Gene-Hull Sailboat 3.5_User Guide

This new version 3.5 includes some improvements like :

** for the sections generation : an upgraded formulation (still using the same input data) with more output data proposed for a better mastery of the angles and curvatures,

** for the heeled hull : more output data to check its relevance, e.g. the line connecting the centers of the immersed sections areas which is a bit like the spine of the heeled hull,

** + other minor improvements or bugs correction detected by practice or by users,

** and last but not least, this present User Guide partially rewritten for more clarity

Gene-Hull Sailboat makes possible the **generation of hulls for sailing yacht** with their 2D views + a 3D perspective, and their hydrostatic characteristics as output, keel and rudder included. It is based on a spreadsheet application (with Open Office Calc 4.0.1) involving fit for purpose formulations able to generate the hull fairing lines. It needs a relatively small number of data to enter : basic geometrical data, 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 in place in the application, which can allow him to start with Gene-Hull with a complete design :

- For the beginner : it is recommended to first test the influence of each adimensional parameter, without changing the geometrical data, to see and learn about the influence of each one, in conjunction with the explanations given in the present User Guide.
- For the more advanced user : you can take advantage of one of the 17 examples showed in the « Examples » document, of which input data are stored in the « Hulls storage » sheet , to start a new project.

For each new data introduced, all the computations and the drawings are updated automatically (in quasi real time,~ 1 to 2 secondes). 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 sailboat with a loading (to input) and with heel angle is also proposed : in hydrostatic condition, at displacement = weight and LCB = LCG, thanks to iteration on height (sinkage or elevation) and trim parameters. It provides the GZ, the righting moment RM, the wetted surface,... and 2D drawings of the heel hull (sections and floatation waterline) which can help assess the relevance of the heeled hull waterlines.

After an apprenticeship that should be light thanks to this User Guide, with the hull of reference given to initiate a new project and/or with other proposed Examples (of which input data are stored in the « Hulls Storage » sheet), it is easy and even fun to create a great number of hulls within just few clicks, even up to test unusual values of parameters, to find out new style or shape of hulls : combinations are infinites and sometimes unpredictables (it is also a way to test the limits of the application). 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 speadsheet application, developed on a support itself free and widespread (Open Office Calc 4.0.1) : to open and use an .ods file, you have to download Open Office or Libre office according to : http://www.openthefile.net/extension/ods

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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 (from line 348) where all the computations are carried out. The User space includes 5 successive sections :

Gene-Hull input (from page 4) :

1. Data to enter

Gene-Hull output (from page 38) :

2. Data sum-up and results of hydrostatic and surfaces calculations
3. The 3 views 2D
4. Curves of control

Gene-Hull complementary input (for the loading) and output

5. Stability and righting moment with a loading

Hulls storage : is the storage space of the input data (page 58)

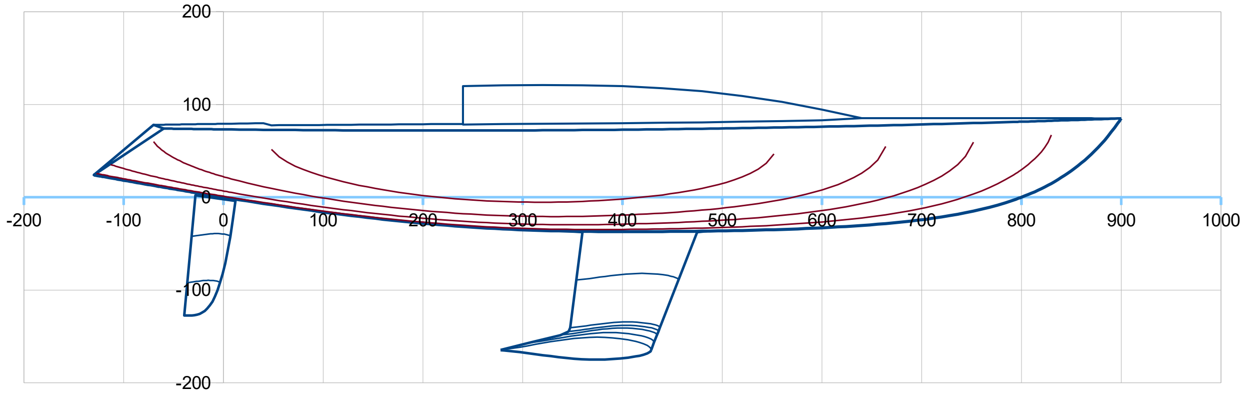
Sailplan : includes an User space (input and output, 2D view of the sailplan) followed by an Administrator space where the computations are carried out (page 49)

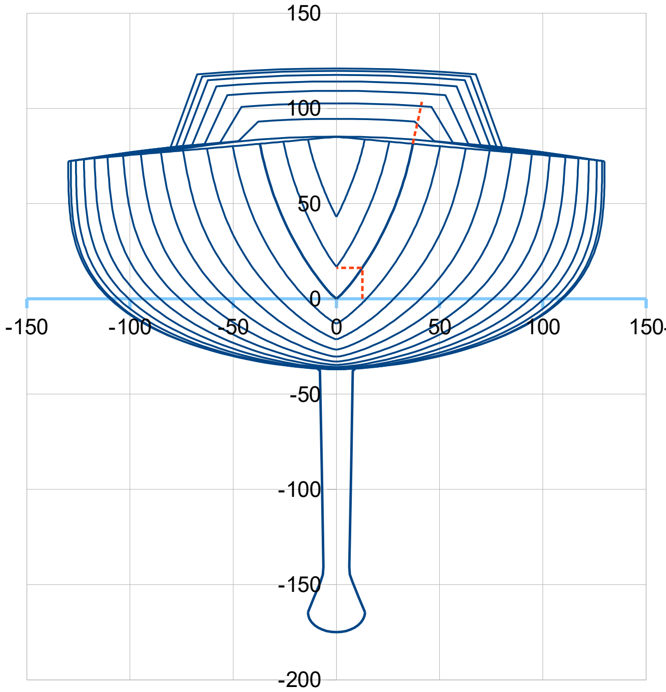
Mass spreadsheet : includes an User space (input and output) (page 53)

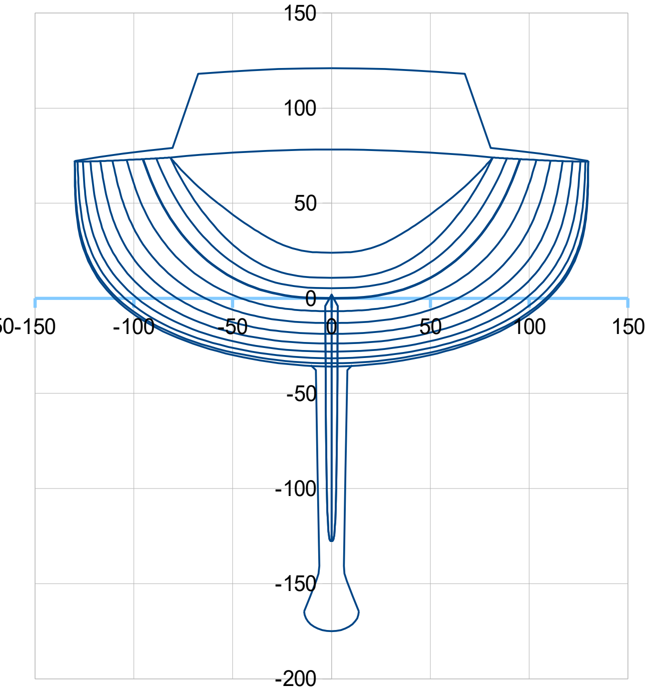
Offsets x,y,z : where all the geometrical output data are gathered and can be copy/paste for a transfer towards software tools oriented for engineering studies or 3D renderings (page 55)

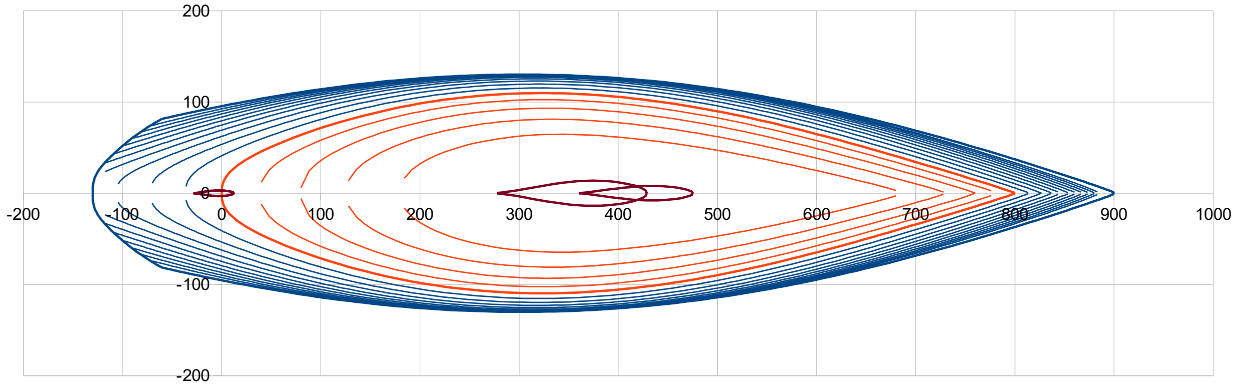
The coordinates x,y,z used fo the views include :

- Origin 0,0,0 at the cross of the designed waterline (« H0 » level) and the perpendicular at the rear point of the waterline, named station C0. The perpendicular at the front point of the waterline is station C10 (here below at 800).
- 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. But it is suggested for the User, as long as the main dimensions of the new project are fixed, to put if necessary the views at another scale more relevant for the project dimensions and to fix it.

Gene-Hull sheet / Input

1. Data to enter for the hull body

Data to enter are in columns A to D, lines 10 to 58. Geometrical d*ata are in metric units,* with automatic feet conversion in column C *(in italic blue in the file).* Examples with boat V1 values :

Hull data		*feet conversion*		
Lenght of waterline :			Type of geometrical data	
Lwl (m)	**8,00**	*26,25*	<<< Length	
Maximum draft of the hull body :				
Tc (m)	**0,3700**	*1,21*	<<< Height	
X Tc (%Lwl)	**50,0**			
Hull bow :				
Xbow (m)	**9,00**	*29,53*	<<< Length	
Zbow (m)	**0,85**	*2,79*	<<< Height	
Shape coefficient of the bow :				
Cet	**3,00**			
Kbrion	**0,00**			
Polynomials of the keel line, front part and rear part :				
Pui q av	**2,45**			
Pui q ar	**2,35**			
Rear end of the transom :				
X tab ar (m)	**-1,30**	*-4,27*	<<< Length	
Z tab ar (m)	**0,24**	*0,79*	<<< Height	
Sheer line, in horizontal projection xy :				
Bg (m)	**2,199**	*7,21*	<<< width	
X Bg (% Lwl)	**43,0**			
Alfa (°)	**2,00**			
Pui liv y	**2,00**			
Cor Pui liv	**0,025**			
Pui Cor Pui	**2,00**			
X liv ar (m)	**-0,60**	*-1,97*	<<< Length	
Scow	**0,03**			
Pui Scow	**0,25**			
Option Hard Chine line, in vertical projection xz :				
Type	**0**	**Bratio fore**		
1,2 Zhc av (m)	**0,75**	**1,00**		
2 Zhc m (m)	**0,20**	**Bratio aft**		
1,2 Zhc ar (m)	**0,42**	**1,00**		
Pui hc z	**2**			
Sheer line, in vertical projection xz :				
Z liv m (m)	**0,72**	*2,36*	<<< Height	
Z liv ar (m)	**0,74**	*2,43*	<<< Height	
Deck / central line rear end				
Z p m (m)	**0,83**	*2,72*	<<< Height	
X p ar (m)	**-0,70**	*-2,30*	<<< Length	
Z p ar (m)	**0,78**	*2,56*	<<< Height	
Kroof (%B)	**29,0**			
Sections :				
	PE1	**C PE1**	**PE2**	
Fore	**2,000**	**1,630**	**1,000**	
Mid	**3,310**	**1,000**	**1,700**	
Aft	**2,000**	**1,490**	**2,800**	

Lenght of waterline

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

Lwl (m)	**8,00**

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)**

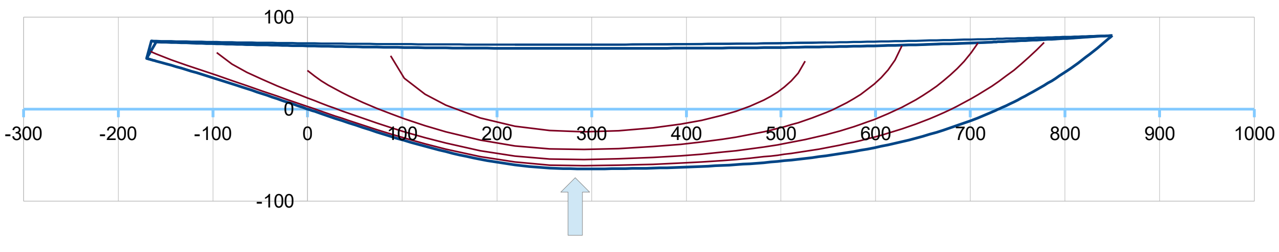
Tc (m)	**0,3700**

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

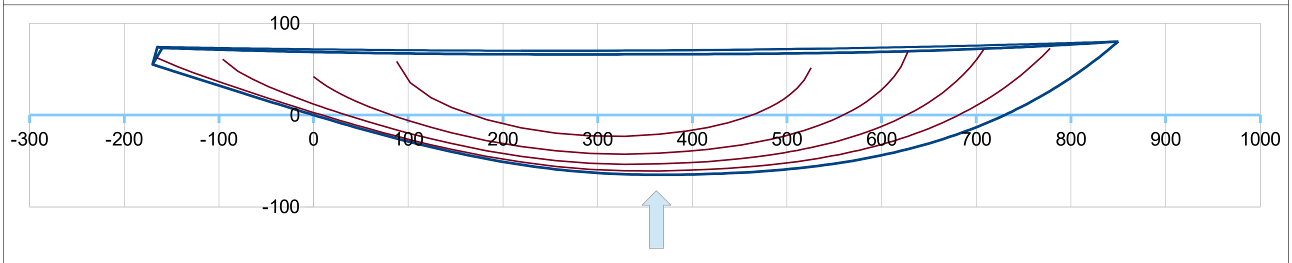
X Tc (%Lwl)	**50,0**

>>> Examples of X Tc with exaggerated values to better show the influence :

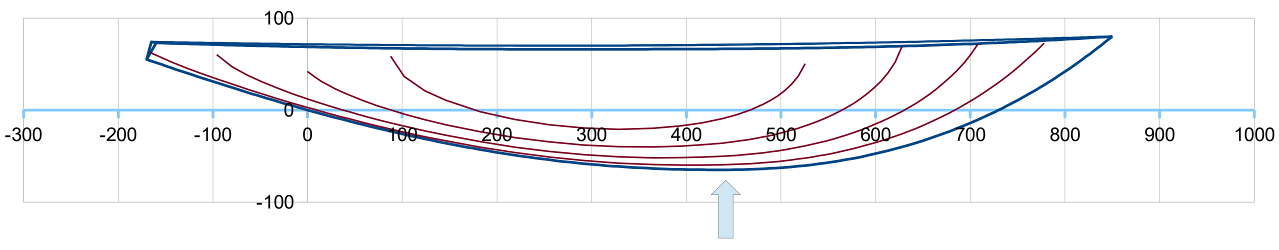
X Tc : 40 %Lwl



X Tc : 50 %Lwl *(the usual design value, or close too)*



X Tc : 60 %Lwl



Bow end

Xbow (m) : should be > Lwl (inverted bow is not possible) **(cell B17)**
Zbow (m) : it is the front freeboard **(cell B18)** See Xbow, Zbow in the drawing here after.

Xbow (m)	**9,00**
Zbow (m)	**0,85**

Bow coefficients

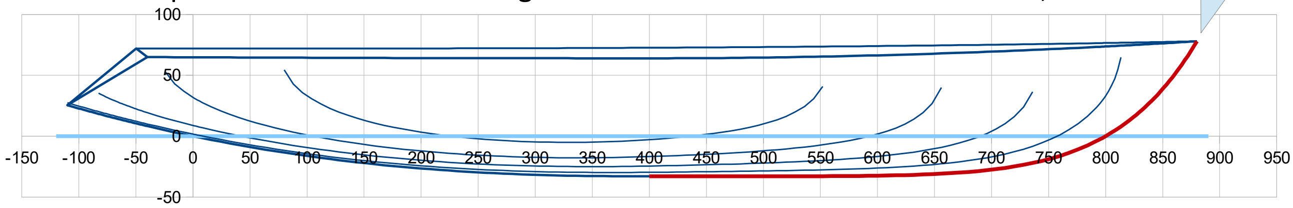
For the bow shape, in addition to Xbow and Zbow acting on the front overhang, 2 parameters are influent and in interaction : **Cet, Kbrion**

Cet	**3,00**
Kbrion	**0,00**

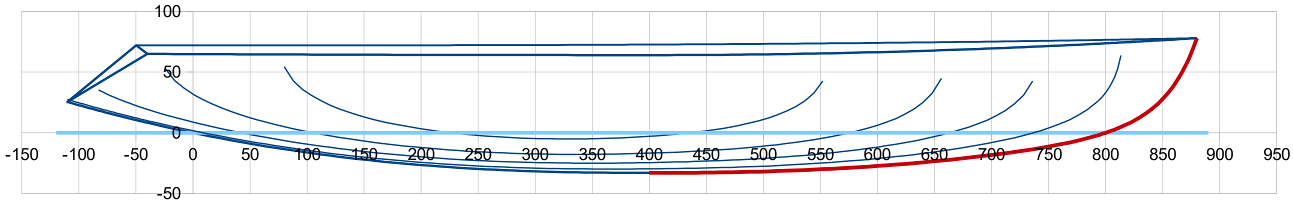
Cet : adimensional coefficient > 0, from 0,1 to 100 typically. **(cell B 20)**
This coefficient is involved in the polynomial formulation of the front part of the keel line and mostly influence the bow shape.

