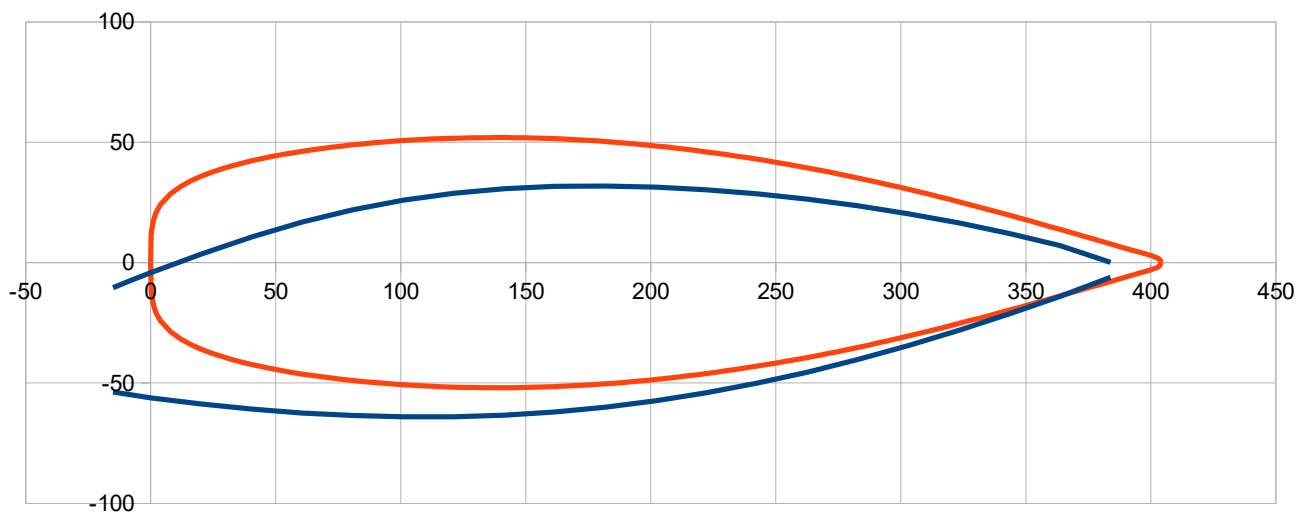
Data to enter : yellow cells	Results	Specific results
Heel (°) 10,0	Disp. (m3) 0,15668 / Disp. (m3) 0,15668	Relevant only when heel = 0°
Height (cm) 1,4962	Xc heel (m) 1,666 / Xg (m) 1,666	Lwl (m) 3,977
Trim (°) 0,230	Yc heel (m) -0,192 Yg heel (m) 0,513	Bwl (m) 0,940
	Zc heel (m) -0,043 > GZ (m) 0,705	Draft (m) 0,070
	Sw heel (m2) 3,42 RM (kN.m) 1,110	Relevant only when heel = 1°
	Freeboard minimum (cm) 17,30	Yg heel (m) -0,103 with crew at center
	Obliquity (°) 3,81	Gz (m) 0,090
		> GM1° (m) 0,52

>>> GZ (m) 0,705 ; RM (kN.m) = 1,110 ; Sw (m2) = 3,42 ; FP mini (cm) : 17,3

Corresponding drawings are automatically produced :



The blue arrow represents the buoyancy force, the red arrow represents the weight force

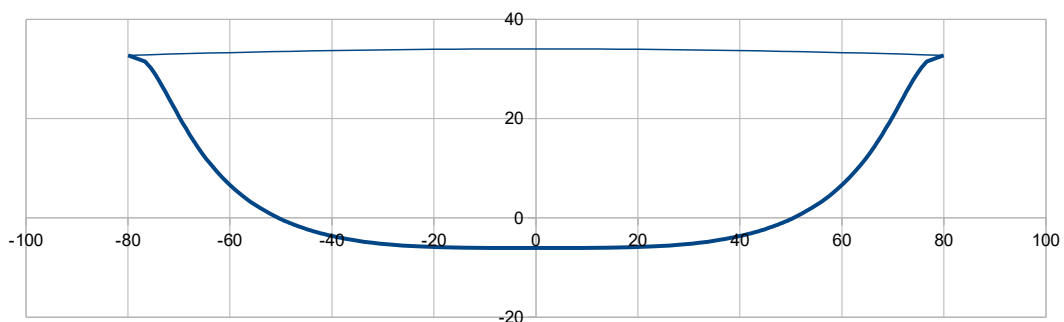


### 6. Data for hull sections drawing at scale one

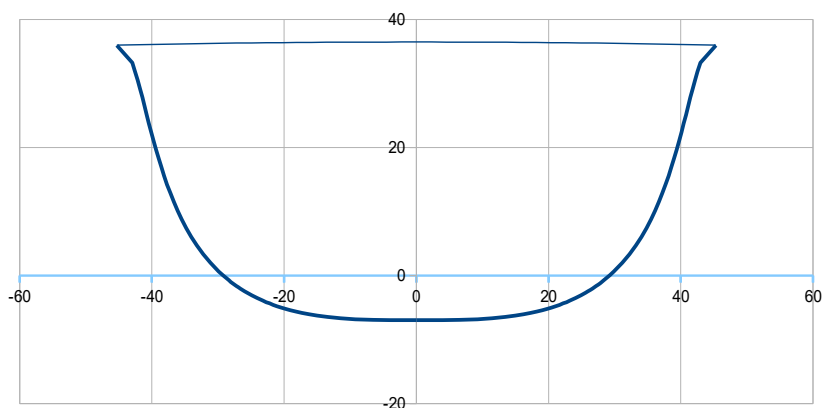
This section provides the data which can be used for a scale one drawing of any section at a given X position. This section is divided in 2 sub-sections 6.1 and 6.2 for respectively sections behind or in front of C3,5.

The User should enter the X value of the section, **Unities : cm** . Examples:

Data to enter      x (cm)  
>                      101,0



Data to enter      x (cm)  
>                      303,0





### Sailplan input and output

This sheet can provide an early stage definition of the sailplan with the cat-boat configuration, with main results about the sail surface and the so-called « Lead ». Also computed are ratios usually considered by naval architects.

#### Sailplan – early stage definition with a cat-boat configuration

Data to enter			Results for the Sailplan			
		>> in feet				
Xmast (m)	3,15	10,33	Main sail (m2)	8,01	Small sail	5,36
Zmast (m)	6,42	21,06	Lead Xv – Xd (%)	2,4	Xv – Xd (%)	6,1
Zboom (m)	0,95	3,12	Sdaggerboard/Sv (%)	2,0		
Lboom (m)	2,80	9,19	Srudder/Sv (%)	1,2		
			Sv/Sw with Main	2,22		



The 4 input data in column B, cells B3 to B6. The other needed data come from the Gene-Hull sheet.

**Xmast (m)** : is the X position of the mast (cell B3)

**Zmast (m)** : is mast the height / waterline (cell B4)

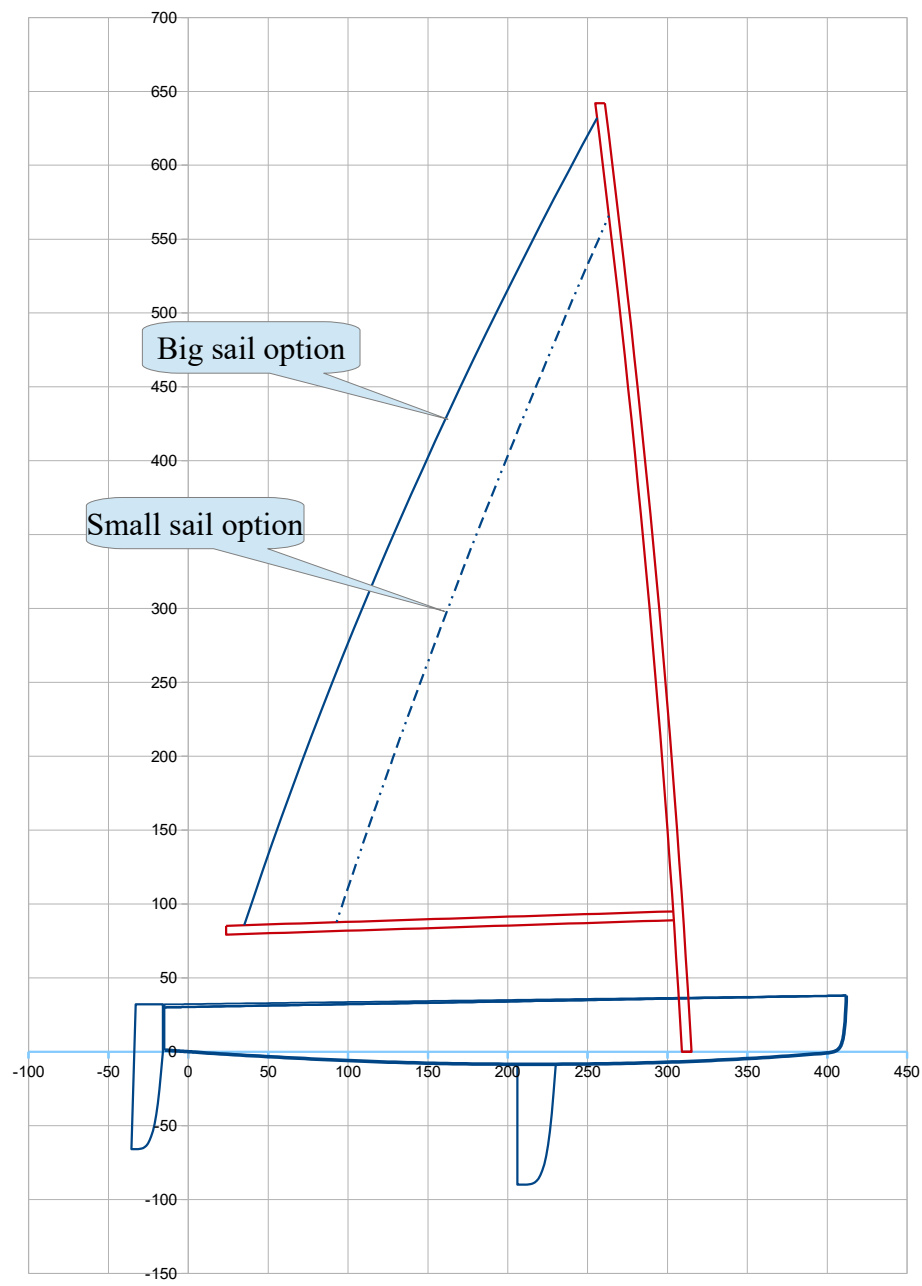
**Zboom (m)** : is the Z position of the boom (cell B5)

**Lboom (m)** : is the length of the boom (cell B6)

#### The output includes :

- The surface Sv of the main sail,
- ratio Sv / Sw , Sw being the wetted surface
- ratio Sdaggerboard / Sv , Sdaggerboard being its xz surface
- ratio Srudder / Sv, Srudder being its xz surface
- Lead Xv – Xd :
  - Xv being the geometrical center of the main sail,
  - Xd = CLR being the Center of Lateral Resistance estimated by this method : daggerboard profile extended to the waterline, CLR at 25% chord and 45% draft oa

, all the needed data for these ratios automatically coming from the Gene-Hull sheet.



### Mass spreadsheet input and output

This mass spreadsheet can provide the frame for an early stage estimation of the light weight mass and CoG position, in order to help adjust accordingly the hull design concerning its displacement and CoD position.

#### Mass spreadsheet – Preliminary

Eléments	L m	S m2	V m3	Mass units to enter	Masse (kg)	X (cm)	M X	Z (cm)	M Z
<b>Hull :</b>									
Hull assuming at ~ 4 kg/m2		6,93		<b>4,00</b>	27,73	176,8	4903,143	6,3	173,366
Transom assuming at ~ 4 kg/m2		0,34		<b>4,00</b>	1,35	-15,0	-20,203	17,0	22,922
<b>Deck</b>									
Deck assuming at ~ 3 kg/m2		5,17		<b>3,00</b>	15,51	157,6	2443,727	38,0	589,383
<b>Daggerboard :</b>									
Daggerboard system, assuming ~ 3 kg				<b>3,00</b>	3,00	218,2	654,590	-30,0	-90,000
<b>Rudder :</b>									
Rudder system, assuming ~ 2 kg				<b>2,00</b>	2,00	-24,5	-49,000	-10,79	-21,574
<b>Rig and sails :</b>									
Mast carbon Dia 64 Ep 2 >> 0,7 kg/m		6,420		<b>0,70</b>	4,72	284,9	1344,230	321,0	1514,703
Boom carbon Dia 54 Ep 2 >> 0,6 kg/m		2,800		<b>0,60</b>	1,76	163,6	288,537	87,1	153,664
Mainsail 300g/m2		8,01		<b>0,30</b>	2,52	233,9	590,047	149,1	376,093
<b>Deck &amp; cockpit equipment :</b>									
Various deck equipment ~ 2 kg provision				<b>2,00</b>	2,00	202,0	404,000	17,0	34,000
<b>Light weight &gt;&gt;&gt;</b>					<b>60,59</b> %Lf >>>	<b>174,3</b> 43,1	10559,072	<b>45,4</b>	2752,558

The input data to enter by the user (and based on his experience), are in black bold police and yellow highlighted, including :

- average mass / m2 for the Hull (skin, foam structure, reinforcements)  
, based on the hull surface data coming from the Gene-Hull sheet
- average mass / m2 for the « Deck » (actually the benches and the cockpit floor, )  
, based on the « deck » equivalent surface data coming from the Gene-Hull sheet
- estimated mass / m for mast and the boom , mass / m2 for the sail
- others estimated mass for the various equipment, inc. daggerboard and rudder

The output data, i.e. the dinghy light weight and position Xg, Zg , are reported in the Gene-Hull sheet under the Hull hydrostatics (2.1 section) , also reported and used in the « Hull with heel » study (6.1 section).

These data are also automatically produced, they are provided to facilitate a transfer towards a 3D modeller like Multisurf or equivalent. It includes :

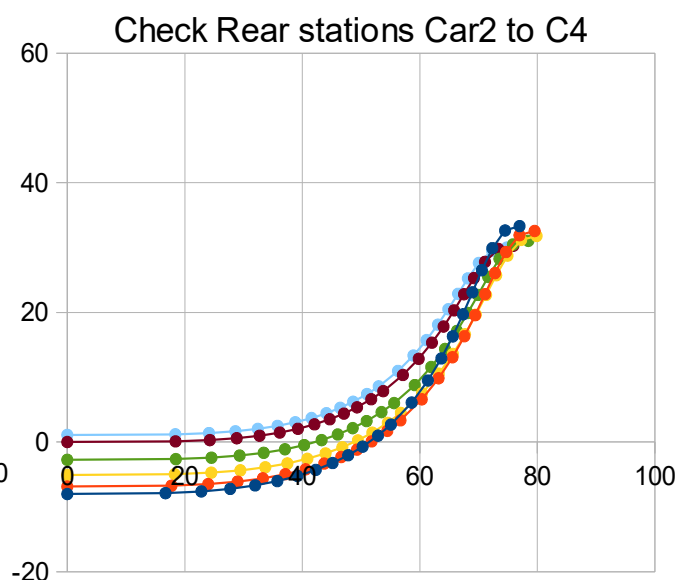
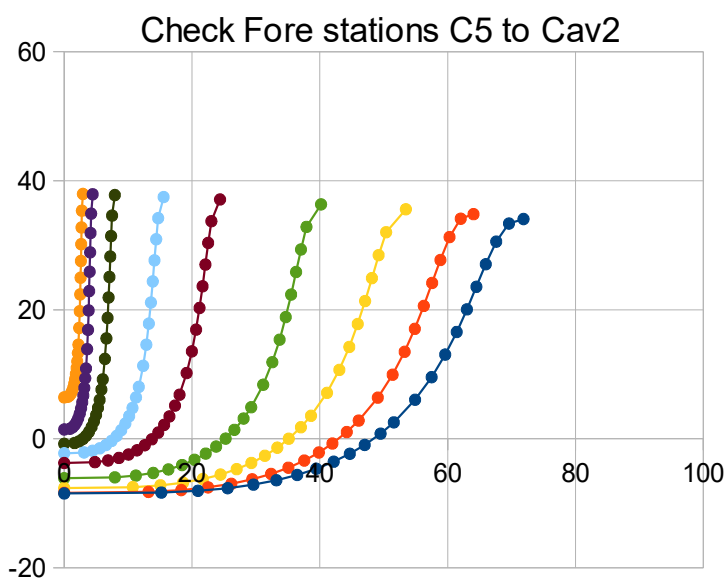
**Offset x,y,z      All units in cm**