Xbow , Zbow

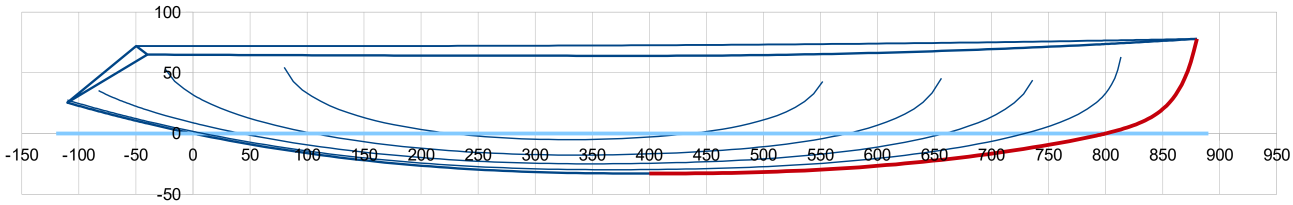
Examples at same front overhang and various Cet : Cet = 0,1 :



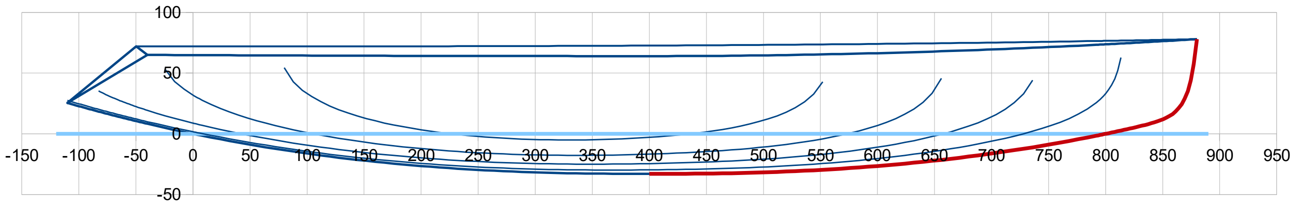
Cet =10 :



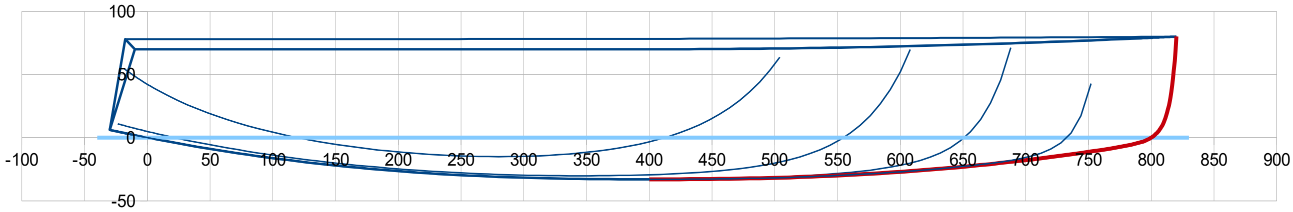
Cet 20 :



Cet 50 :

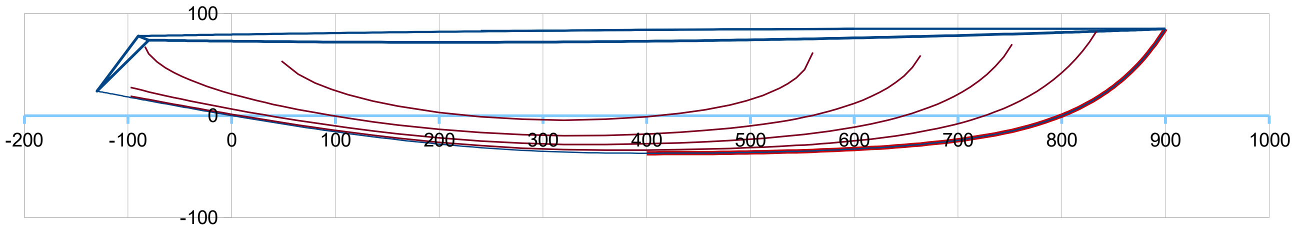


Example with Cet 50 and a shorter front overhang (Xbow slightly greater than Lwl) :

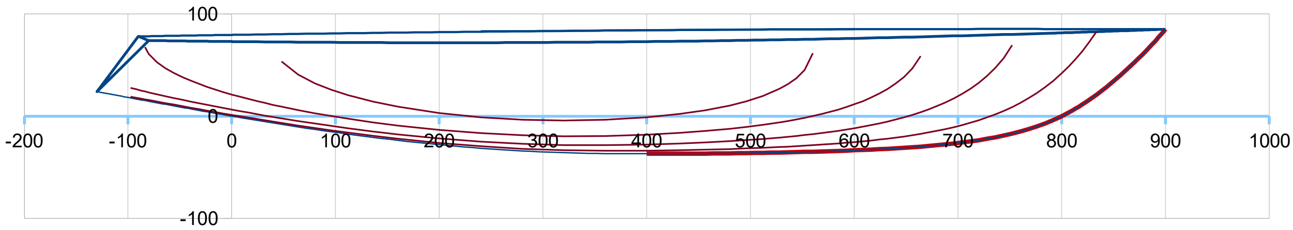


Kbrion : adimensional parameter ≥ 0 , complentary to **Cet**, in order to both straighten the bow line (above the water) and to accentuate the fore foot (below the water). **Cell B21**
<u>It is an optional parameter</u>, if you don't want to use it, just put Kbrion = 0 (recommended at first).

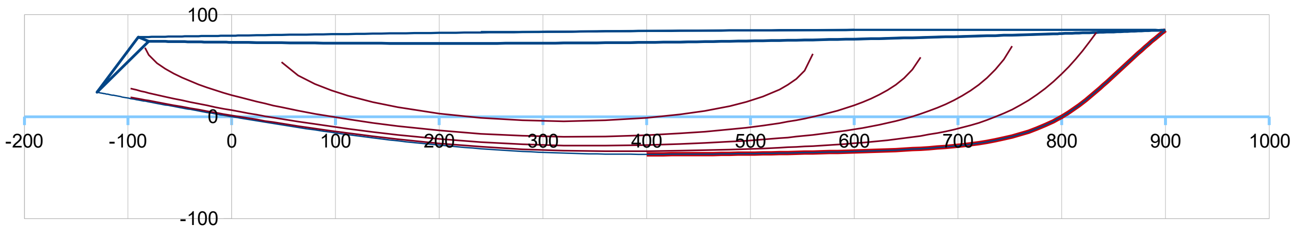
Examples : **Kbrion = 0** >>> no influence



Kbrion = 0,10



Kbrion = 0,20



Nota : the use of high value for Kbrion can introduced some slight ondulations in the front waterlines >> you should adjust also the fore sections parameters to streamline again the waterlines.

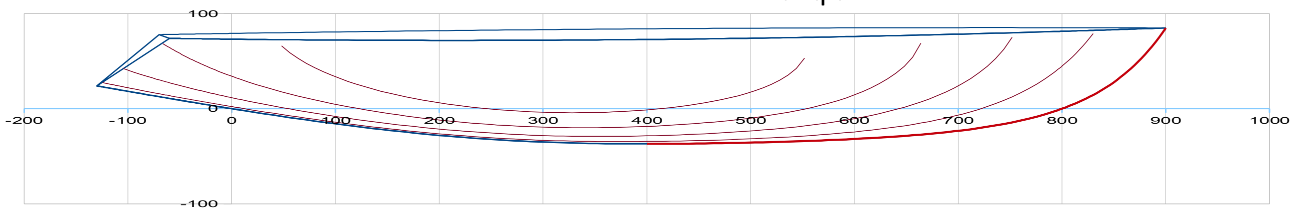
Keel line polynomial / front part (x > X Tc)

Pui q av : adimensional coefficient which figures the power factor of the front polynomial (**Cell B23)**

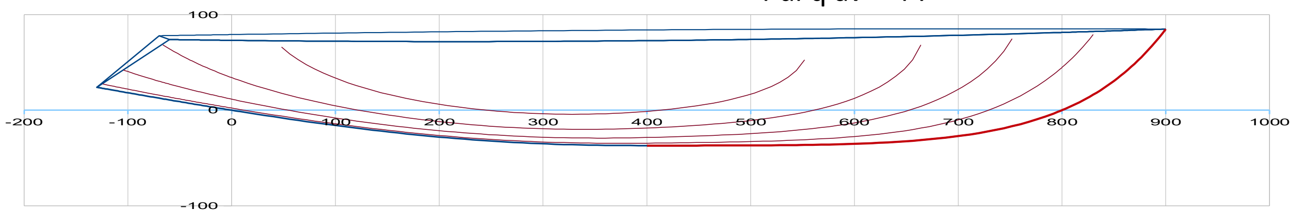
Pui q av 2,45

Pui q av has an influence on the fore volume, the higher the value the more the fore volume. The most used values are 2,0 to 3,5 (<u>Pui q av < 2 is not recommended</u>). Some examples :

Pui q av = 2 :



Pui q av = 4 :



To note : Pui q av influence on the bow line itself is less visible than with using Cet or Kbrion.

Keel line polynomial / rear part (x < X Tc)

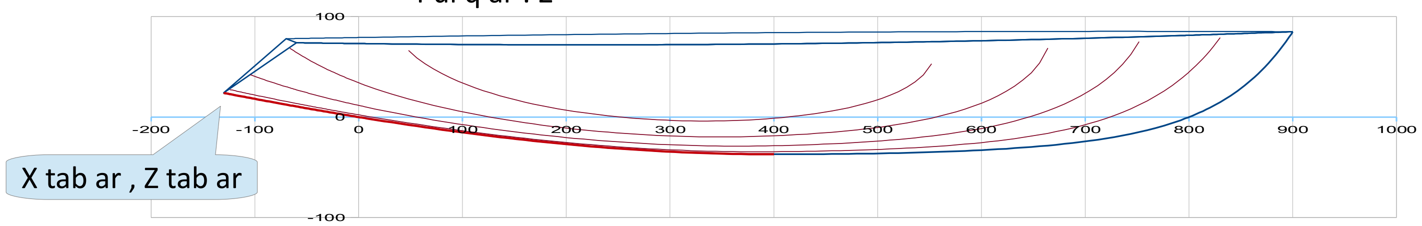
For the rear keel line shape, 3 data are influent and in interaction : **X tab ar**, **Z tab ar** (= the rear point location) and **Pui q ar** (acting on the overall shape of the rear keel line).

Pui q ar : adimensional coefficient which figures the power factor of the rear polynomial **(cell B24)**

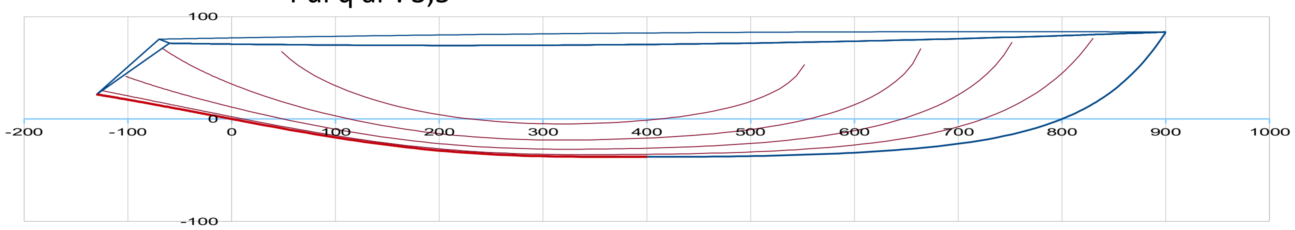
Pui q ar 2,35

The most usual values are 2,0 to 3,5 (<u>Pui q ar < 2 is not recommended</u>), some examples :

Pui q ar : 2

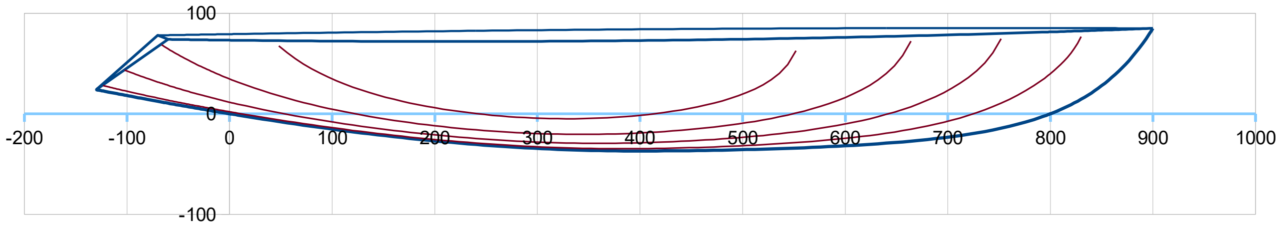


Pui q ar : 3,5

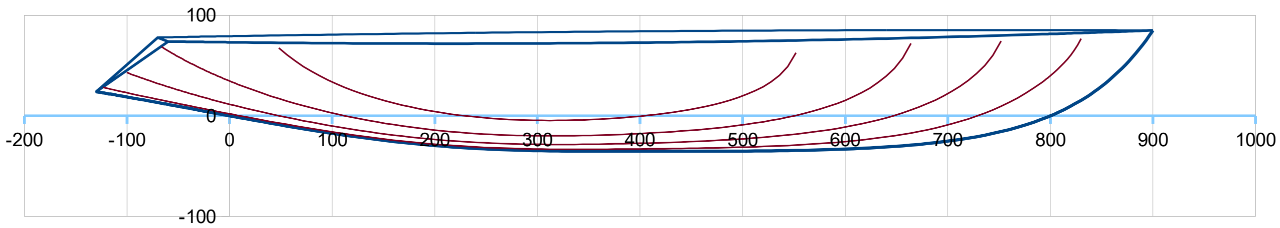


Pui q ar has an influence on the rear volume, the higher the value the more the volume.

Using high values for both Pui q av and Pui q ar contributes to increase volume towards fore and aft ends and so leads to an higher prismatic coefficient Cp. Here is a comparison with low Pui q av & ar (= 2) and high Pui q av & ar (= 3,5) , with hull V1 data and hull draft Tc adjusted to keep constant the displacement :



Pui q ar = 2 & Pui q av = 2 + Tc = 0,3792 m **>>> Cp = 0,533** and D= 2674 kg



Pui q ar = 3,5 & Pui q av = 3,5 + Tc = 0,3530 m **>>> Cp = 0,566** and D= 2674 kg

And also : to use different values for Pui q ar and Pui q av can help adjust the LCB location.

Rear transom end point

X tab ar (m) : X of the rear transom end point, always a negative value **(cell B26)**

Nota : **two types of rear transom can be modelled :**

an inverted rear transom, implying the respect of this condition :

X tab ar *< X p ar < X liv ar < 0*

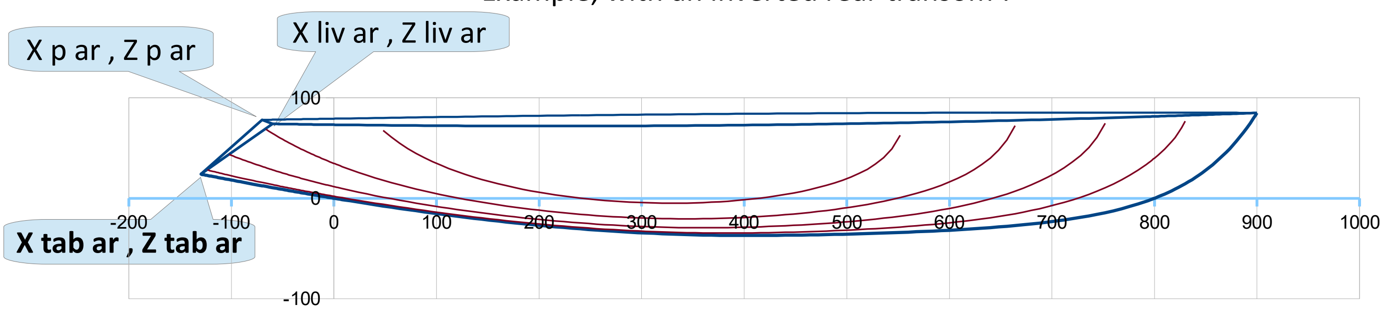
an classic rear transom, implying the respect of this condition :

X p ar < X liv ar < ***X tab ar*** *< 0*

Z tab ar (m) : Z of the rear point. **(cell B27)**

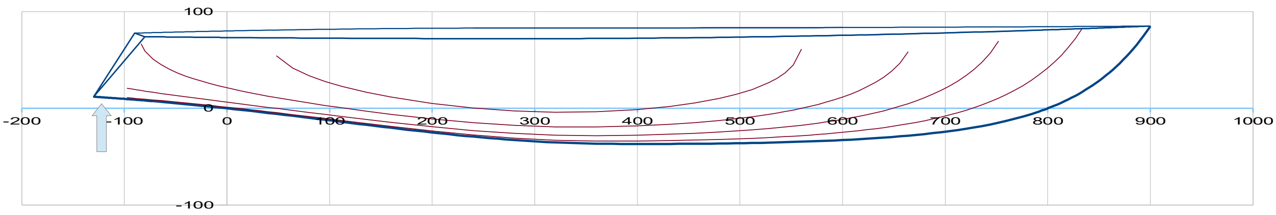
X tab ar (m)	**-1,30**
Z tab ar (m)	**0,24**

Example, with an inverted rear transom :

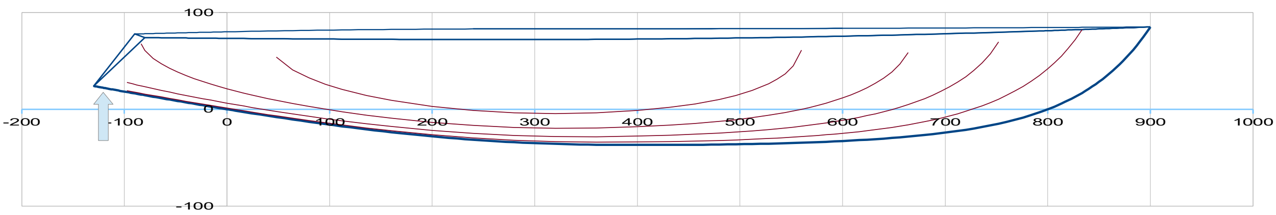


Z tab ar value, i.e. the height above the water of the rear transom tip, has a major influence on rear part of the keel line inc. the rear vault. Examples with a low, medium or high value :

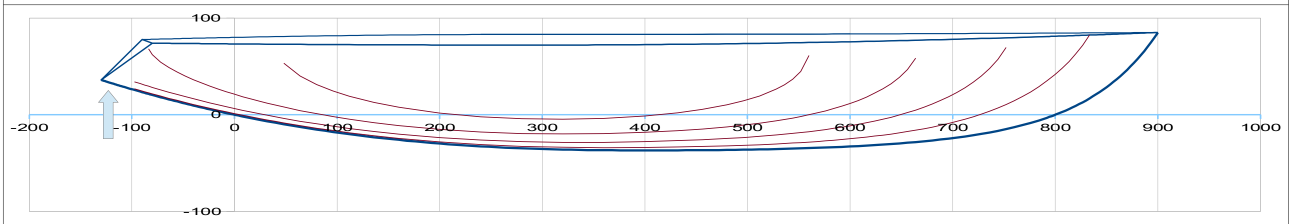
Z tab ar = 0,12 m



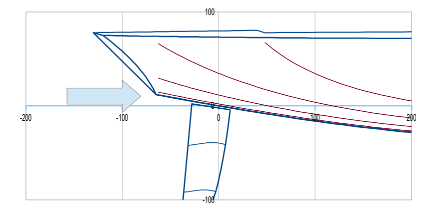
Z tab ar = 0,24 m



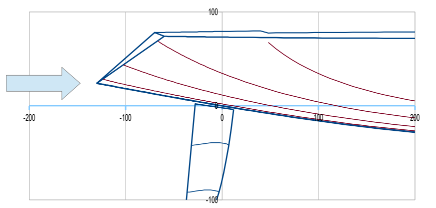
Z tab ar = 0,36 m



Examples with 2 values of X tab ar, leading to the two types of rear transom :



X p ar < X liv ar < ***X tab ar*** *< 0*
(i.e. Xdeck < Xsheer < Xkeel line)