These data are also automatically produced, they are provided to facilitate a transfer towards a 3D modeller like Multisurf or equivalent. It includes :

**1. Hull sections :** Offsets y ,z data for each section at x : Car2, C0, C1, ...etc ..., C9, C9,5, C9,9, C10, Cav1, Cav2. (C9,5 and C9,9 have been added for a better representation of the keel line by splines).  
Example, offsets of the station C4 :

C4    x >>	161,60	
	y	z
Sheer line >>	76,97	33,31
Hard chine, if any >>	76,97	33,31
	74,51	32,63
	72,34	29,91
	70,56	26,50
	68,95	23,10
	67,34	19,70
	65,61	16,30
	63,66	12,89
	61,38	9,49
	58,60	6,09
	55,07	2,69
	52,88	0,99
Transition chine, if any >>	50,26	-0,72
	47,81	-2,04
	45,16	-3,24
	42,28	-4,30
	39,16	-5,23
	35,75	-6,03
	31,97	-6,69
	27,73	-7,22
	22,82	-7,62
	16,71	-7,89
Keel line >>	0,00	-8,02

In addition, for check purpose, the half-sections are shown with the points provided :



**2. Keel line, Transition line (if any), Hard chine line (if any), Sheer line**

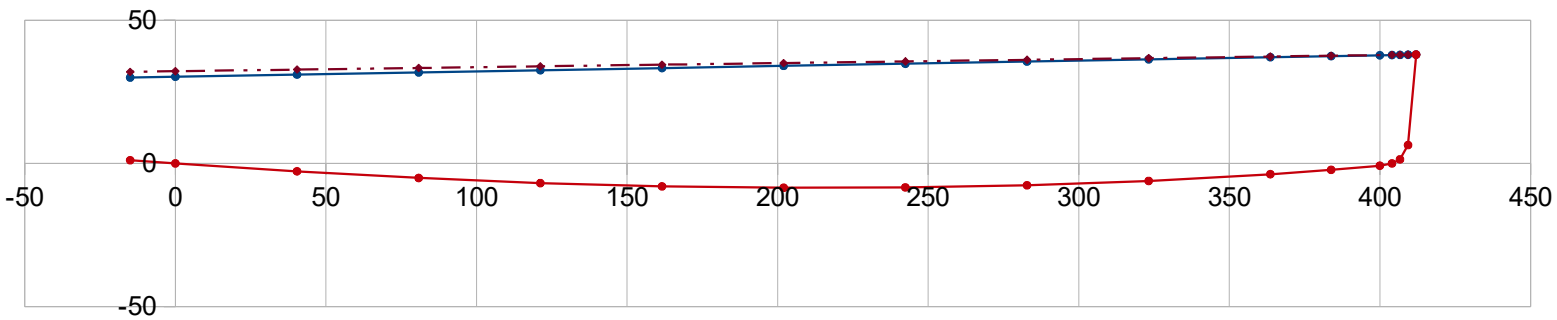
x,z data of the keel line including the bow,

x,y,z data of the sheer line, inc. the hard chine (up) and the hard transition (down) if any,

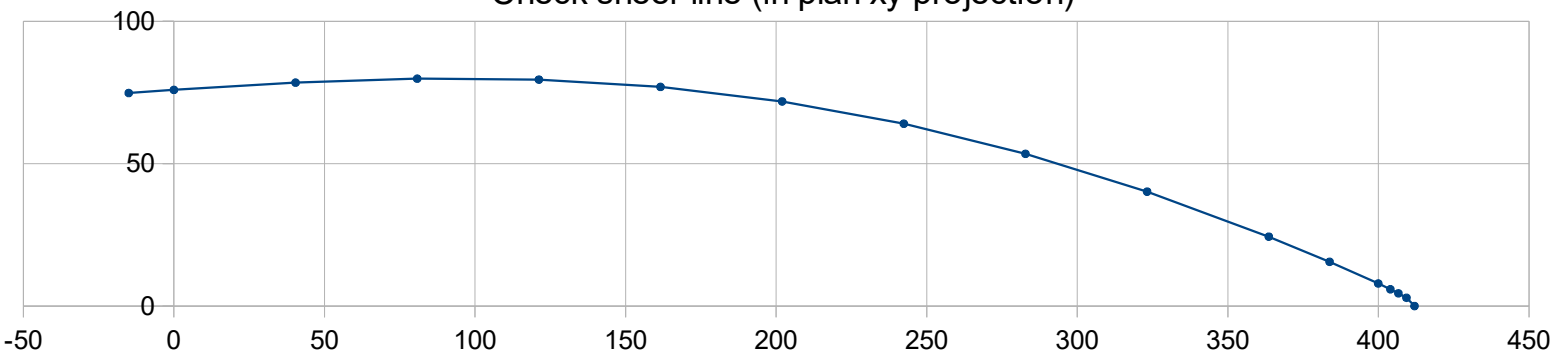
x,z data of the deck central line of symmetry,

... and corresponding drawings for check purpose, example :

Check keel, hard (if any) and sheer lines + "deck" central line (in plan xz projection)



Check sheer line (in plan xy projection)



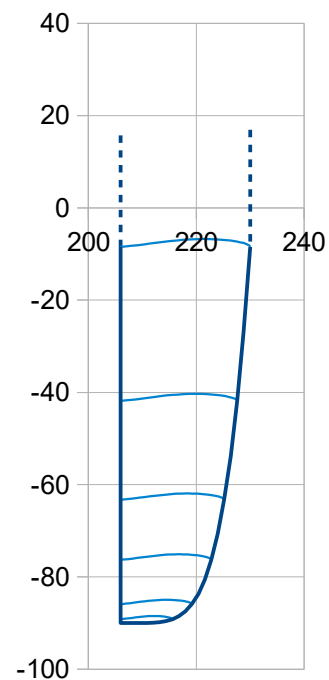
### 3. Daggerboard

- x,z data of the longitudinal profile of the daggerboard, data of the naca profiles in various horizontal sections

Example :

#### Profile in the vertical plan

x	z
230,00	16,93
230,00	-8,46
228,80	-26,91
227,60	-41,85
226,40	-53,82
225,20	-63,28
224,00	-70,65
222,80	-76,30
221,60	-80,54
220,40	-83,66
219,20	-85,90
218,00	-87,45
216,80	-88,50
215,60	-89,17
214,40	-89,57
213,20	-89,80
212,00	-89,92
210,80	-89,97
209,60	-89,99
208,40	-90,00
207,20	-90,00
206,00	-90,00
206,00	-8,49
206,00	16,93



#### Profiles in the horizontal plan / z levels

Z level	Xfront at 0% c	Xrear at 97,5% c	Chord c for calcul.	>> t/c (%)
-8,46	230,00	206,00	24,62	14,00
-41,85	227,60	206,00	22,15	14,00
-63,28	225,20	206,00	19,69	14,00
-76,30	222,80	206,00	17,23	14,00
-85,90	219,20	206,00	13,54	14,00
-89,17	215,60	206,00	9,85	14,00

Profile 1 is used :

naca 00xx	naca 63-0xx	naca 65-0xx
0	1	0

## &gt;&gt; Horizontal sections :

at Z >>		-8,46	at Z >>		-41,85	at Z >>		-63,28	at Z >>		-76,30	at Z >>		-85,90	at Z >>		-89,17
x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y
230,00	0,00	227,60	0,00	225,20	0,00	222,80	0,00	219,20	0,00	215,60	0,00						
229,88	0,29	227,49	0,26	225,10	0,23	222,71	0,20	219,13	0,16	215,55	0,11						
229,82	0,35	227,43	0,31	225,05	0,28	222,67	0,24	219,10	0,19	215,53	0,14						
229,69	0,44	227,32	0,40	224,95	0,35	222,58	0,31	219,03	0,24	215,48	0,18						
229,38	0,61	227,05	0,54	224,71	0,48	222,37	0,42	218,86	0,33	215,35	0,24						
228,77	0,84	226,49	0,76	224,22	0,67	221,94	0,59	218,52	0,46	215,11	0,34						
228,15	1,02	225,94	0,91	223,72	0,81	221,51	0,71	218,18	0,56	214,86	0,41						
227,54	1,16	225,38	1,04	223,23	0,93	221,08	0,81	217,85	0,64	214,62	0,46						
226,31	1,38	224,28	1,24	222,25	1,10	220,22	0,96	217,17	0,76	214,12	0,55						
225,08	1,53	223,17	1,38	221,26	1,23	219,35	1,07	216,49	0,84	213,63	0,61						
223,85	1,64	222,06	1,47	220,28	1,31	218,49	1,15	215,82	0,90	213,14	0,66						
222,62	1,70	220,95	1,53	219,29	1,36	217,63	1,19	215,14	0,94	212,65	0,68						
221,38	1,72	219,85	1,55	218,31	1,38	216,77	1,21	214,46	0,95	212,15	0,69						
220,15	1,70	218,74	1,53	217,32	1,36	215,91	1,19	213,78	0,94	211,66	0,68						
218,92	1,64	217,63	1,48	216,34	1,31	215,05	1,15	213,11	0,90	211,17	0,66						
217,69	1,55	216,52	1,39	215,35	1,24	214,18	1,08	212,43	0,85	210,68	0,62						
216,46	1,43	215,42	1,28	214,37	1,14	213,32	1,00	211,75	0,78	210,18	0,57						
215,23	1,28	214,31	1,15	213,38	1,02	212,46	0,90	211,08	0,70	209,69	0,51						
214,00	1,11	213,20	1,00	212,40	0,89	211,60	0,78	210,40	0,61	209,20	0,45						
212,77	0,93	212,09	0,84	211,42	0,75	210,74	0,65	209,72	0,51	208,71	0,37						
211,54	0,75	210,98	0,67	210,43	0,60	209,88	0,52	209,05	0,41	208,22	0,30						
210,31	0,56	209,88	0,50	209,45	0,45	209,02	0,39	208,37	0,31	207,72	0,22						
209,08	0,37	208,77	0,34	208,46	0,30	208,15	0,26	207,69	0,21	207,23	0,15						
207,85	0,21	207,66	0,19	207,48	0,17	207,29	0,15	207,02	0,11	206,74	0,08						
206,62	0,07	206,55	0,07	206,49	0,06	206,43	0,05	206,34	0,04	206,25	0,03						
206,00	0,04	206,00	0,03	206,00	0,03	206,00	0,03	206,00	0,02	206,00	0,01						

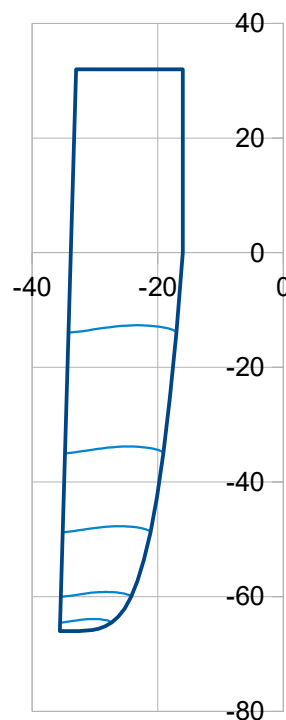
## 4. Rudder

x,z data of the longitudinal profile of the daggerboard, data of the naca profiles in various horizontal sections

Example :

## Profile in the vertical plan

x	z
-16,00	32,00
-16,00	0,00
-17,03	-13,97
-18,06	-25,54
-19,09	-35,01
-20,12	-42,67
-21,15	-48,78
-22,18	-53,57
-23,21	-57,26
-24,24	-60,04
-25,27	-62,08
-26,30	-63,54
-27,33	-64,53
-28,36	-65,18
-29,39	-65,59
-30,42	-65,81
-31,45	-65,93
-32,48	-65,98
-33,51	-66,00
-34,54	-66,00
-35,57	-66,00
-33,00	32,00
-16,00	32,00



## Profiles in the horizontal plan / z levels

Z level	Xfront at 0% c	Xrear at 97,5% c	Chord c for calcul.	t/c (%)
32,00	-16,00	-33,00	17,44	15,00
-13,97	-17,03	-34,20	17,61	15,00
-35,01	-19,09	-34,75	16,07	15,00
-48,78	-21,15	-35,12	14,32	15,00
-60,04	-24,24	-35,41	11,46	15,00
-64,53	-27,33	-35,53	8,41	15,00

## Profile 1 is used :

naca 00xx	naca 63-0xx	naca 65-0xx
0	1	0

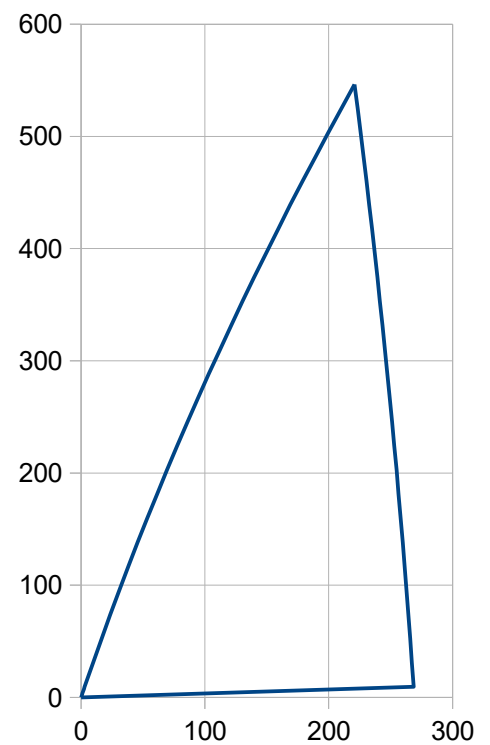
## &gt;&gt; Horizontal sections :