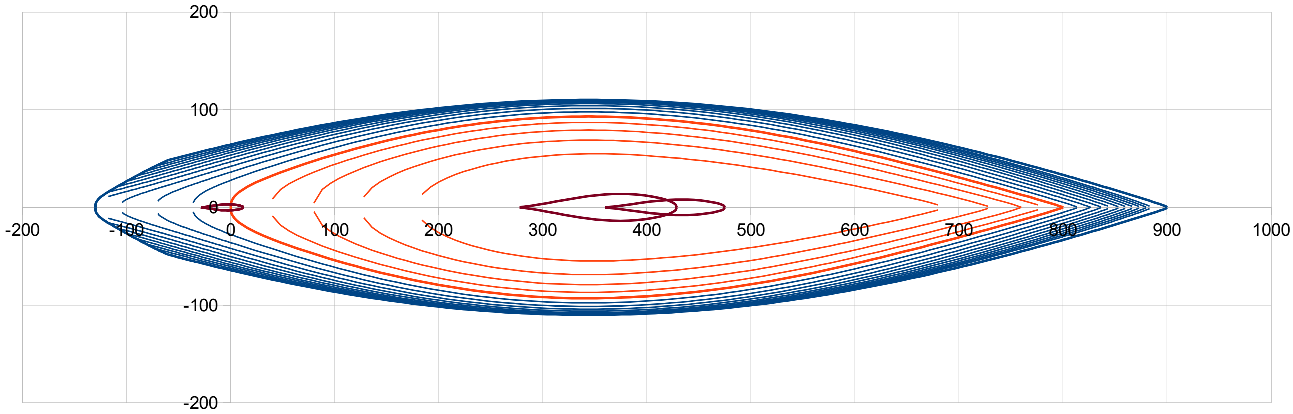
X tab ar *< X p ar < X liv ar < 0*
(i .e. Xkeel line < Xdeck < Xsheer)

Sheer line in horizontal plan (plan xy)

An indirect approach is proposed to define the sheer line in projection on the horizontal plan, using 3 data : **Bg (m) , X Bg (%Lwl) and Alfa (°).** Why this apparent complication ? Because this approach allows to position the maximum beam Bmax independently of the sheer line maximum curvature. This allows to position the maximum curvature forward of the maximum width, usually leading to a better shape of the sheer line. So, the process is two steps :

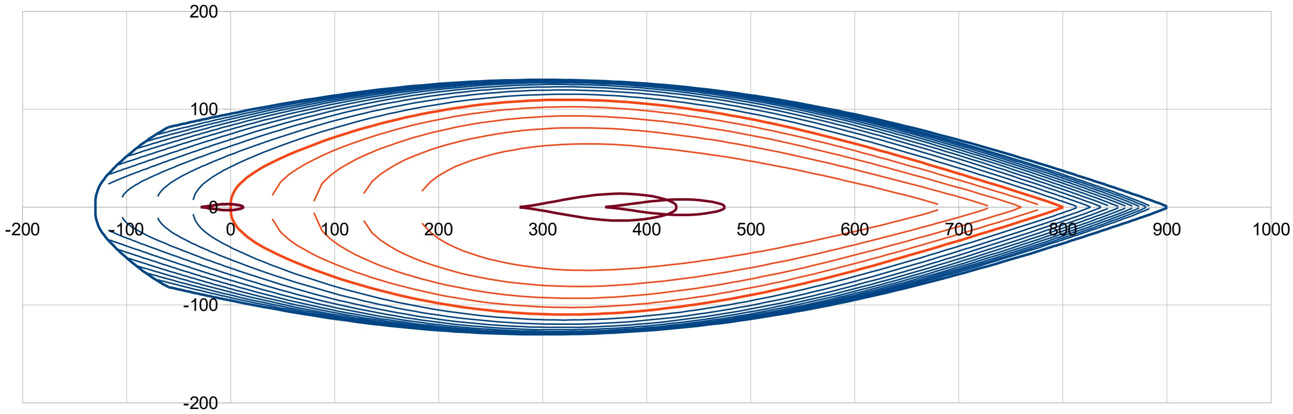
1) A first sheer line can be defined with as input the maximum beam **Bg (m) (cell B29)** positioned in **X Bg (%Lwl) (cell B30)** while keeping **Alfa(°) = 0 (Cell B31).** Example with V1 :

Bg (m)	**2,199**
X Bg (% Lwl)	**43,0**
Alfa (°)	**0,00**



2) Then, the sheer lines can be « open like scissors» through a rotation of half-angle **Alfa** with the bow end as center for this rotation. The effect is : <u>the new sheer line has a maximum beam **Bmax** at a new location **Xb**</u> aft of X Bg . Examples with V1 , using Alfa (°) = 2 :

Bg (m)	**2,199**
X Bg (% Lwl)	**43,0**
Alfa (°)	**2,00**



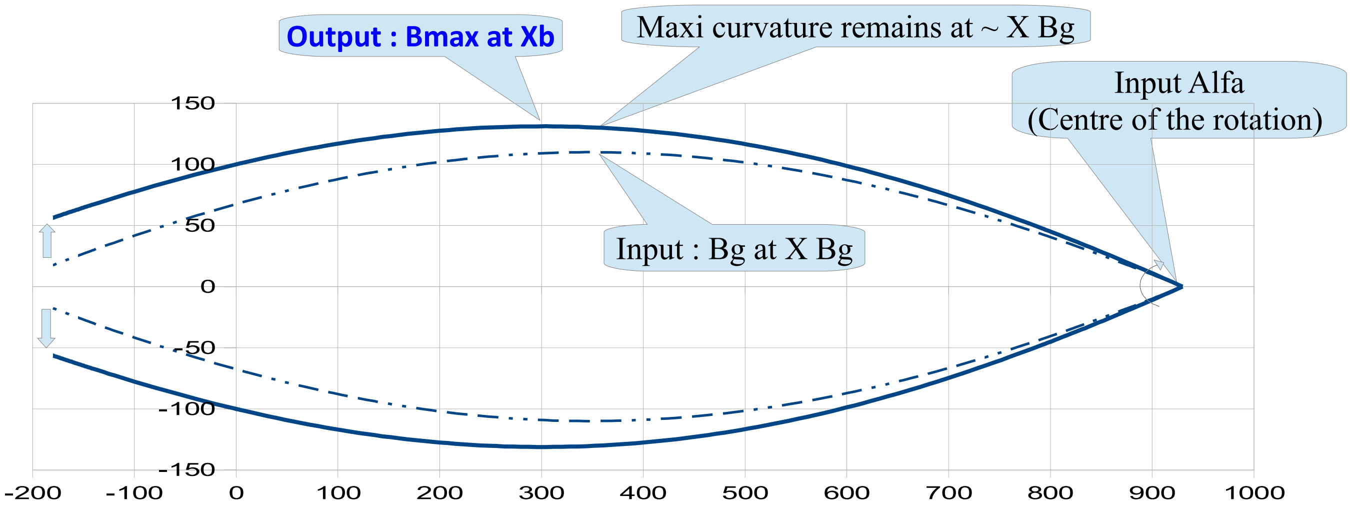
The new value of Bmax and its position Xb (here at 38 % Lwl instead of 43% for X Bg) are indicated in the left side of the sheet :

> Bmax (m)	**2,600**	**at Xb(%Lwl)**	**38,0**

So through this process a set of values for Bg, X Bg and Alfa leads to the real sheer line with its maximum beam **Bmax** at a real position **Xb**. And by doing so, the sheer line maximum curvature remains close to X Bg and is disconnected to Xb. The rear transom width is of course directly impacted by this rotation and also indicated on the left side of the sheet, with its ratio relative to Bmax :

>B Transom	**1,63**	**(m)**
Ratio	*0,63*	

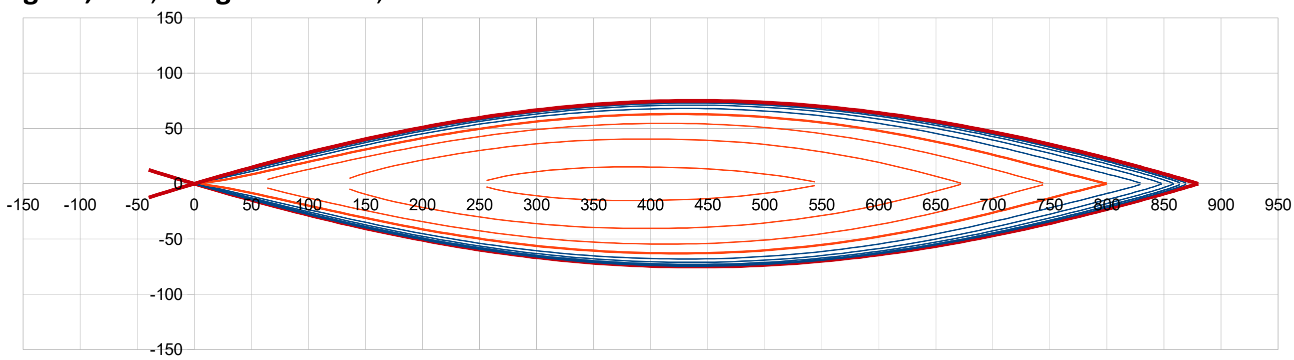
Another schematic view of the process :



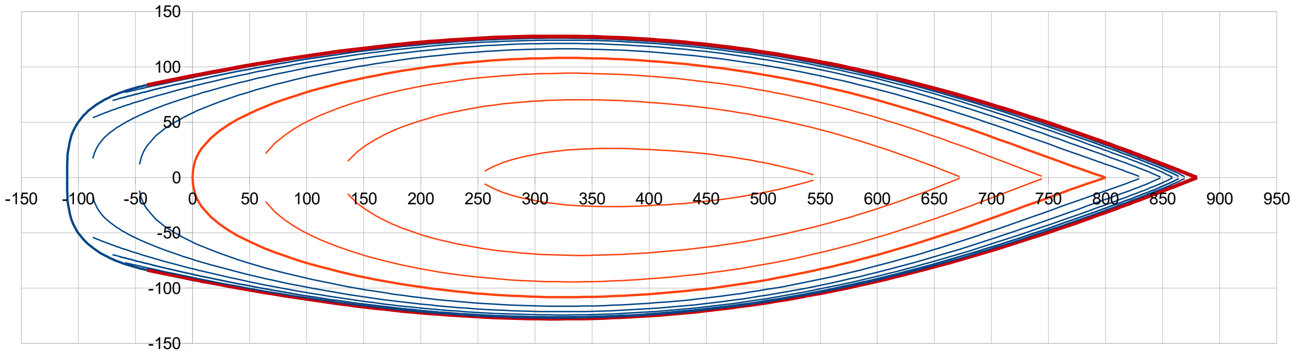
Nota : this « Alfa » reshaping of the hull is powerful, it can be done at any moment of the hull definition, all the stations and waterlines are automatically updated.

Another example here below to show that the first hull obtained with Alfa = 0 could be virtual, as long it can be transformed into a real one by application of a great enough Alfa :

Bg = 1,5 m ; **X Bg = 55 %Lwl** ; Alfa = 0° >>> « virtual » hull



… + **rotation Alfa = 6°** >>> « Real » hull leading to **Bmax = 2,55 m** at **Xb 40 % Lwl**



The maximum curvature of the real sheer line remains close to X Bg , so here at ~ 55 % Lwl, while the maximum beam is at 40% Lwl.

Nota : the « rotation » actually concerns only the y values of the sheer line, the x values are kept unchanged (the rotation matrix is used but only for the y values).

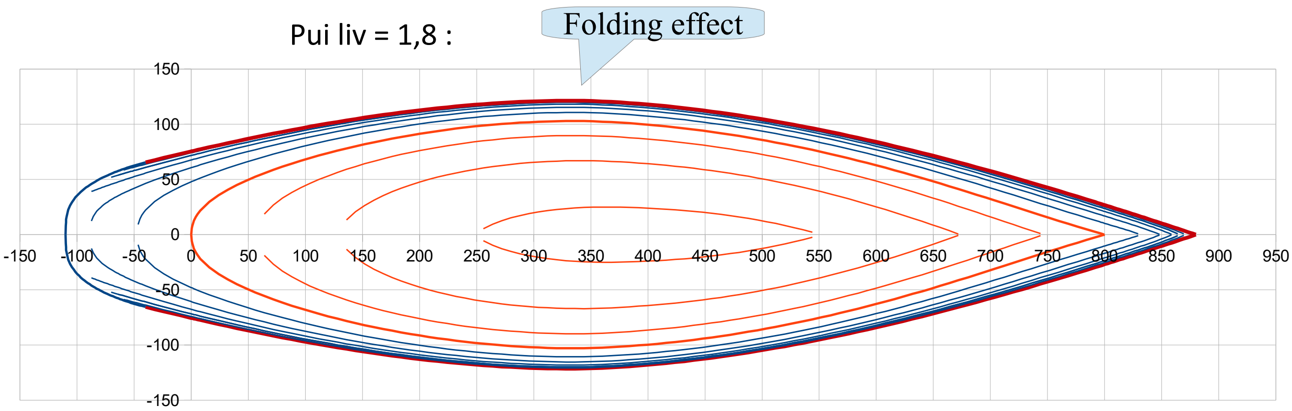
Pui liv y, **Cor Pui liv** and **Pui Cor Pui** are 3 adimensional coefficients for respectively the power of the sheer line polynomial, its correction along with x and the power of the correction polynomial itself (formulation details in the technical appendix).

Pui liv y	**2,00**
Cor Pui liv	**0,025**
Pui Cor Pui	**2,00**

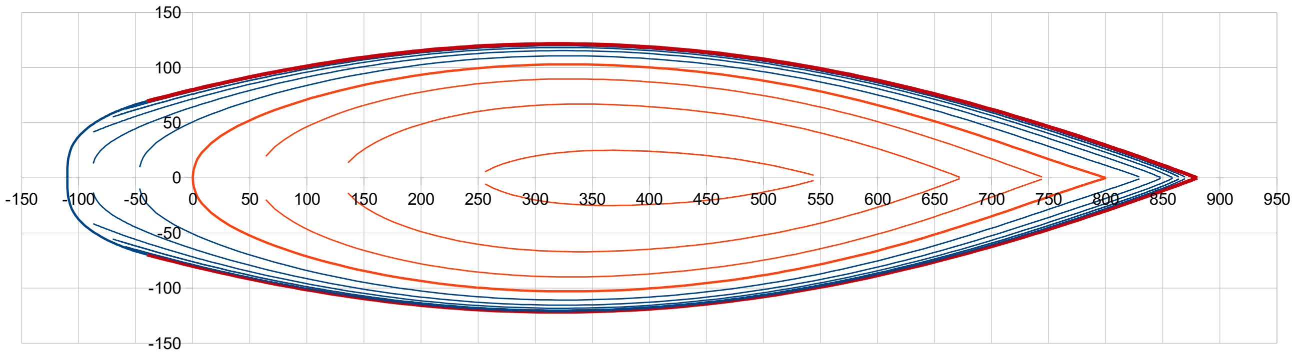
Pui liv y (cell B32) :

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

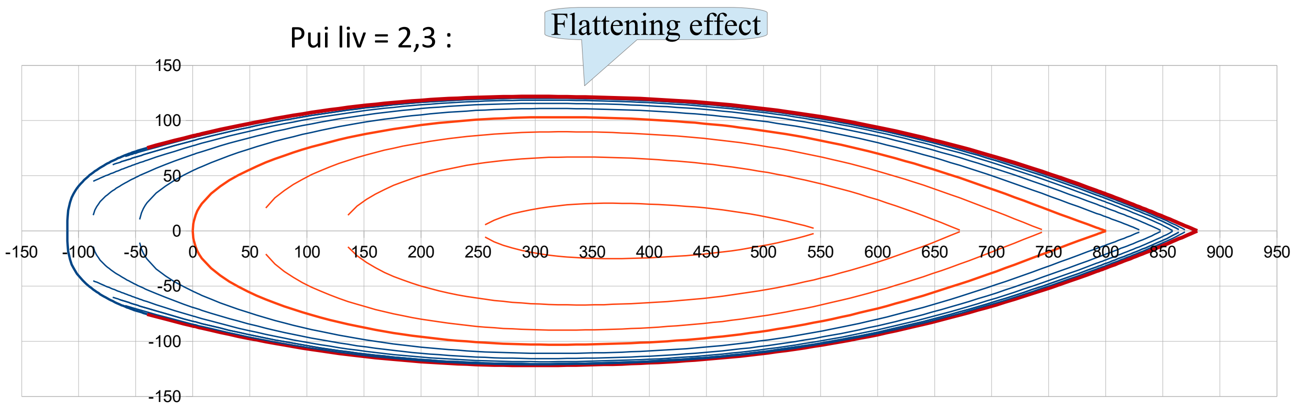
Pui liv = 1,8 :



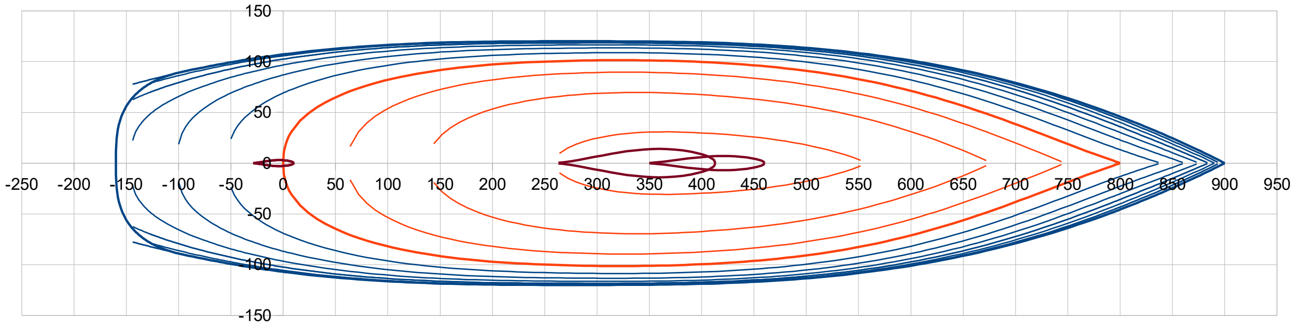
Pui liv = 2,0 : recommended for most designs



Pui liv = 2,3 :

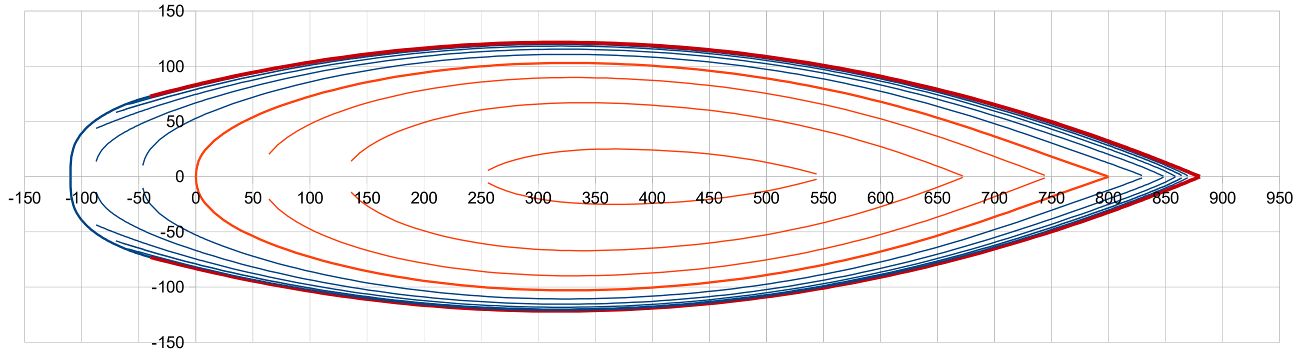


… up to a « barge » like shape when using for example Pui liv ≥ 3 :

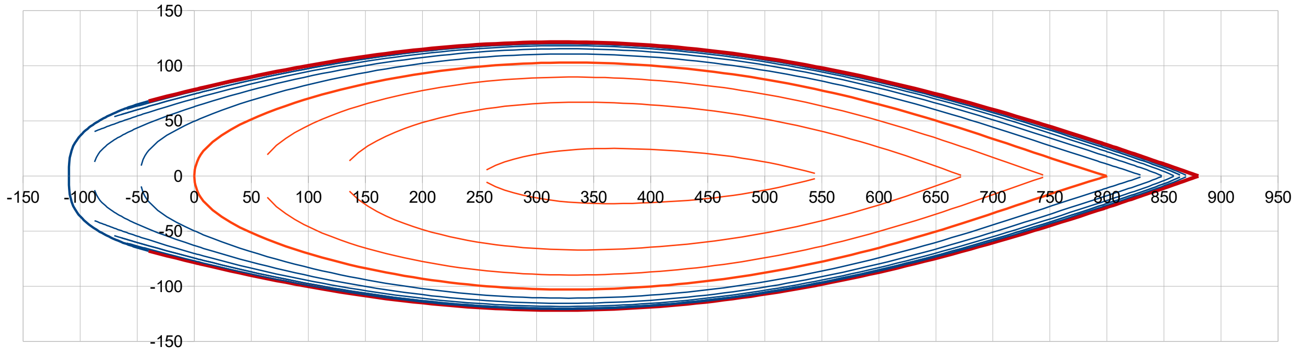


Cor Pui liv (cell B33) : when > 0 this parameter can strecht the sheer line towards the front and aft ends, meaning ends with less curvature. Examples :

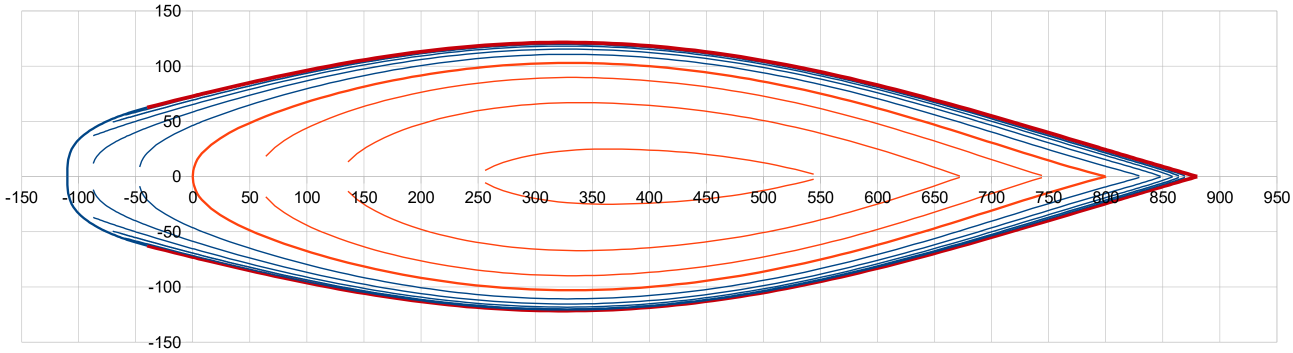
From Cor Pui liv = 0 (no influence)



>>> Cor Pui liv = 0,03



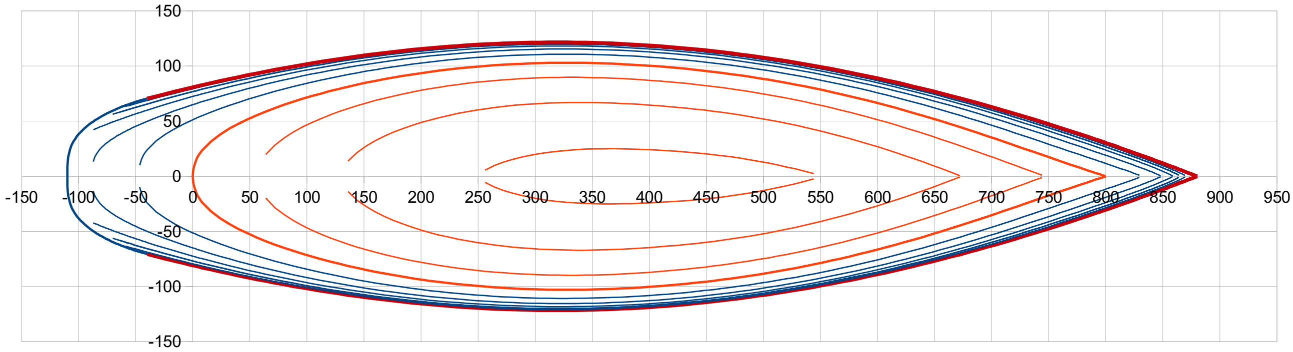
>>> Cor Pui Liv = 0,06 :



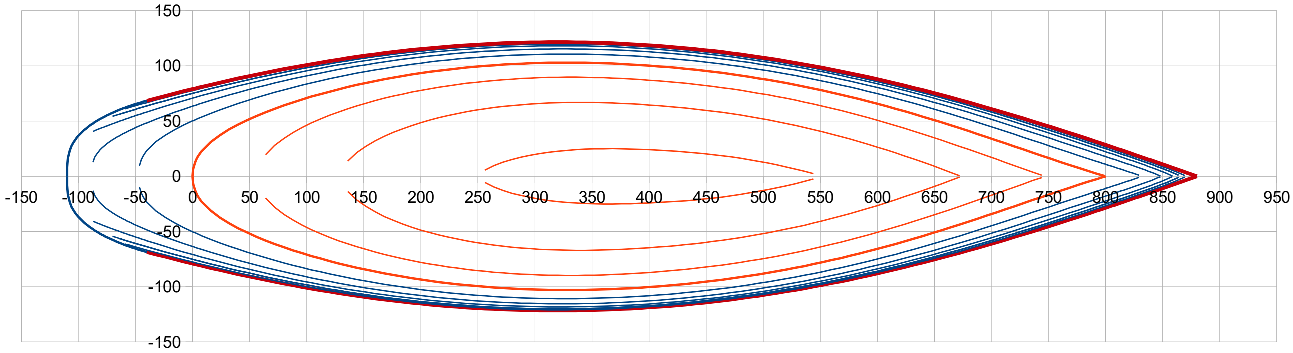
Negative values of Cor Pui Liv can be tested too, with the inverted effect.

Pui Cor Pui (cell B34) acts on the application with x of the above correction Cor Pui liv.
Pui Cor Pui = 1 >>> the correction is applied linearly
Pui Cor Pui > 1 >>> amplifies the correction application towards the ends. Some examples :

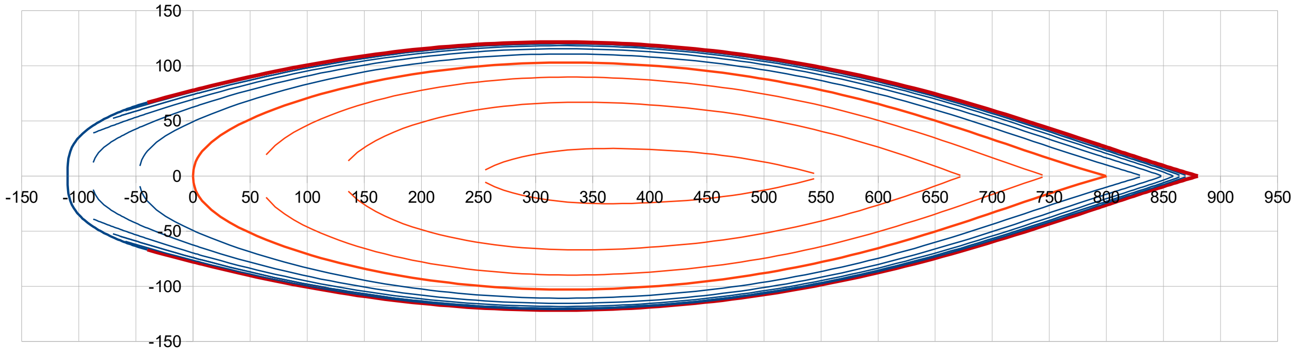
Pui Cor Pui = 1



Pui Cor Pui = 2,5



Pui Cor Pui = 5



Nota : with recommended values of 1 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**. _If you have no better idea, just use Pui Cor Pui = 2_

X liv ar (m) (cell B35) : it is the X position of the rear point of the sheer line (see Figure page 9). Condition to fullfil : X p ar < X liv ar < 0 . X liv ar is the X position of the rear station named Car 2 .

X liv ar (m)	-0,60

Nota : the Y value of the sheer line aft point is not specified, not an input as such but an output because it results from the 6 previous parameters defining the sheer line, here above detailed.

Scow (cell B36) and Pui Scow (cell 37) : Scow is a coefficient introducing a scow influence on the bow shape of the sheer line. **Pui scow** influences the shape of the scow bow, from mostly squared to mostly rounded.

Scow	**0,03**
Pui Scow	**0,25**

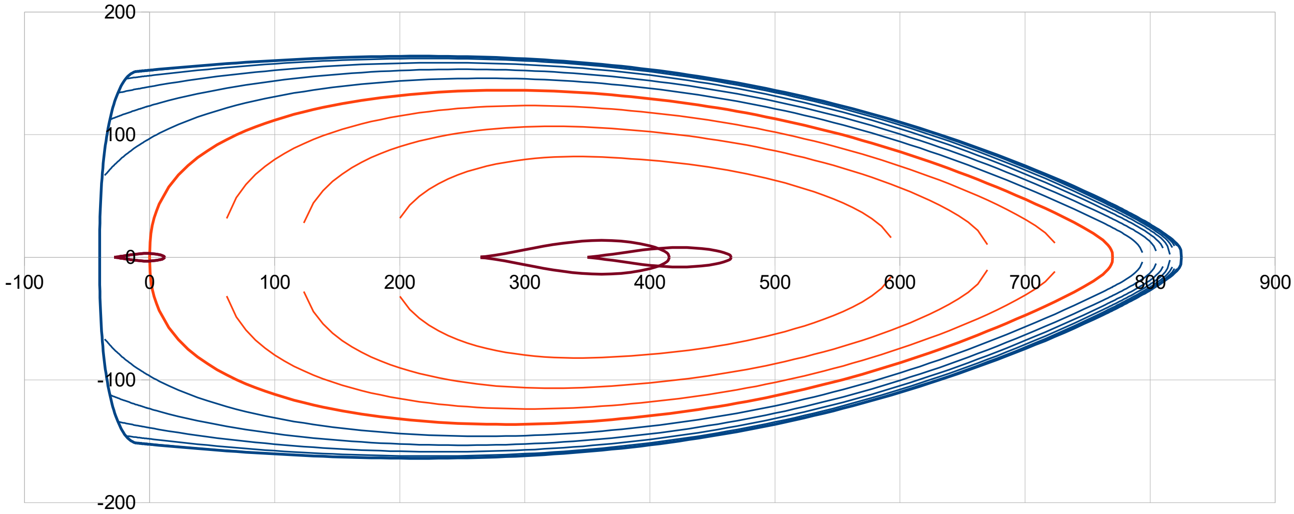
Scow = 0 to 1 , acting on the amplitude of the scow bow

= 0 >> no scow bow

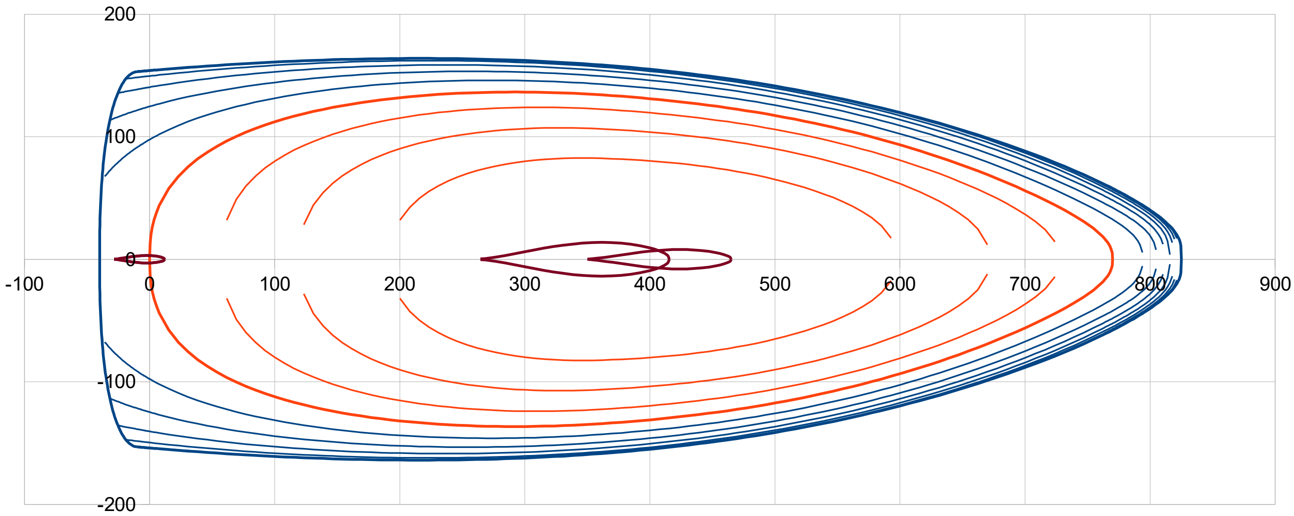
= 1 >> full « rectangular » size scow bow

Pui Scow = 0,2 to 1,0 , acting on the shape of the scow bow

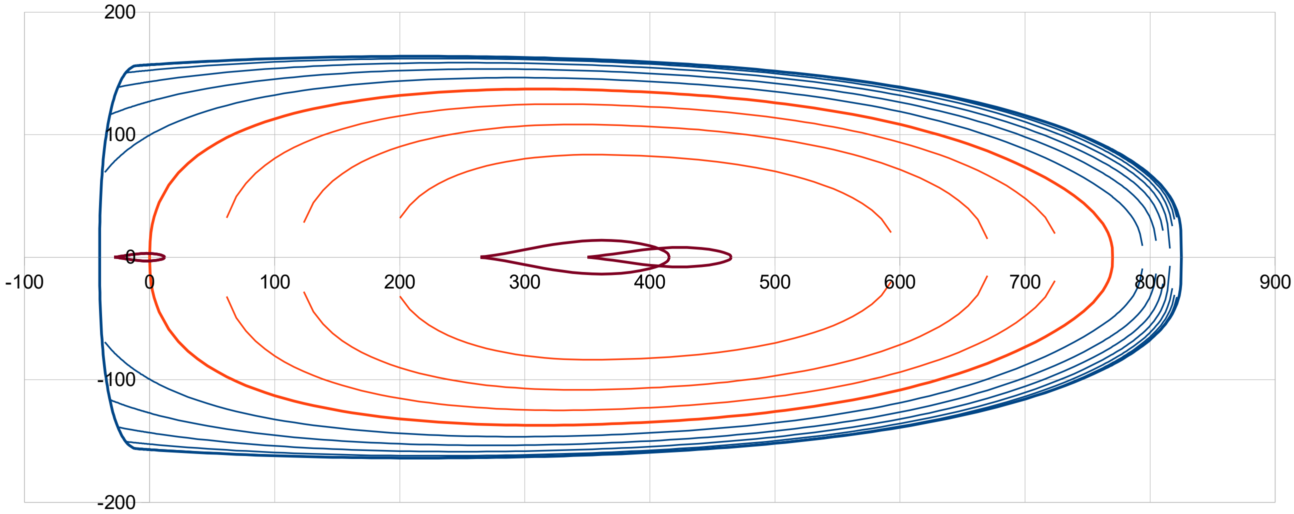
Example with Scow = 0,2 , and Pui scow = 0,25



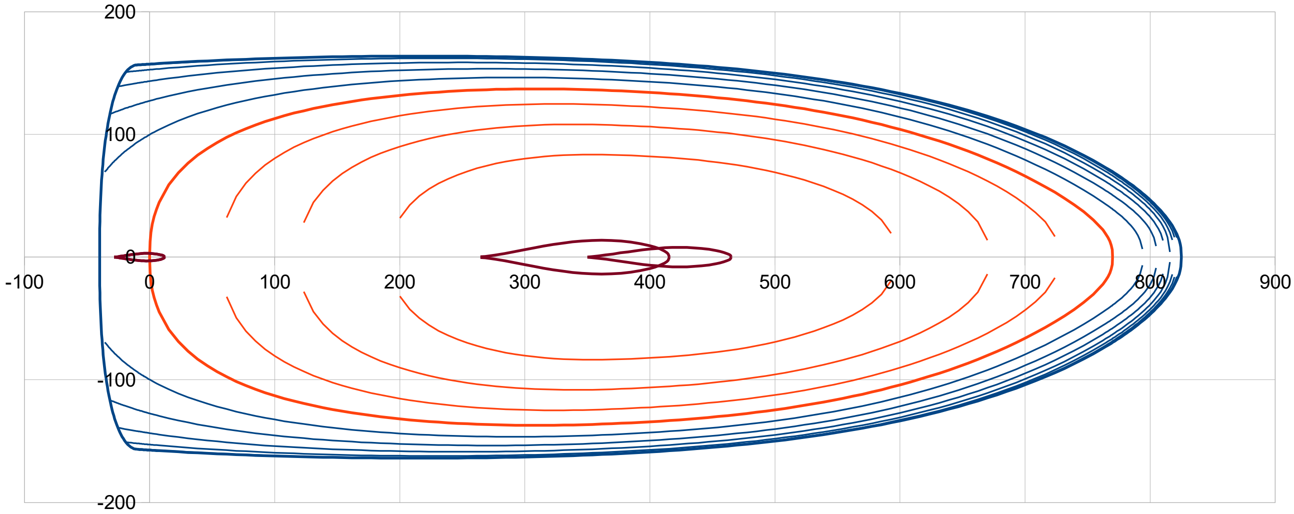
Example with Scow = 0,4 , and Pui scow = 0,25