at Z >> 32,00		at Z >> -13,97		at Z >> -35,01		at Z >> -48,78		at Z >> -60,04		at Z >> -64,53	
x	y	x	y	x	y	x	y	x	y	x	y
-16,00	0,00	-17,03	0,00	-19,09	0,00	-21,15	0,00	-24,24	0,00	-27,33	0,00
-16,09	0,22	-17,12	0,22	-19,17	0,20	-21,22	0,18	-24,30	0,14	-27,37	0,10
-16,13	0,26	-17,16	0,27	-19,21	0,24	-21,26	0,22	-24,32	0,17	-27,39	0,13
-16,22	0,33	-17,25	0,34	-19,29	0,31	-21,33	0,27	-24,38	0,22	-27,43	0,16
-16,44	0,46	-17,47	0,46	-19,49	0,42	-21,51	0,38	-24,52	0,30	-27,54	0,22
-16,87	0,64	-17,91	0,64	-19,89	0,59	-21,87	0,52	-24,81	0,42	-27,75	0,31
-17,31	0,77	-18,35	0,78	-20,29	0,71	-22,22	0,63	-25,10	0,51	-27,96	0,37
-17,74	0,88	-18,79	0,89	-20,70	0,81	-22,58	0,72	-25,38	0,58	-28,17	0,42
-18,62	1,04	-19,67	1,06	-21,50	0,96	-23,30	0,86	-25,96	0,69	-28,59	0,50
-19,49	1,16	-20,55	1,17	-22,30	1,07	-24,01	0,95	-26,53	0,76	-29,01	0,56
-20,36	1,24	-21,43	1,26	-23,11	1,15	-24,73	1,02	-27,10	0,82	-29,43	0,60
-21,23	1,29	-22,31	1,30	-23,91	1,19	-25,45	1,06	-27,68	0,85	-29,85	0,62
-22,10	1,31	-23,19	1,32	-24,71	1,21	-26,16	1,07	-28,25	0,86	-30,27	0,63
-22,97	1,29	-24,08	1,30	-25,52	1,19	-26,88	1,06	-28,82	0,85	-30,69	0,62
-23,85	1,25	-24,96	1,26	-26,32	1,15	-27,60	1,02	-29,39	0,82	-31,11	0,60
-24,72	1,18	-25,84	1,19	-27,12	1,08	-28,31	0,97	-29,97	0,77	-31,53	0,57
-25,59	1,08	-26,72	1,09	-27,93	1,00	-29,03	0,89	-30,54	0,71	-31,95	0,52
-26,46	0,97	-27,60	0,98	-28,73	0,90	-29,74	0,80	-31,11	0,64	-32,37	0,47
-27,33	0,85	-28,48	0,85	-29,53	0,78	-30,46	0,69	-31,69	0,56	-32,79	0,41
-28,21	0,71	-29,36	0,72	-30,34	0,65	-31,18	0,58	-32,26	0,47	-33,21	0,34
-29,08	0,57	-30,24	0,57	-31,14	0,52	-31,89	0,46	-32,83	0,37	-33,64	0,27
-29,95	0,42	-31,12	0,43	-31,94	0,39	-32,61	0,35	-33,40	0,28	-34,06	0,20
-30,82	0,28	-32,00	0,29	-32,75	0,26	-33,32	0,23	-33,98	0,19	-34,48	0,14
-31,69	0,16	-32,88	0,16	-33,55	0,15	-34,04	0,13	-34,55	0,10	-34,90	0,08
-32,56	0,06	-33,76	0,06	-34,35	0,05	-34,76	0,05	-35,12	0,04	-35,32	0,03
-33,00	0,03	-34,20	0,03	-34,75	0,03	-35,12	0,02	-35,41	0,02	-35,53	0,01



## 5. Mainsail 2D plan

	<b>x aft</b>	<b>xfore</b>	<b>z</b>
boom rear point >>	<b>0,00</b>	<b>0,00</b>	<b>0,00</b>
	0,57	53,71	1,88
	1,15	107,43	3,75
	1,73	161,14	5,63
	2,31	214,86	7,50
boom fore point >>	<b>2,89</b>	<b>268,57</b>	<b>9,38</b>
	9,61	267,22	30,86
	16,51	265,82	52,34
	23,57	264,37	73,82
	30,80	262,88	95,30
	38,19	261,34	116,78
	45,75	259,76	138,26
	53,47	258,13	159,74
	61,36	256,46	181,22
	69,42	254,73	202,70
	77,64	252,97	224,18
	86,03	251,15	245,66
	94,58	249,29	267,14
	103,31	247,38	288,62
	112,19	245,43	310,10
	121,25	243,43	331,58
	130,46	241,39	353,06
	139,85	239,30	374,54
	149,40	237,16	396,02
	159,12	234,98	417,50
	169,00	232,75	438,98
	179,05	230,47	460,46
	189,27	228,15	481,94
	199,65	225,78	503,42
	210,19	223,37	524,90
mainsail top point >>	<b>220,91</b>	<b>220,91</b>	<b>546,38</b>



## Annex : formulations involved in the core of Gene Hull VE Dinghy

As a complement to the User Guide, this annex proposes the main formulations involved in the core of Gene-Hull, for the hull body generation. involving the geometrical definition with x,y,z of the keel line, of the sheer line and of the sections.

### Coordinates system :

x = 0 at section C0 (= rear point of the waterline), x positive towards front

y = 0 in the symmetrical longitudinal plan, y positive towards starboard,

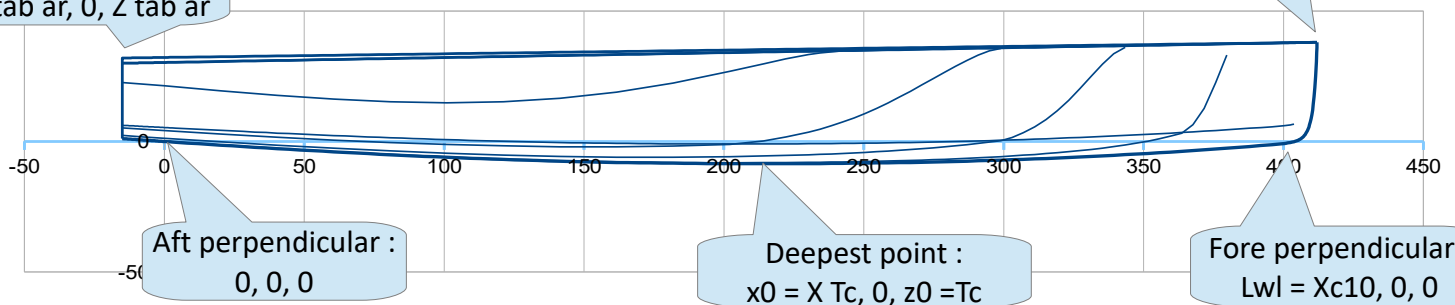
z = 0 waterline surface, z positive towards up

### 1. The keel line in the vertical plan of symmetry xz

#### Reference points :

Rear transom end :  
X tab ar, 0, Z tab ar

Bow end :  
Xbow, 0, Zbow



The keel line is defined by 2 polynomes for respectively the fore part (when  $x > x_0$ ) and the rear part (when  $x < x_0$ ). Both polynomes are of the type :

$$z = z_0 + a (x - x_0)^b + c (x - x_0)^n$$

, where a, b, c are defined to comply with the reference points showed here above and n is an adimensional parameter :

n = Cet, an additional input for the fore polynome, contributing to shape the bow, Cet can vary from 0,1 to 100

n = 1, for the rear polynome.

When applied within Gene-Hull, that gives :

**For x such as Xtab ar < x < X Tc :**

$$z = -Tc + (X Tc - x) ^ [PuiZoar + CorPuiZoar*((X Tc - x) / X Tc)] / Kar$$

, where Kar, CorPuiZoar and PuiZoar are :

$$K_{ar} = X_{Tc} \wedge P_{ui} q_{ar} / T_c$$

$$CorPuiZoar = [\text{Log}(K_{ar} * (Z_{tab} ar + T_c) / \text{Log}(X_{Tc} - X_{tab} ar) - P_{ui} q_{ar})] / [(X_{Tc} - X_{tab} ar) / X_{Tc} - 1]$$

$$PuiZoar = P_{ui} q_{ar} - CorPuiZoar$$

**For x such as  $X_{Tc} \leq x < X_{bow}$  :**

$$z = -T_c + (x - X_{Tc}) \wedge [PuiZoav + CorPuiZoav * ((x - X_{Tc}) / (Lwl - X_{Tc}))^{Cet}] / K_{av}$$

, where  $K_{av}$ ,  $CorPuiZoav$  and  $PuiZoav$  are :