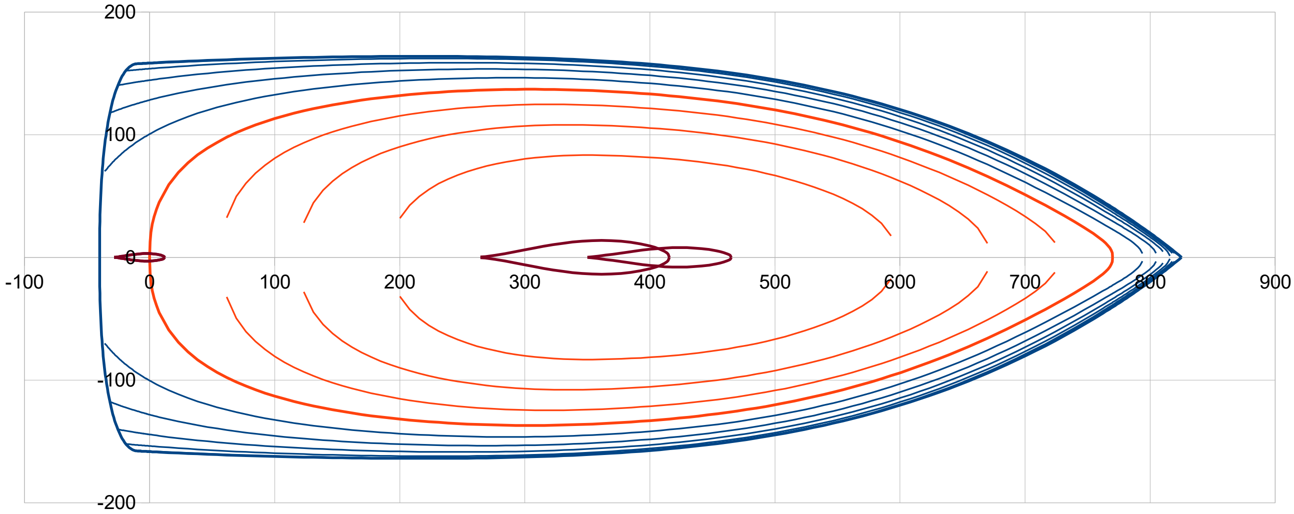
Example with Scow = 0,8 and Pui scow = 0,25



Example with Scow = 0,8 and Pui scow = 0,40



Example with Scow = 0,8 and Pui scow = 0,90 : here you can see a scow influence for the waterlines can be mixed with a pointy sheer line



Option Hard chine line

At first, the input for its definition in the vertical projection (xz plan) :

Type (Cell B39) : 0 = no hard chine ;
1 = hard chine defined by 2 heights ;
2 = hard chine defined by 3 heights ;

When Type = 1 , two data to input + the power of the polynomial :

1,2 **Zhc av (m):** height of the hard chine line at the bow **(cell B40)**

1,2 **Zhc ar (m) :** height of the hard chine line at the aft **(cell B42)**

Pui hc z : power of the polynomial defining the hard chine line, should be > 0 **(cell B43)**

(Pui hc z : < 1 >>> convex line ; = 1 >>> straight line ; > 1 >>> concav line)

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

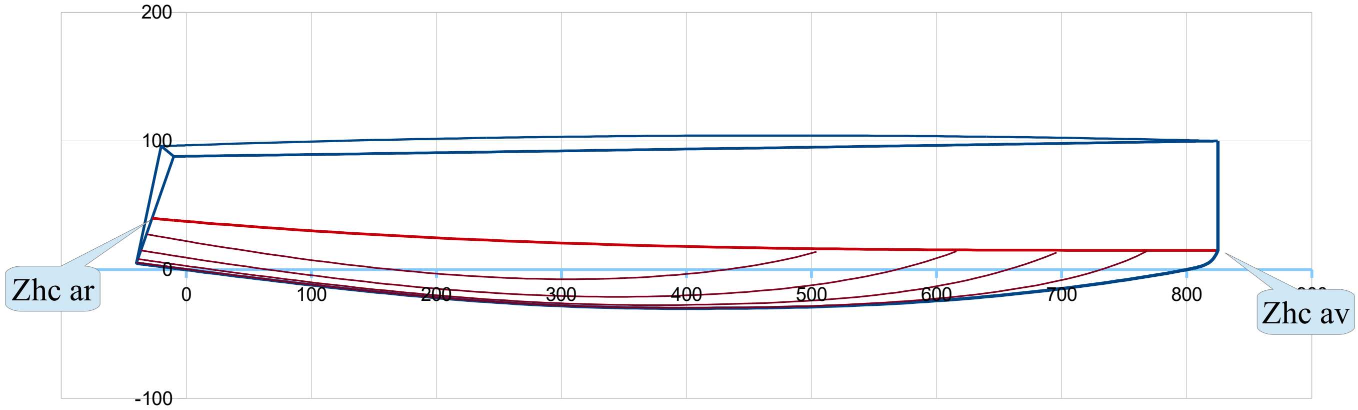
2 **Zhc m (m) :** height of the hard chine line at 35% Lwl **(cell B41)**

and **Pui hc z** has then no influence, you can leave the current value.

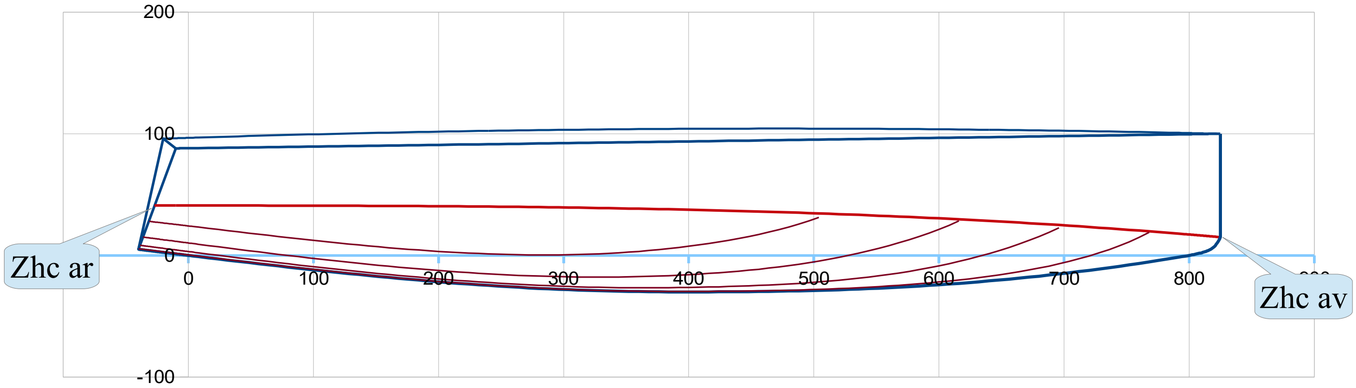
Example with Type = 1 within boat U1, to show the influence of Pui hc z :

Type	**1**
1,2 Zhc av (m)	**0,15**
2 Zhc m (m)	**0,38**
1,2 Zhc ar (m)	**0,41**
Pui hc z	**0,33**

Type 1 (2 points) with Zhc av = 0,15 m ; Zhc ar = 0,41 m and **Pui hc z = 0,33 (convex line)**



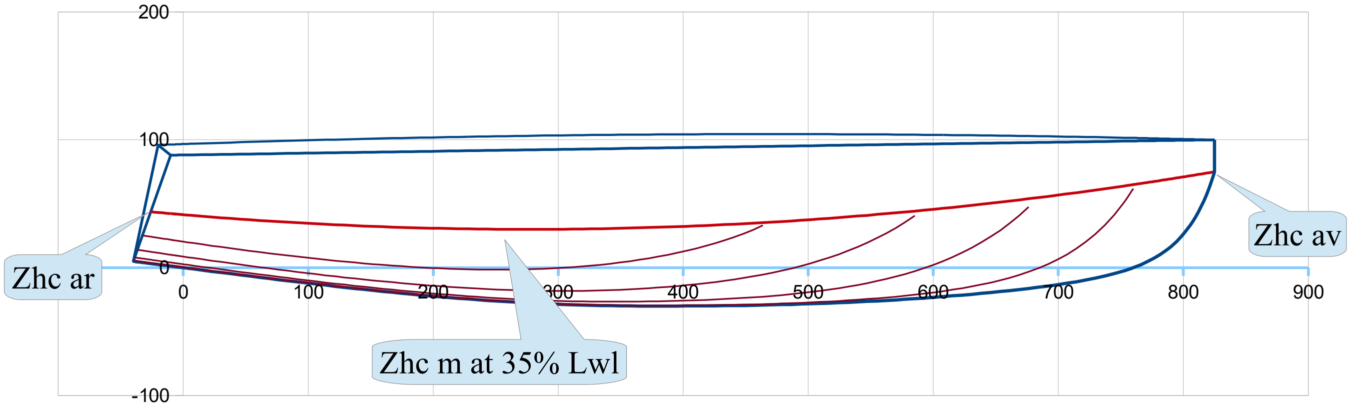
Type 1 (2 points) with Zhc av = 0,15 m ; Zhc ar = 0,41 m and **Pui hc z = 4 (concav line)**



Example with Type = 2 : the 3 points heights are used to define the line

Type	2
1,2 Zhc av (m)	0,75
2 Zhc m (m)	0,30
1,2 Zhc ar (m)	0,45

Type 2 (3 points) with Zhc av = 0,75 m ; Zhc ar = 0,30 m ; Zhc ar = 0,45 m

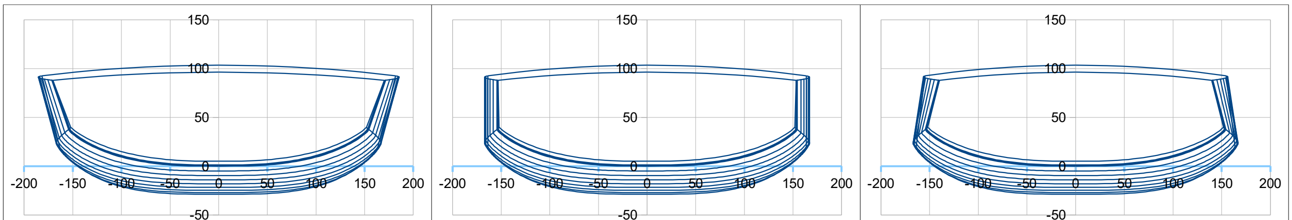


Secondly, the input for the topsides definition above the hard chine line :

The topsides can be tilted outward, or inward or maintain vertical. Two parameters are involved, **Bratio fore** and **Bratio aft**, in **cells C40** and **C42**. (*Bratio should be > 0*)

Bratio fore
1,00
Bratio aft
0,90

Bratio means the ratio of the hard chine line beam / sheer line beam, defined at fore and at aft : a linear relation relies the two values in order to set the Bratio everywhere, at any sections. Examples :



Bratio < 1 (hard chine beam smaller than the sheer beam)	Bratio = 1	Bratio > 1 (hard chine beam greater than the sheer beam)

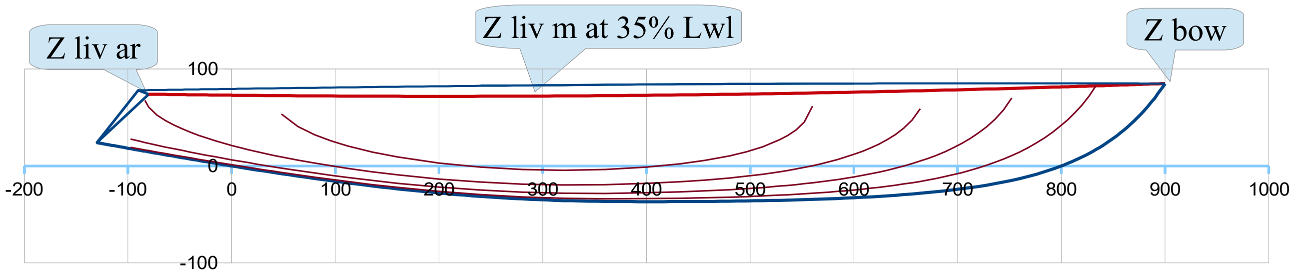
You can input a Bratio < 1 at fore and a Bratio > 1 at aft, or reversely, all combinations are possible.

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

Z liv m (m) : it is the freeboard at 35% Lwl **(cell B45)**
Z liv ar (m) : it is the aft freeboard, specified at the sheer line aft point. **(cell B46)**

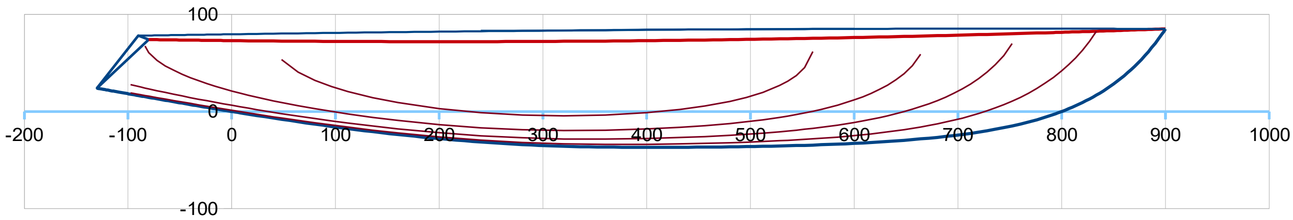
Z liv m (m)	**0,72**
Z liv ar (m)	**0,74**

Together with **Z bow** already defined here before, these are the 3 freeboards on which leans the xz polynomial for the sheer line definition.

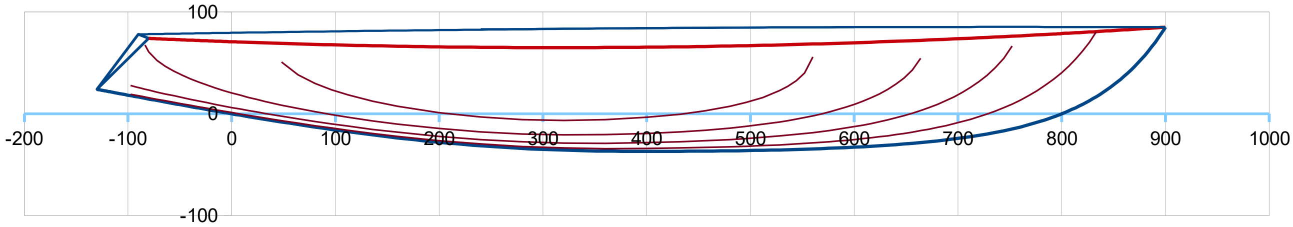


Examples :

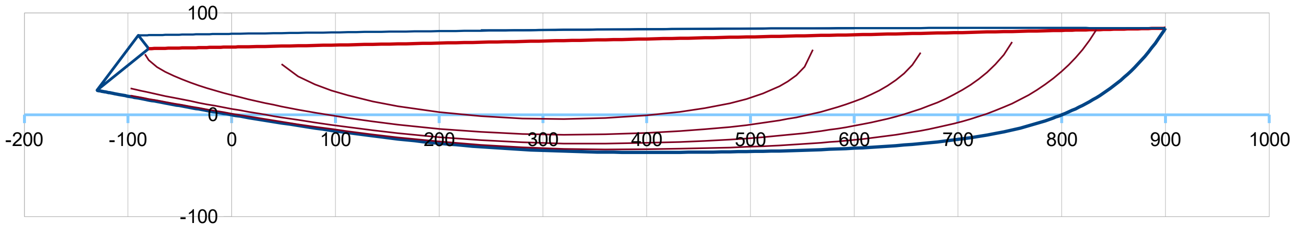
Z liv ar = 0,74 m Z liv m = 0,72 m Z bow = 0,85 m



Z liv ar = 0,74 m Z liv m = 0,65 m Z bow = 0,85 m



Z liv ar = 0,65 m Z liv m = 0,72 m Z bow = 0,85 m



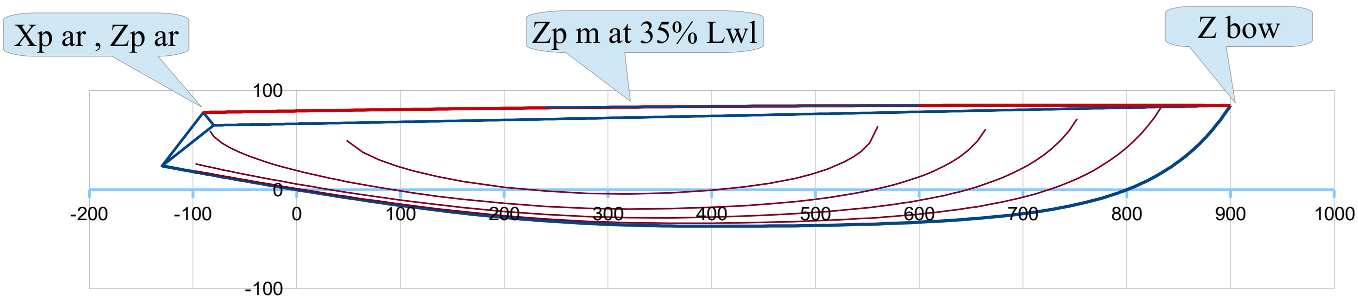
Deck / central line of symmetry

A deck surface is proposed, made of transversal circular arcs based on both the sheer line definition and a 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 (exactly at 35% Lwl) : **Zp m (m)** at X = 35% Lwl **(cell B49)**
- a point at the rear end of the deck : **Xp ar (m) , Zp ar (m)** **(cells B50 & B51)**

Z p m (m)	**0,83**
X p ar (m)	**-0,70**
Z p ar (m)	**0,78**

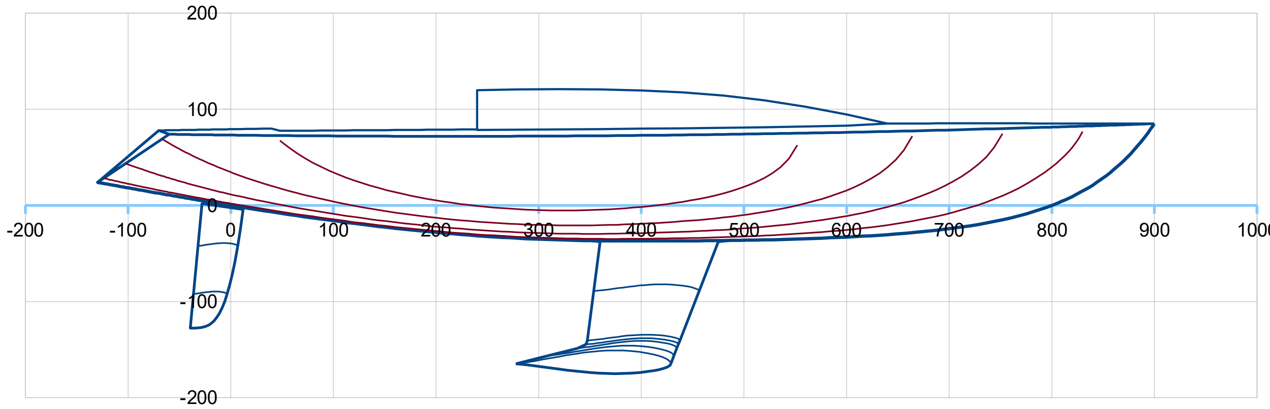
Example :



In addition, a standard roof line is proposed, just to give an idea of what can be possible and an order of magnitude of the possible headroom. From C3 to C8 stations, defined by just one parameter, **Kroof (%B) :** the height of the roof, as a % of the local beam.

Kroof (%B)	**29,0**

Example with Boat V1 and **Kroof = 29,0** >>> the possible headroom is then 145 cm, as indicated in blue in the right zone of the input data



>> Possible headroom (cm) ~ 145

Sections

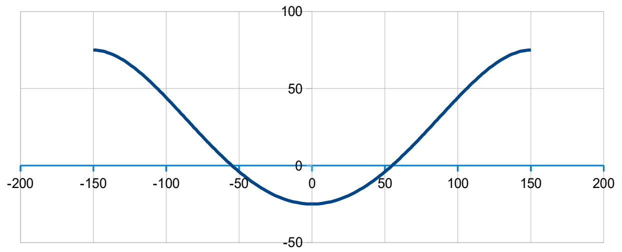
Sections are defined through the use of a generalised « E » formulation, « E » for Elliptical because it was the root of the formulation, but now this one is generalised to allow a wide variety of shape.

Three parameters **PE1**, **C PE1** and **PE2** are to be input, each at fore, mid and aft location :

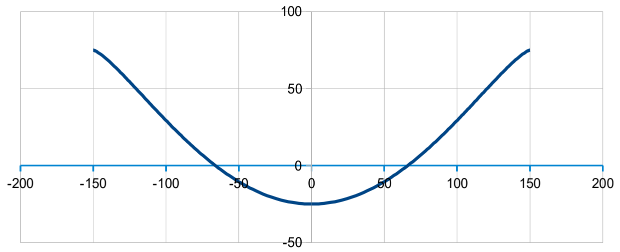
- PE1 mostly acts on the upper part of the section shape, below the sheer line
- PE2 mostly acts on the lower part of the section shape, around the keel line
- C PE1 is a fine tuning of PE1 influence :
  - C PE1 < 1 >>> tumblehome shaping of the section
  - C PE1 =1 >>> neutral value, no influence
  - C PE1 > 1 >>> this streches the top ends of the section

Some typical examples :

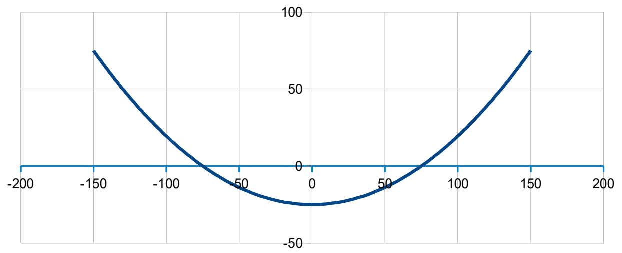
PE1 influence (examples from 0,5 to 4)



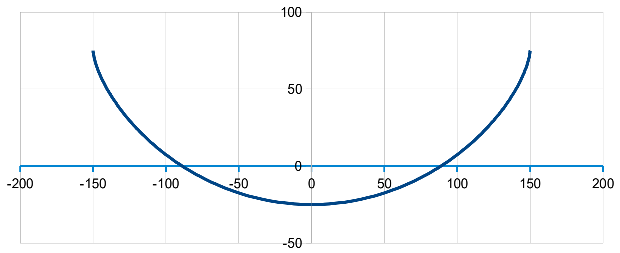
PE1 = 0,5 ; C PE1 = 1 ; PE2 = 2



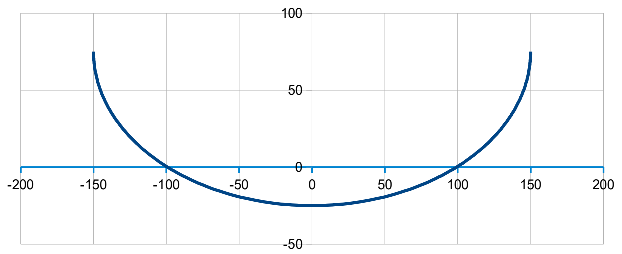
PE1 = 0,75 ; C PE1 = 1 ; PE2 = 2



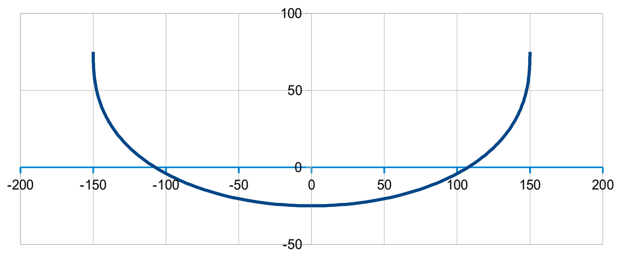
PE1 = 1,0 ; C PE1 = 1 ; PE2 = 2



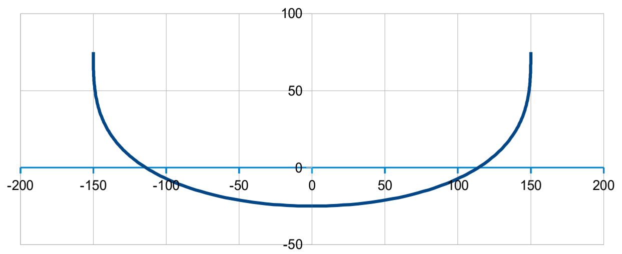
PE1 = 1,5 ; C PE1 = 1 ; PE2 = 2



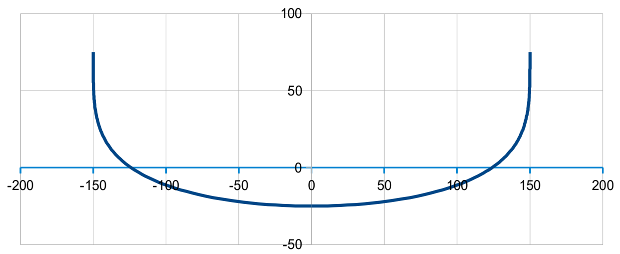
PE1 = 2 ; C PE1 = 1 ; PE2 = 2 (Ellipse case)



PE1 = 2,5 ; C PE1 = 1 ; PE2 = 2

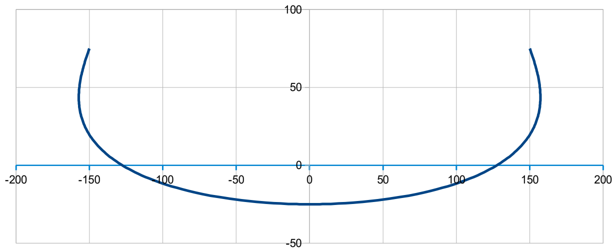


PE1 = 2 ; C PE1 = 1 ; PE2 = 2

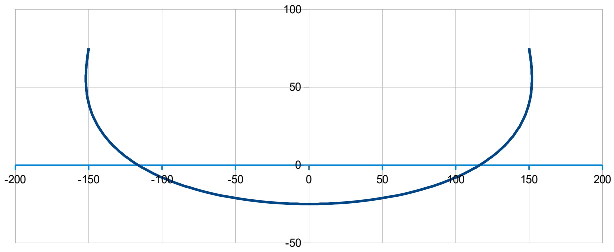


PE1 = 2 ; C PE1 = 1 ; PE2 = 2

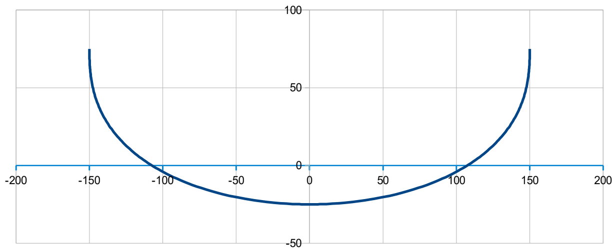
C PE1 influence examples from 0,8 to 1,3 :
(tumblehome effect when C PE1 < 1 , flare effect when CPE1 > 1)



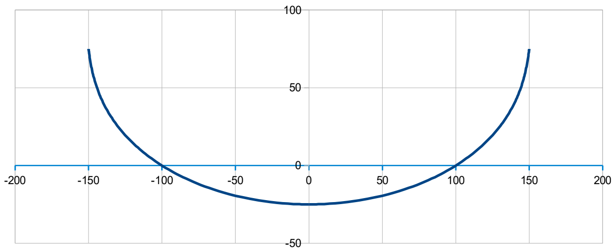
PE1 = 2,5 ; **C PE1 = 0,8** ; PE2 = 2



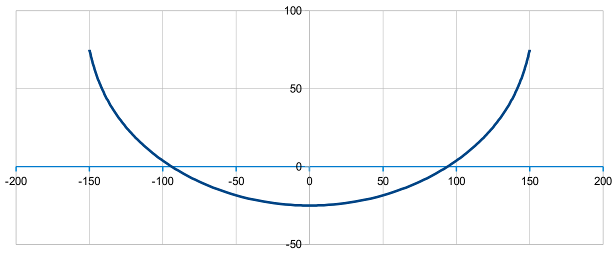
PE1 = 2,5 ; **C PE1 = 0,9** ; PE2 = 2



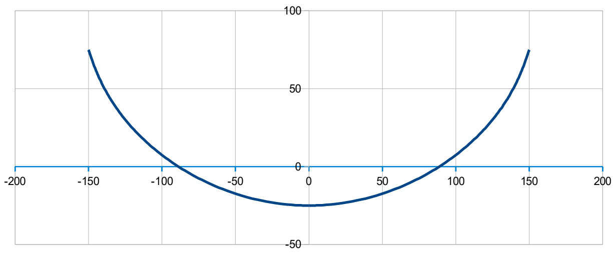
PE1 = 2,5 ; **C PE1 = 1,0** ; PE2 = 2



PE1 = 2,5 ; **C PE1 = 1,1** ; PE2 = 2

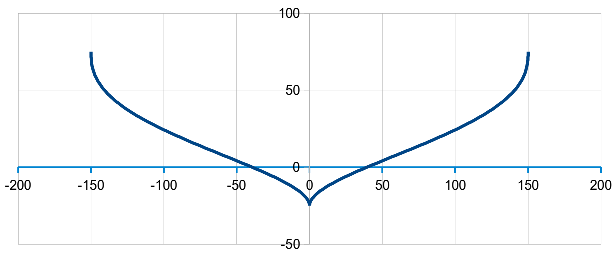


PE1 = 2,5 ; **C PE1 = 1,2** ; PE2 = 2

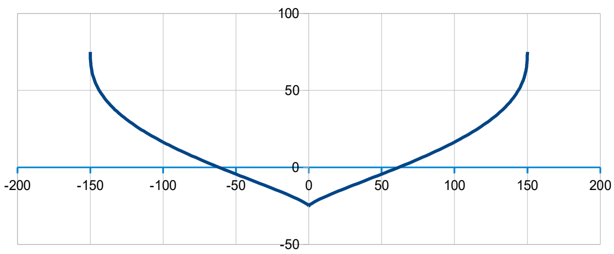


PE1 = 2,5 ; **C PE1 = 1,3** ; PE2 = 2

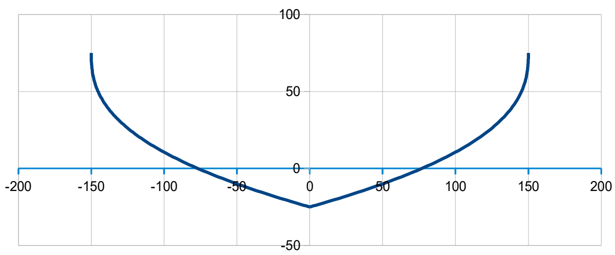
PE2 influence (examples from 0,5 to 3)



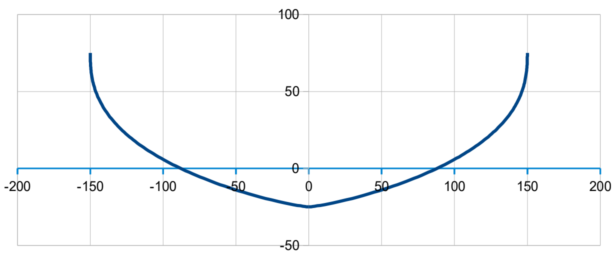
PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 0,5**



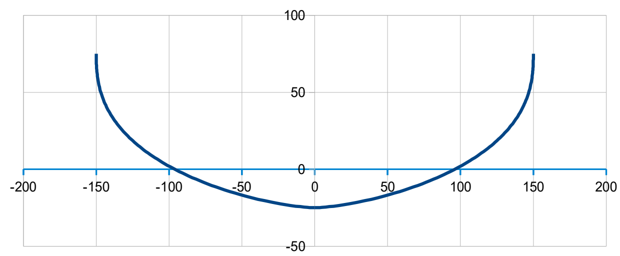
PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 0,75**



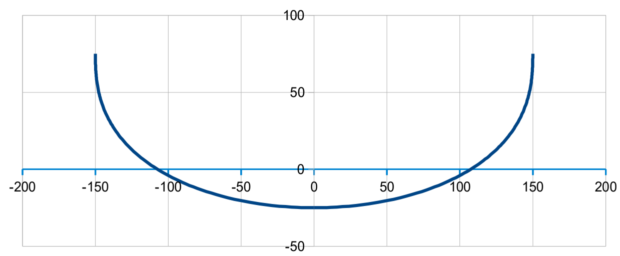
PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 1,0**



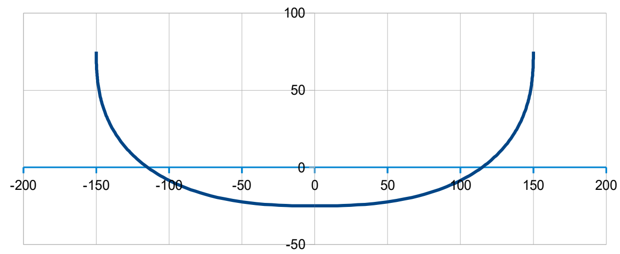
PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 1,25**



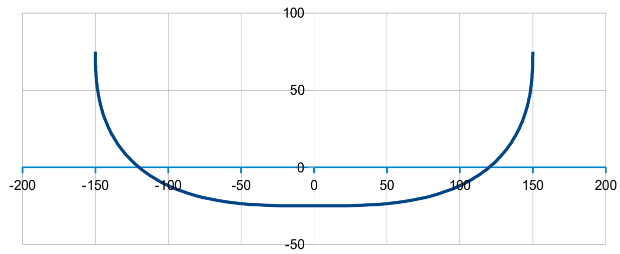
PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 1,5**



PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 2,0**



PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 2,5**



PE1 = 2,5 ; C PE1 = 1 ; **PE2 = 3**

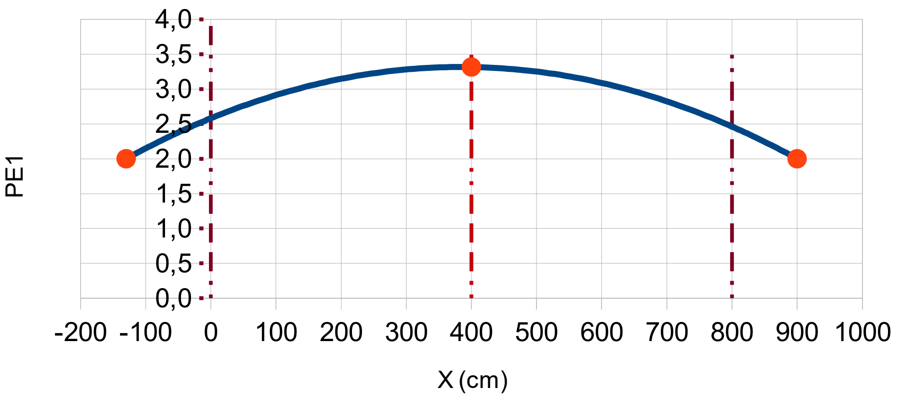
The three parameters Pui E1 , C PE1 and Pui E2 are to be input at fore, mid and aft location. Example (for V1 case) :

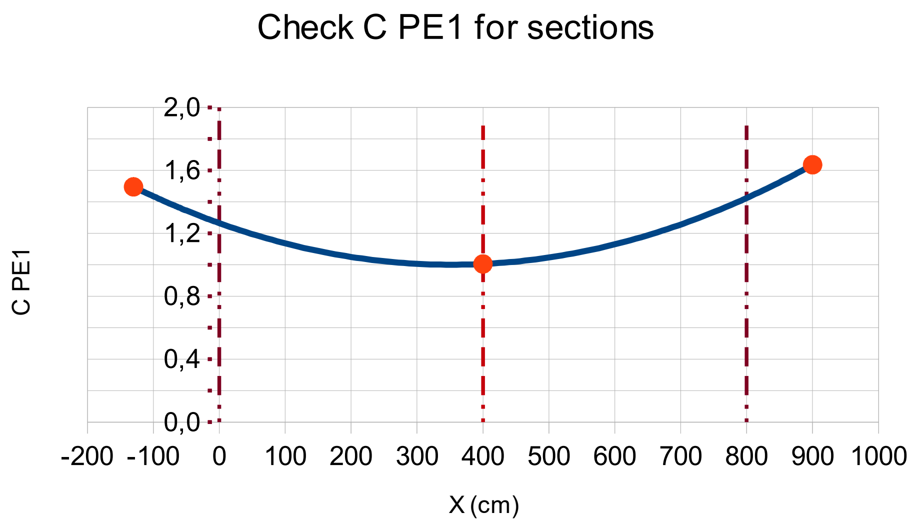
	PE1	C PE1	PE2
Fore	2,000	1,630	1,000
Mid	3,310	1,000	1,700
Aft	2,000	1,490	2,800

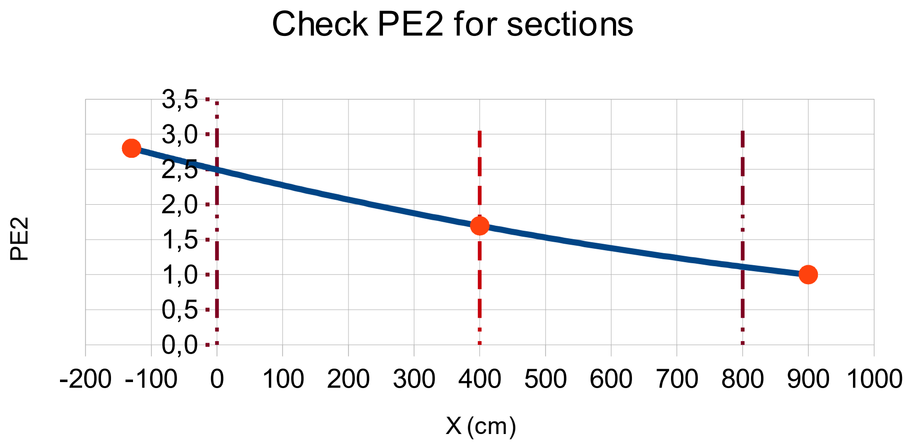
(Cells B to D , 56 to 58)

Here Fore = bow end, mid = station C5, aft = keel line aft end . Once you have enter a set of values, the system computes the values for any stations and you can check them in the Curves of control sub-section : the red points are your input values, the blue curve shows the values computed at any station, the dashed lines are for stations C0 (Aft end of Lwl), C5 (mid of Lwl) and C10 (Fore end of Lwl) :

Check PE1 for sections

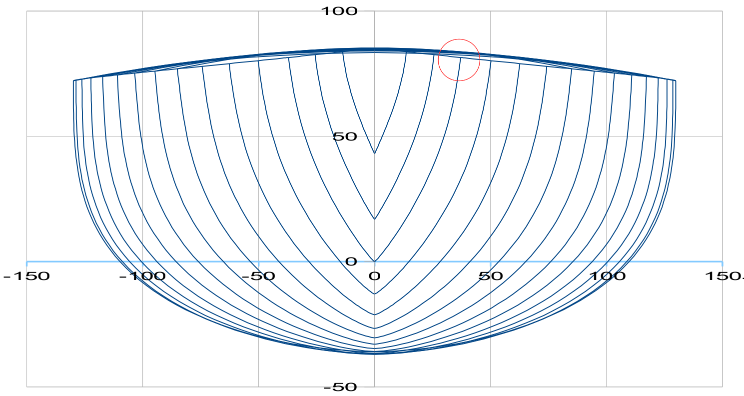


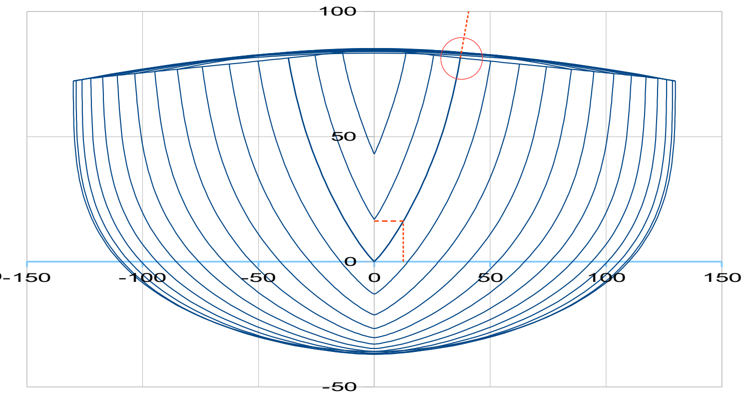




**** New for this 3.5 version :** the sections formulation was improved in order to avoid the slight closure of the section line at its highest point, especially for the fore sections, and so to have a better regular curvature from the top to the bottom of the line.