$$K_{av} = (Lwl - X_{Tc}) \wedge P_{ui} q_{av} / T_c$$

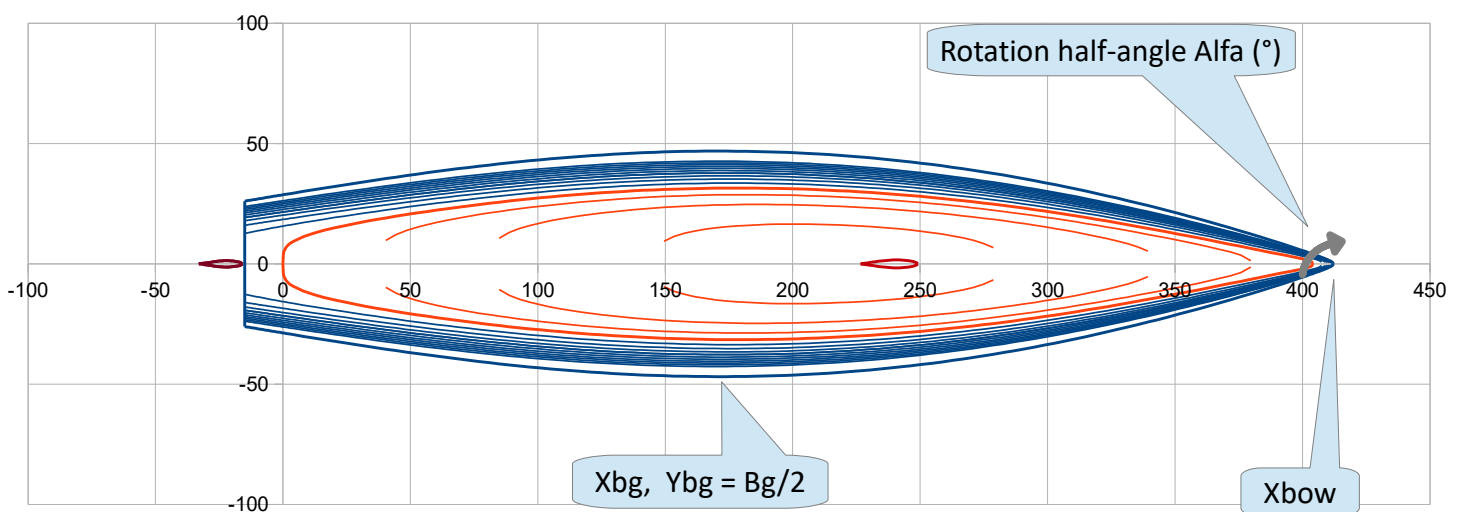
$$CorPuiZoav = [\text{Log}(K_{av} * (Z_{bow} + T_c) / \text{Log}(X_{bow} - X_{Tc}) - P_{ui} q_{av})] / [((X_{bow} - X_{Tc}) / (Lwl - X_{Tc}))^{Cet} - 1]$$

$$PuiZoav = P_{ui} q_{av} - CorPuiZoav$$

## 2. The sheer line, in its horizontal projection xy

The sheer line is computed through a 2 steps method : at first the sheer line of a generic hull, then the real sheer line by « opening » the previous one of an half-angle  $\alpha$  with the bow end as the center of rotation. Exactly, only the y values issued from the rotation are taken into account, the x values are kept unchanged.

**Reference points for the generic sheer line :**



The generic sheer line is defined by a polynome of this type :

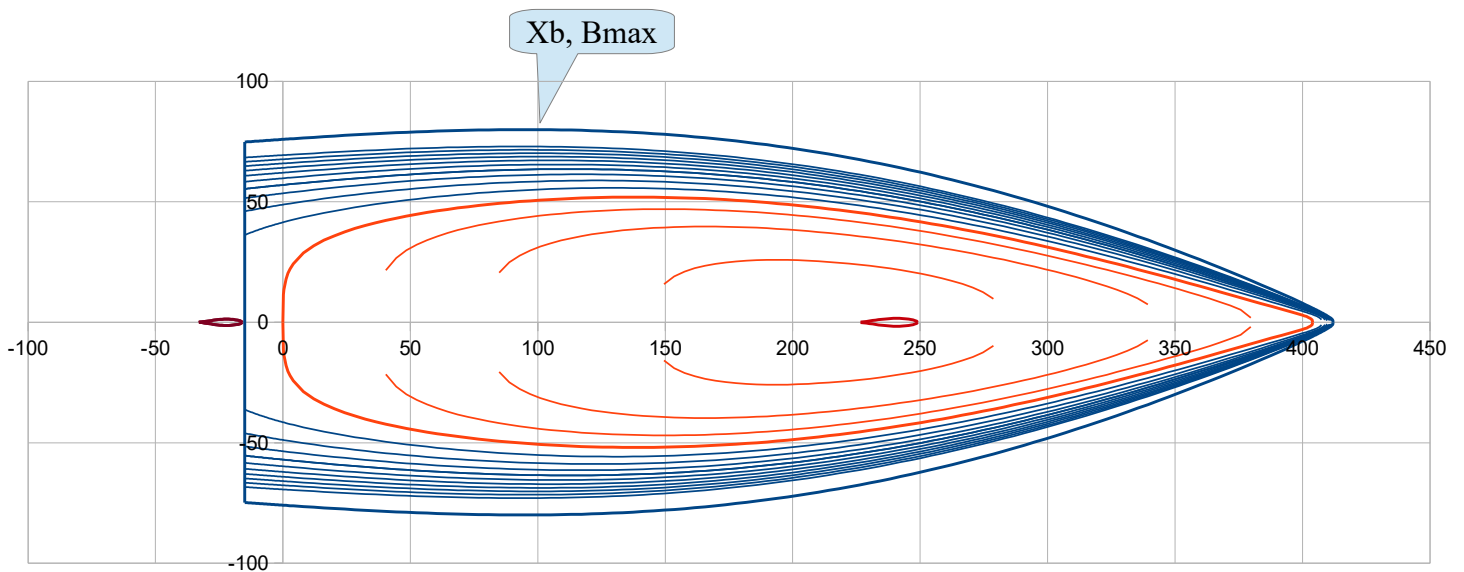
$$Y_g = B_g/2 - a |X_{bg} - X|^{(b + c |X_{bg} - X|^n)}$$

, where a, b, c are computed to comply with the reference points showed here above and n is an adimensional parameter.

Then the real sheer line is computed through :

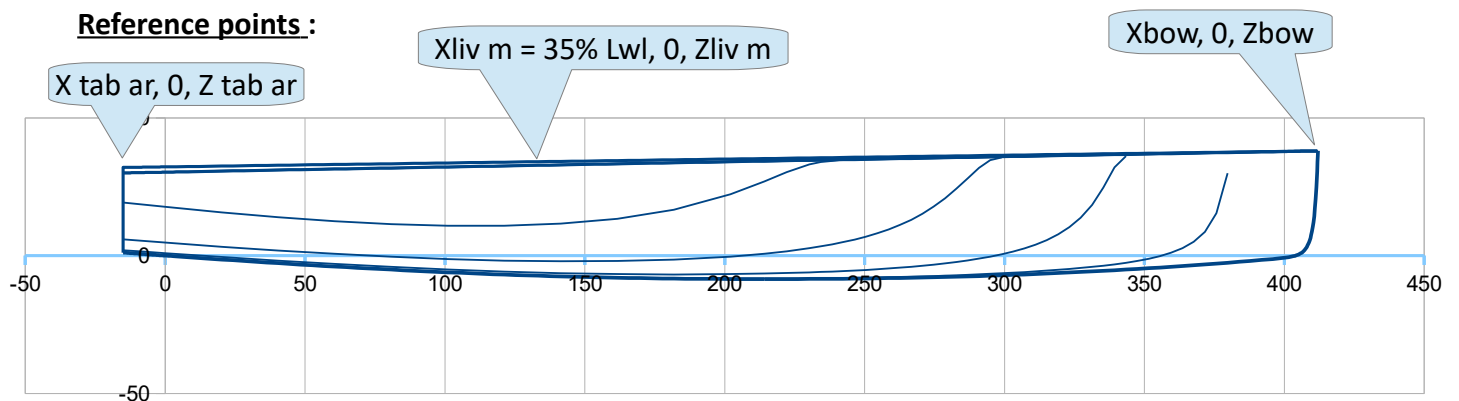
$$Y = Y_g + (X_{bow} - X) \sin(\alpha) + Y_g (1 - \cos(\alpha))$$

After this reformulation of Y, the maximum beam Bmax and its position Xb can be computed. An example of the view after the opening  $\alpha$  :



### 3. Sheer line / in its vertical projection xz

**Reference points :**



The keel line is defined by 2 polynomes for respectively the fore part (when  $x > 35\% Lwl$ ) and the rear part (when  $x < 35\% Lwl$ ). Both polynomes are of the type :

$$\text{Fore : } Z = Z_{liv m} + (Z_{bow} - Z_{liv m}) / (X_{bow} - X_{liv m})^n * (X - X_{liv m})^n$$