V1 fore sections with the 3.4 version >>>>>>>> V1 fore sections with the 3.5 version



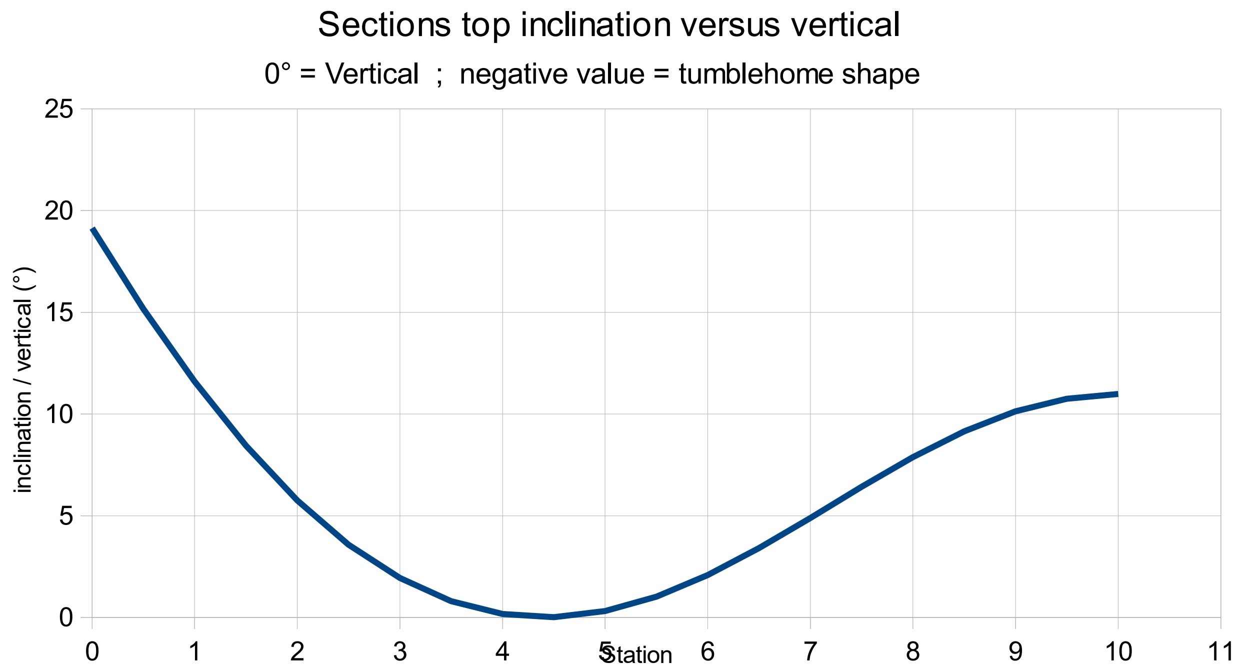


Here in this example, at C10 section (i.e. the Fore perpendicular station), the angle / vertical of the section line at its highest point is 8.1° in the 3.4 version, and now it is 11,0° in the 3.5 version.

The 3.5 version gives information on these C10 angles, both at top (at Z sheer) and at bottom (more exactly at Z = 20% of the section C10 height), it is showed in the right side of the input data :

Angle C10 at Z sheer (°)
11,0
Angle C10 at Z 20% sheer
37,6

And also , the evolution of the top angle of all sections are given in a figure further on the right (columns M to T, lines 55 to 77). Example for V1 boat :

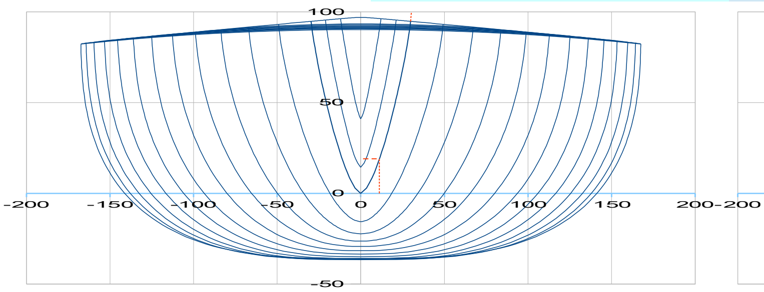


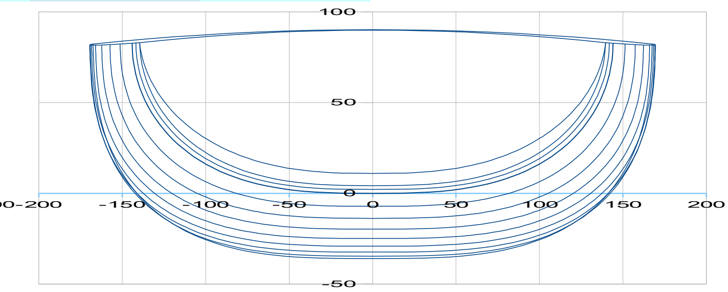
And to be complete on that subject : when you use high value of **C PE1** parameter, you may face a slight concavity at top, not always visible to the eye. So a warning is proposed **Diff angle min** : when it is positive : no problem ; if negative : some local concavity at the top of some sections lines. Example for V1 boat => 0,04 i.e. no problem :

Diff angle min (°)
0,04

Other examples : a modern U shape hull (T10 boat)

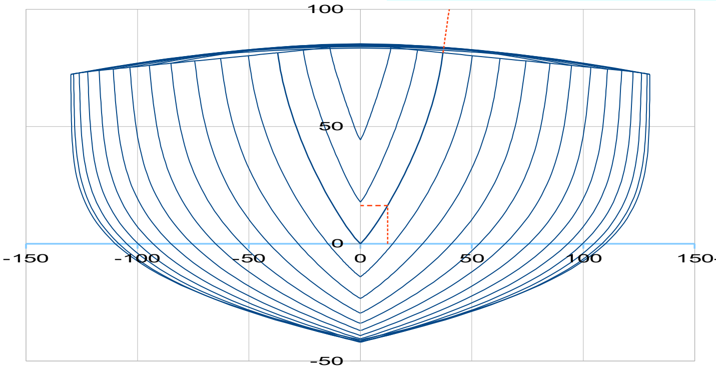
	PE1	C PE1	PE2
Fore	1,000	1,160	1,300
Mid	2,600	1,032	3,000
Aft	1,800	1,010	2,700

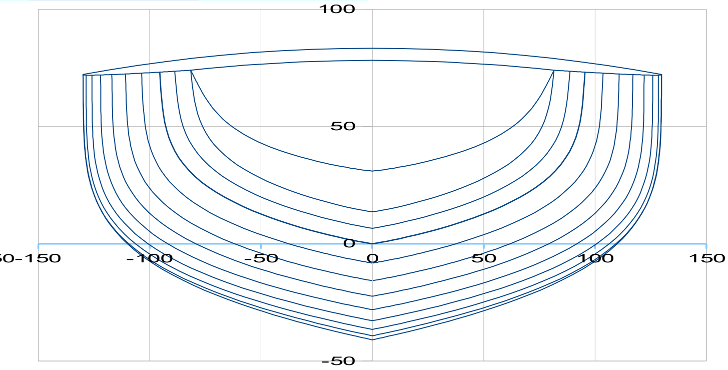




A classic V shape hull (V1,2 boat)

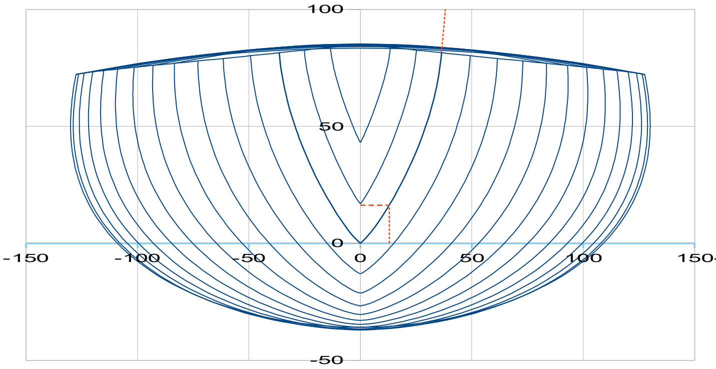
	PE1	C PE1	PE2
Fore	1,200	1,400	1,200
Mid	4,100	1,000	1,000
Aft	3,150	1,100	1,200

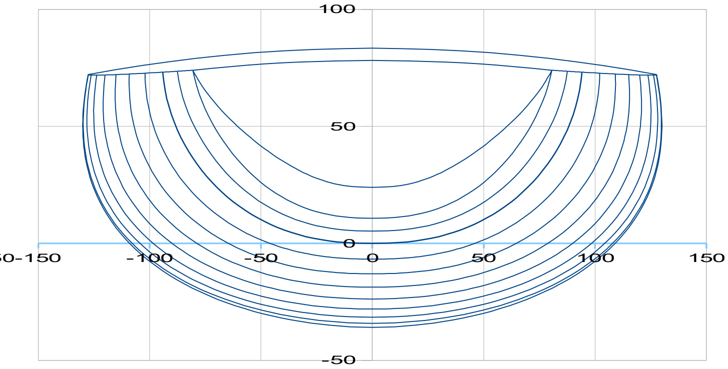




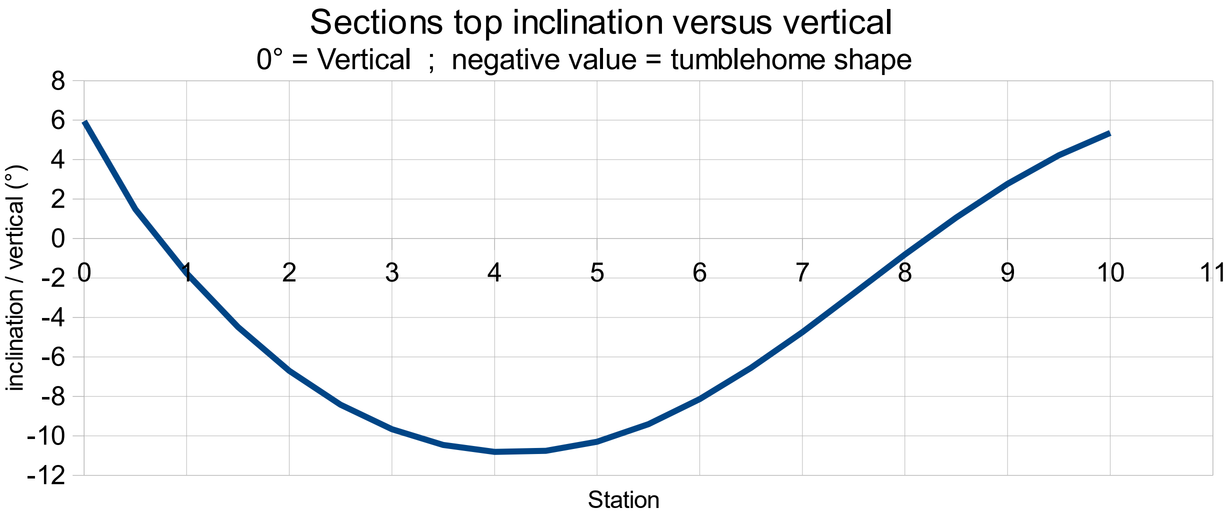
A hull with tumblehome (V1,3 boat) (to note that here C PE1 at Mid = 0,835 < 1 , which generate such shape)

	PE1	C PE1	PE2
Fore	1,750	1,350	1,000
Mid	2,250	0,835	1,800
Aft	1,750	1,250	2,500





For this case, the evolution of the sections top angle show where are the tumblehome ones, i.e. where this top angle is negative, here about C1 to C8 :



A last recommendation about the input data for the hull :

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

- The ones of hull of reference data (in place when you open the filefor the first time) are there to guide in your first steps,

- Before changing the geometrical data (i.e. the metric ones) for a new project, I recommend to the beginner to test other values of such or such adimensional parameter (inc. data given in %), including by trying a priori very low or very high values with regard the usual ones recommended, in order to better see and learn about their respective effects alone or combined, …

- This « learning by testing » process is easy and fun to do, and will help you to progress rapidly

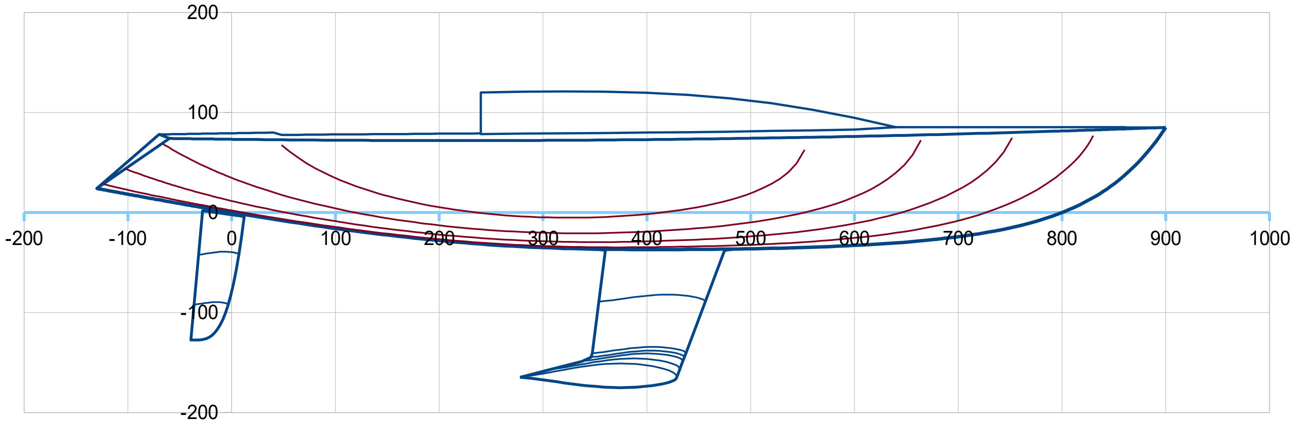
- Secondly, you can also test with some other geometrical values (more length, more beam, …) …

- And at the end, you will be able to design your own sailboat hull !

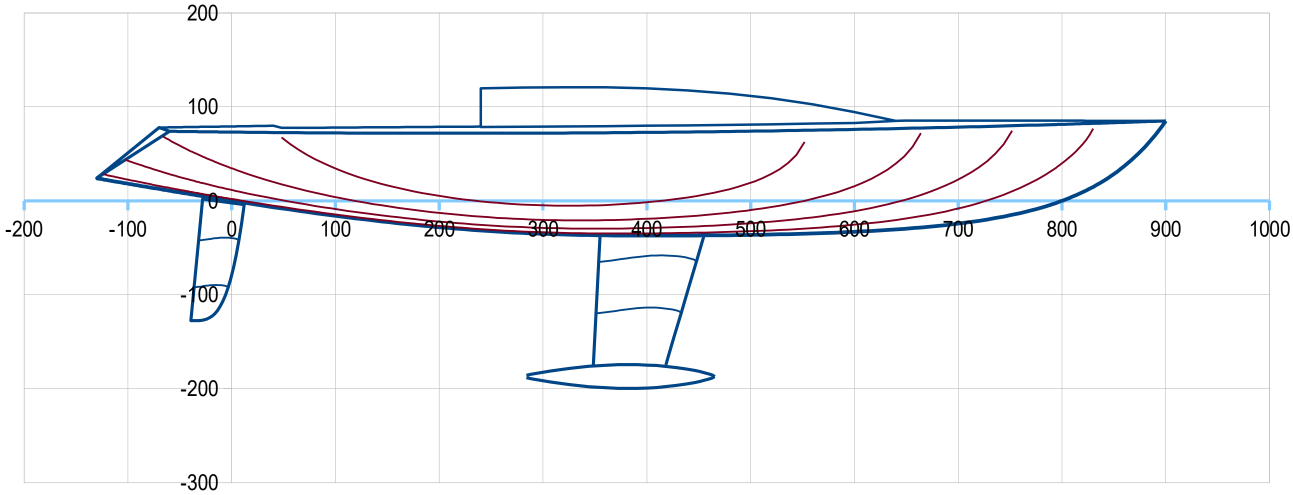
1.2 Keel data

You have the choice between 3 types of keel :

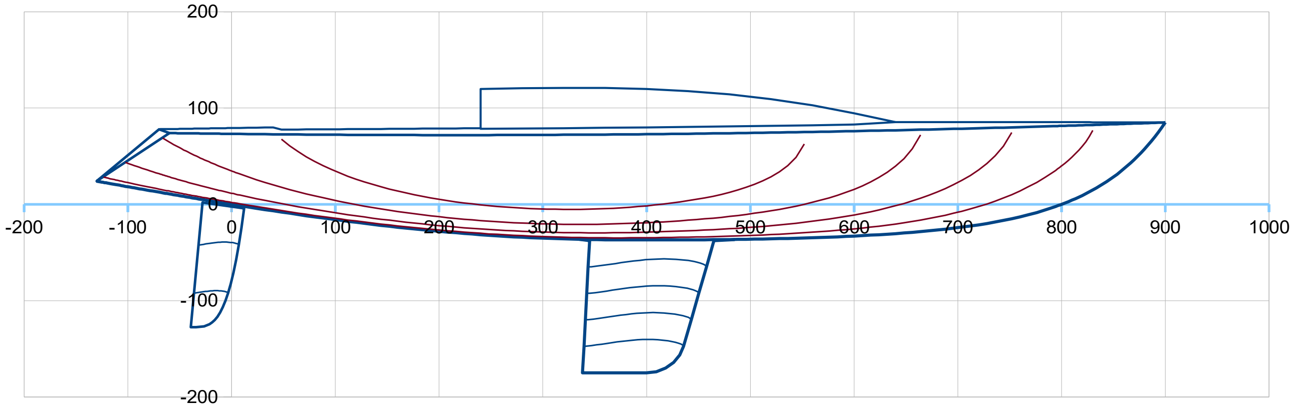
The inverted L keel :