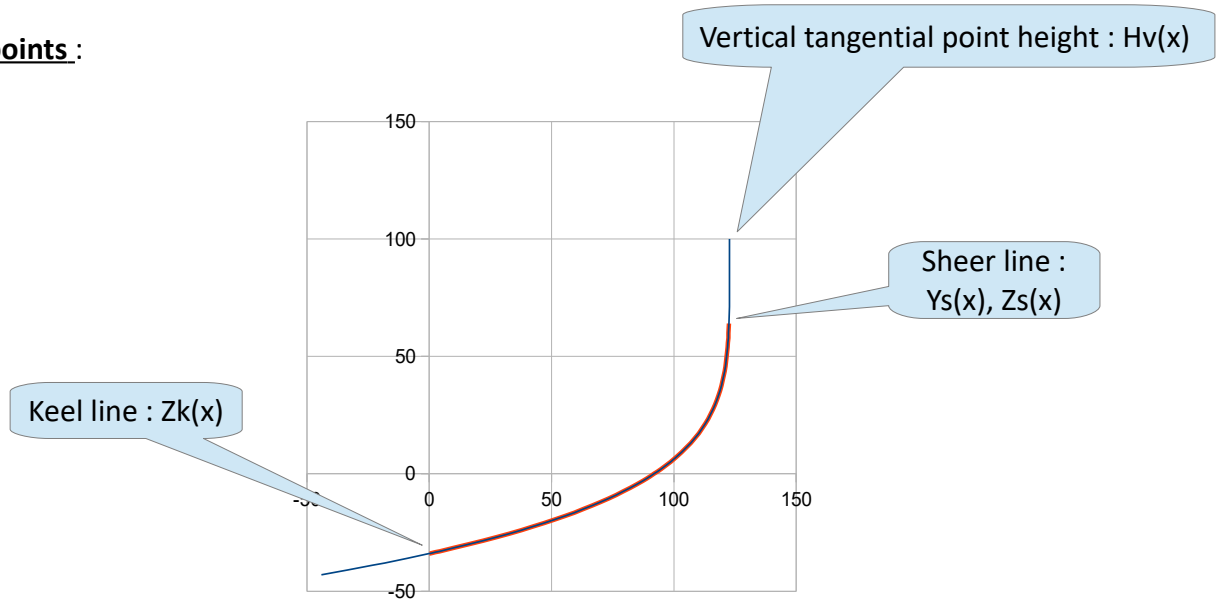
$$\text{Aft : } Z = Z_{liv m} + (Z_{liv ar} - Z_{liv m}) / (X_{liv m} - X_{liv ar})^n * (X_{liv m} - X)^n$$

## 4. Sections

3 types of elementary sections are defined, « V » shape, « U » shape and « E » shape, and then combination of either V and E shapes, or U and E shapes, is operated to define the real sections.

### 4.1 « V » shape sections

Reference points :



The formulation is of the type :

$$Y_V(x, z) = A(x) - (ABS(H_V(x) - z))^{P_{uiv}(x)} / B(x)$$

, with :

$$H_V(x) = H_{V m} + (H_{V ar} - H_{V m}) * [IX - X_5] / [IX_{ar} - X_5]^{P_{ui} H_V} \quad \text{for } x < x_5$$

$$H_V(x) = H_{V m} + (H_{V av} - H_{V m}) * [IX - X_5] / [IX_{bow} - X_5]^{P_{ui} H_V} \quad \text{for } x > x_5$$

$$P_{uiv}(x) = P_{uiv ar} + (P_{uiv av} - P_{uiv ar}) * [(X - X_{ar}) / (X_{bow} - X_{ar})]^{P_{ui} P_{uiv}}$$

$$B(x) = [ABS(H_V(x) - Z_k(x))^{P_{uiv}(x)} - ABS(H_V(x) - Z_s(x))^{P_{uiv}(x)}] / Y_s(x)$$

$$A(x) = [ABS(H_V(x) - Z_k(x))^{P_{uiv}(x)}] / B(x)$$

, where the input data are the adimensional parameters :

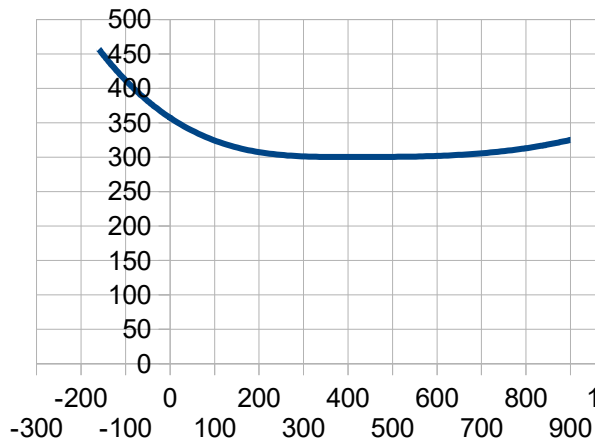
C Hv av
C Hv m
C Hv ar
Pui Hv
Pui V av
Pui V ar
Pui Pui V

, and :

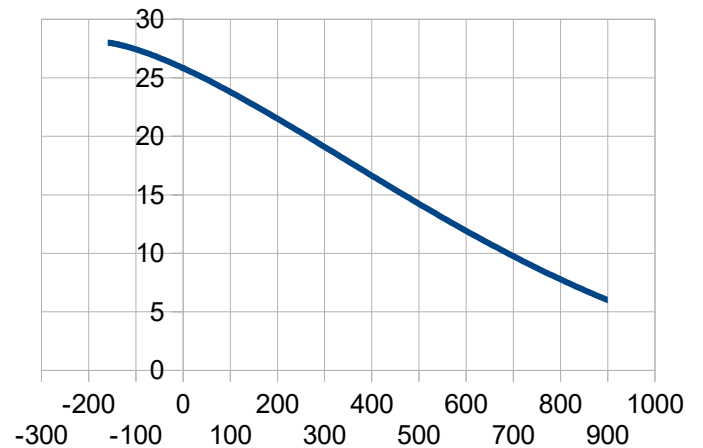
$$Hv_{ar} = C_{Hv_{ar}} * Z_{liv_{ar}} ; Hv_m = C_{Hv_m} * Z_{liv_m} ; Hv_{av} = C_{Hv_{av}} * Z_{bow}$$

Examples of  $Hv(x)$  and  $Puiv(x)$  functions :

$Hv(x)$  for "V" sections

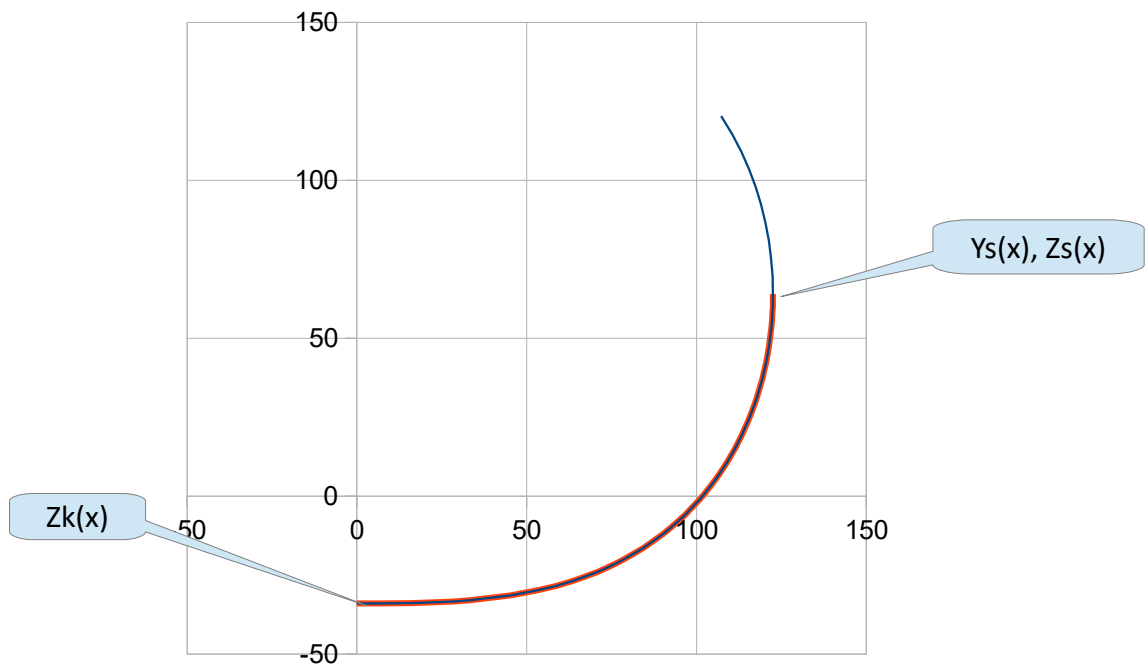


$Puiv(x)$  for "V" sections



#### 4.2 « E » shape sections

Reference points :



The formulation is of the type :

$$Y_E(x, z) = Y_s(x) - [1 - ((Z_s(x) - z) / (Z_s(x) - Z_k(s)))^{P_{uiE1}}]^{1/P_{uiE2}}$$

, where the input adimensional parameters are  $P_{uiE1}$  and  $P_{uiE2}$

$P_{uiE1}$   
 $P_{uiE2}$

### 4.3 Combination of shapes

Two combinations are proposed :

- VE sections
- UE sections

The combination law is the same in both cases :

VE sections :  $Y_{VE}(x,z) = Y_V(x,z)^{\text{mix}(x)} * Y_E(x,z)^{(1-\text{mix}(x))}$

UE sections :  $Y_{UE}(x,z) = Y_U(x,z)^{\text{mix}(x)} * Y_E(x,z)^{(1-\text{mix}(x))}$

, with :

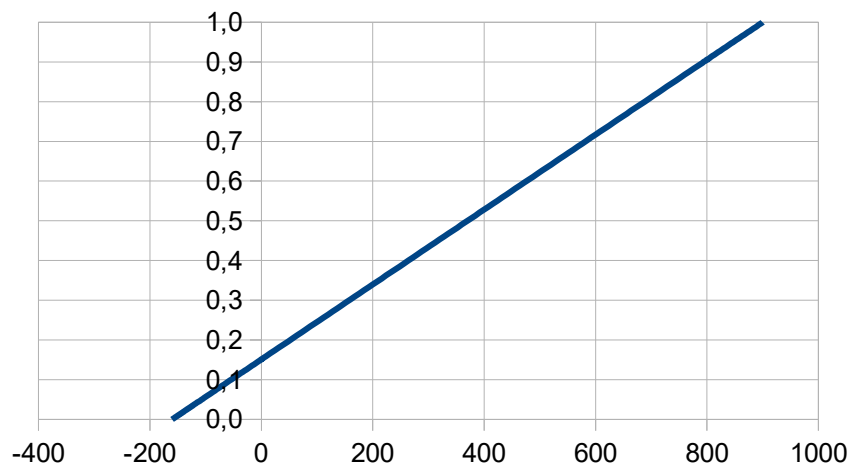
$$\text{mix}(x) = \text{mix}_{av} + (\text{mix}_{ar} - \text{mix}_{av}) * [(X_{bow} - X)/(X_{bow} - X_{tab ar})]^{P_{uimix}}$$

, where the input data are the adimensional parameters :

$\text{mix}_{VE av}$   
 $\text{mix}_{VE ar}$   
 $P_{ui mix VE}$

Example of  $\text{mix}(x)$  with  $\text{mix}_{VE av} = 1$ ,  $\text{mix}_{VE ar} = 0$  and  $P_{ui mix VE} = 1$  (i.e. linear) :

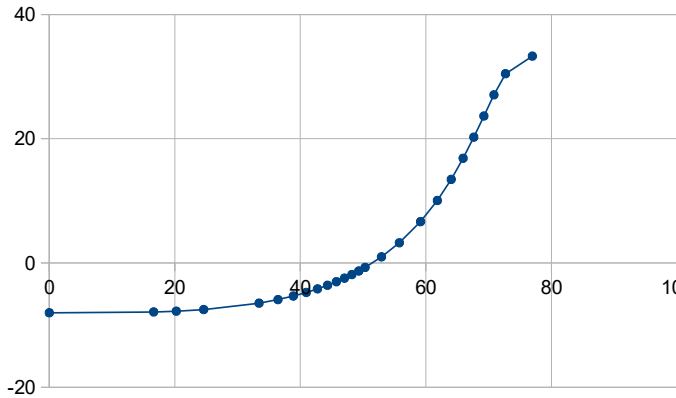
$\text{mix}(x)$  law combination for the sections



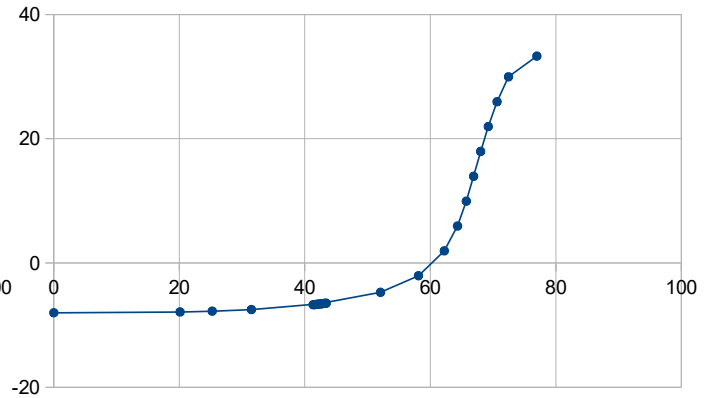
#### 4.4 Additional shaping of the sections (in option, activated when $K_y \neq 1$ )

The  $Y = f(Z)$  fonction resulting from the here above formulations is modified using adimensional parameters  $K_y$ ,  $K_z$  and  $K_{soft}$ . Examples :

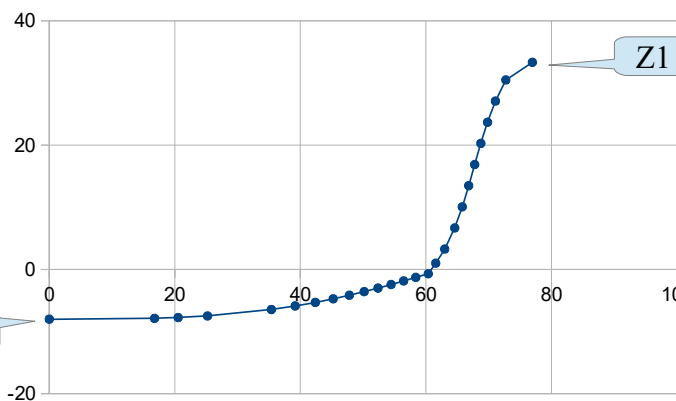
$K_y = 1$  (option not activated)



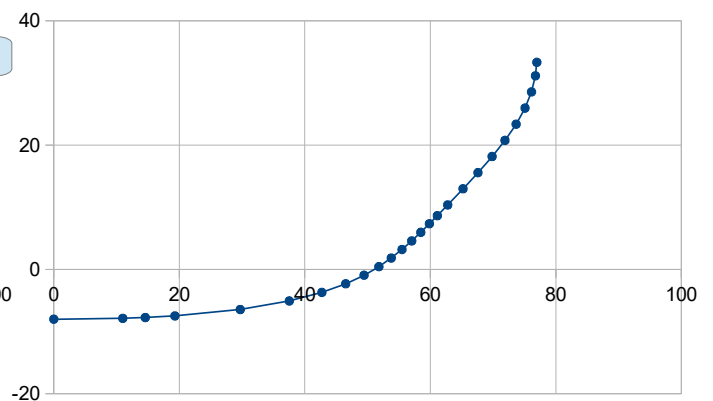
$K_y = 1,3$  ;  $K_z = 0,2$  ;  $K_{soft} = 2,0$



$K_y = 1,2$  ;  $K_z = 0,4$  ;  $K_{soft} = 0,85$



$K_y = 0,9$  ;  $K_z = 0,7$  ;  $K_{soft} = 2,0$



$$Y_{option} = Y * [K_y + (1-K_y) * \text{ABS}(\text{COS}(((Z - Z_0)/(Z_1 - Z_0))^{\wedge K_z}) * \pi)^{\wedge K_{soft}}]$$