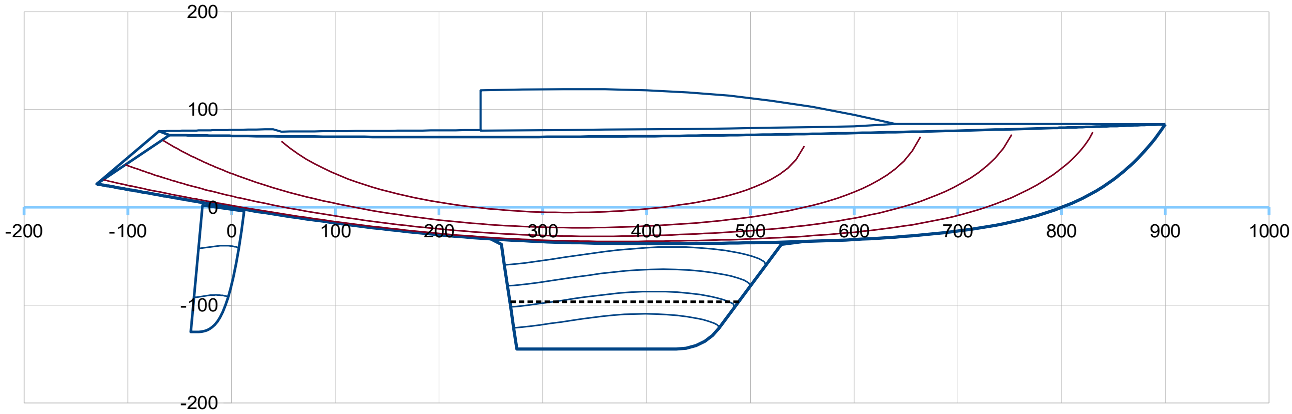
The inverted T keel :



The fin keel withouth bulb , with either a high aspect ratio :



…. or with a low aspect ratio with a low positioned ballast :



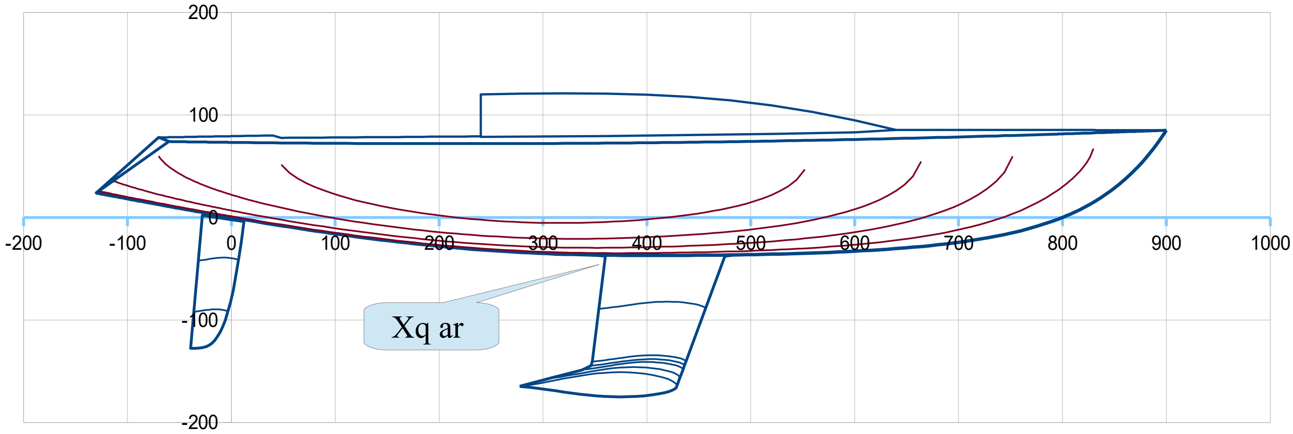
At first, you have to choose the **Type** of keel, by putting **1 for your choice and 0 for the 2 others.**

1.2 Keel	Inverted L		Inverted T		Fin keel without bulb	
Type	0		Type	1	Type	0	Put 1 for the keel profile used, 0 for the other

Input data for the « Inverted L » keel :

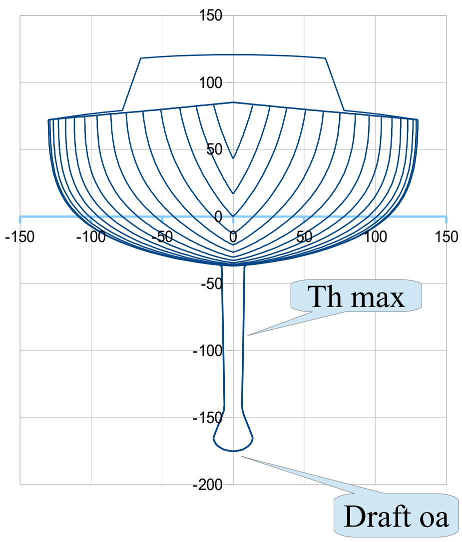
>>> Data to enter are in column B , cells B60 to B74 :

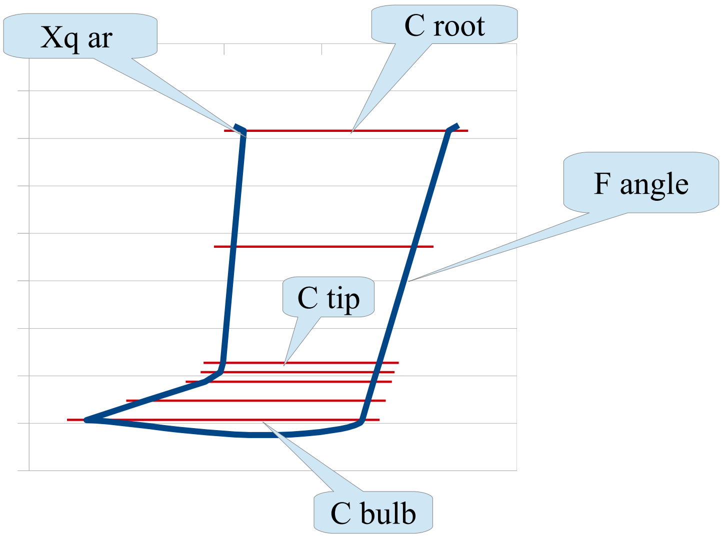
Keel data	Inverted L
Type	1
Xq ar (m)	3,60
C root (m)	1,15
C tip (m)	0,90
Th keel (%)	13,50
F angle (°)	70,00
C bulb (m)	1,55
Th bulb (cm)	27,60
Draft oa (m)	1,75
naca 00xx	0
naca 63-0xx	1
naca 65-0xx	0
Density Wing	7,30
Density Bulb	7,30



Data to enter include the definition of the longitudinal profile and of the Naca profiles of the various horizontal sections :

Xq ar (m) : X of the root profile rear point
C root (m) : chord of the root profile
C tip (m) : chord of the tip profile before enlargement for the bulb
Th max (%) : Maximum thickness of the profiles, in % of the chord
F angle (°) : leading edge angle / horizontal, usually between 45° and 90°
C bulb (m) : lenght of the bulb profile
Th bulb (cm) : Maximum thickness of the bulb, in cm
Draft oa (m) : draft overall

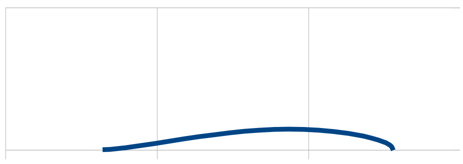




Type of Naca profile : put 1 for the selected profile, 0 for the 2 others

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

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



Nota : Profiles are calculated and drawn with a cut-off at 97,5% chord so to avoid trailing edges too tapered and unfeasible. Chords Croot, Ctip and C bulb here above are the real lenghts taking into account the cut-off, computed chord c being C/0,975.

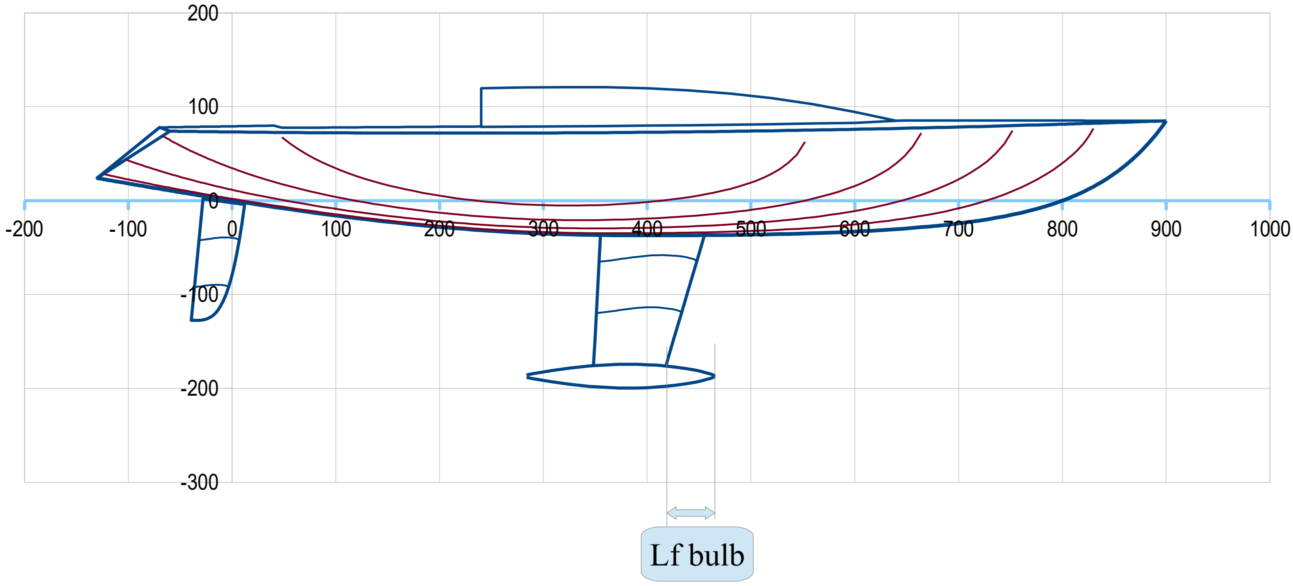
Density keel : wing part of the keel, from C root to C tip **(cell B73)**

Density bulb : Bulb part, below C tip level. **(cell B74)**
Examples : Font 7,3 ; Steel 7,85 ; Lead 11,35, …

Input data for the Inverted T keel :

>>> Data to enter are in column B , cells B60 to B74 :

	Inverted T
Type	1
Xq ar (m)	3,55
C root (m)	1,00
C tip (m)	0,70
Th keel (%)	14,65
F angle (°)	75,00
C bulb (m)	1,815
Th bulb(cm)	26,00
Lf bulb(m)	0,47
Draft oa (m)	2,00
naca 00xx	0
naca 63-0xx	1
naca 65-0xx	0
DensityWing	7,30
Density Bulb	7,30



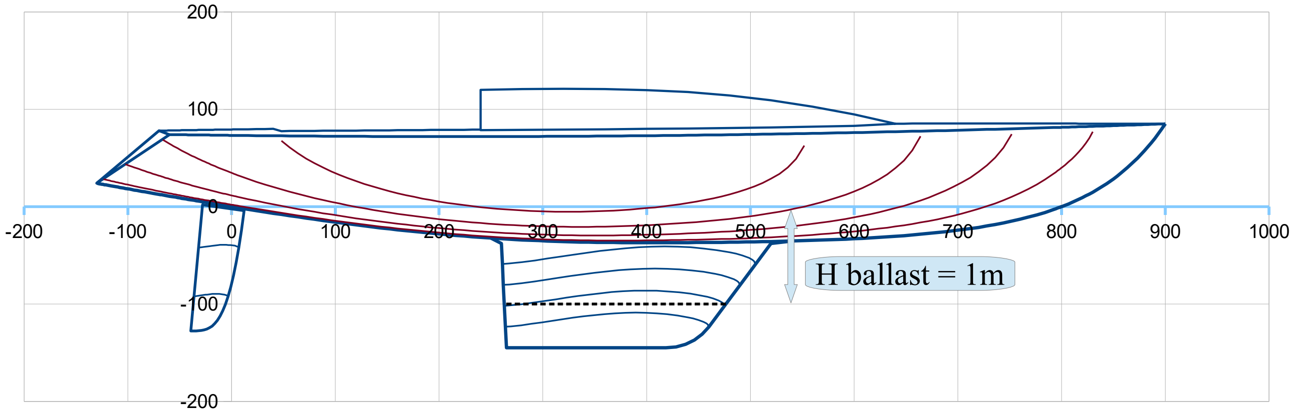
The input data definitions for the inverted T keel are similar to the inverted L keel ones (see here above), with an aditionnal data :

the length **Lf bulb (m)** = from bulb fore end to tip chord fore end of the keel wing

Input data for the fin keel without bulb :

>>> Data to enter are in column B , cells B60 to B74 :

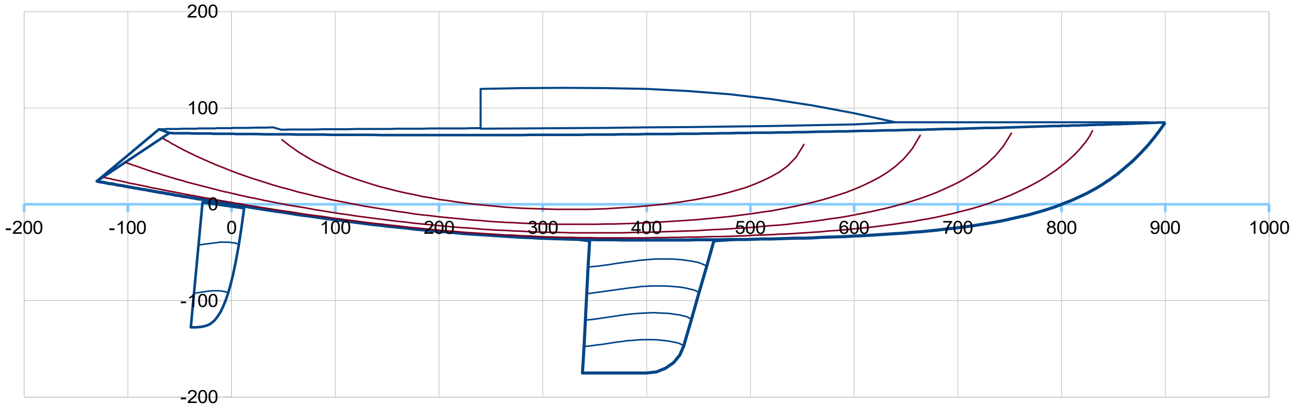
	Without bulb
	1
Xq ar (m)	2,60
C root (m)	2,60
C tip (m)	1,80
Th keel (%)	14,65
F angle (°)	55,00
H ballast (m)	1,0000
Draft oa (m)	1,45
naca 00xx	0
naca 63-0xx	1
naca 65-0xx	0
D Ballast	11,35



The input data definitions for the fin keel are similar to the inverted L keel ones (see here above), with an aditionnal data :

H ballast (m) = depth of the ballast top surface / water surface, especially necessary when it is a low aspect ratio keel wing, showed by a dashed line. All the keel volume under H is considered the ballast at the density « **D ballast** »

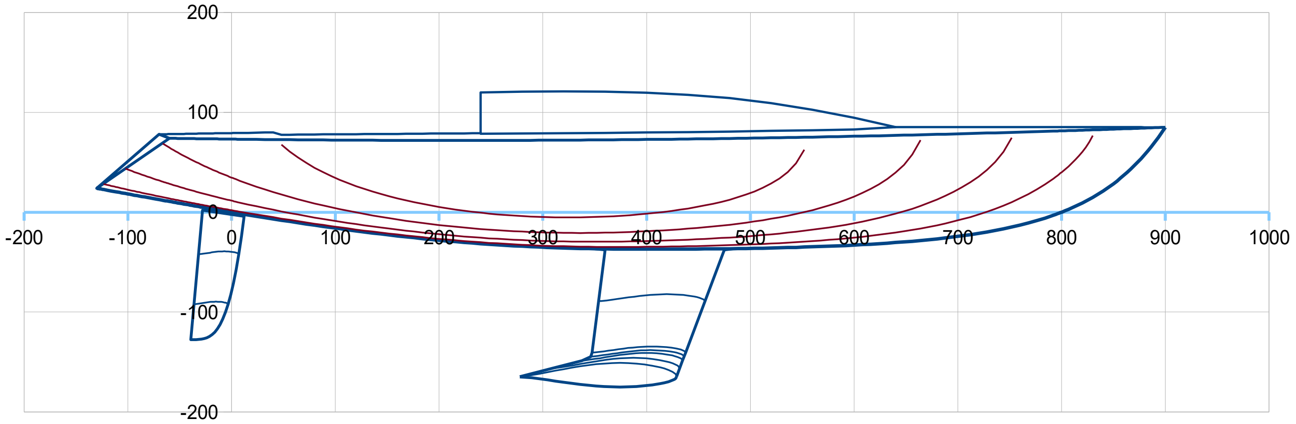
In case of high aspect ratio and when the fin keel is fully made of the same material at density « D ballast », just input **H ballast = 0**, and the dashed line no longer appears on the drawing :



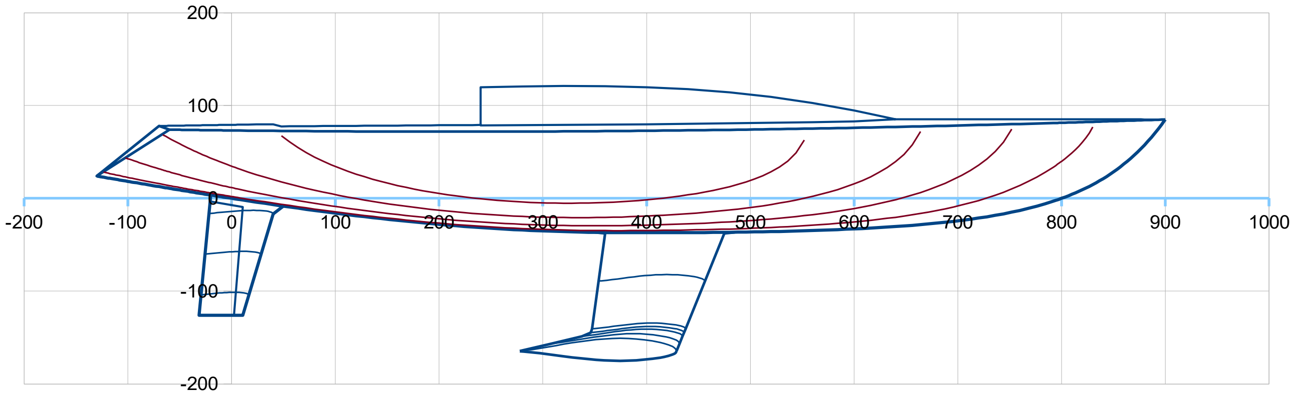
1.3 Rudder data

You have the choice between 2 types of rudder :

Suspended



With skeg

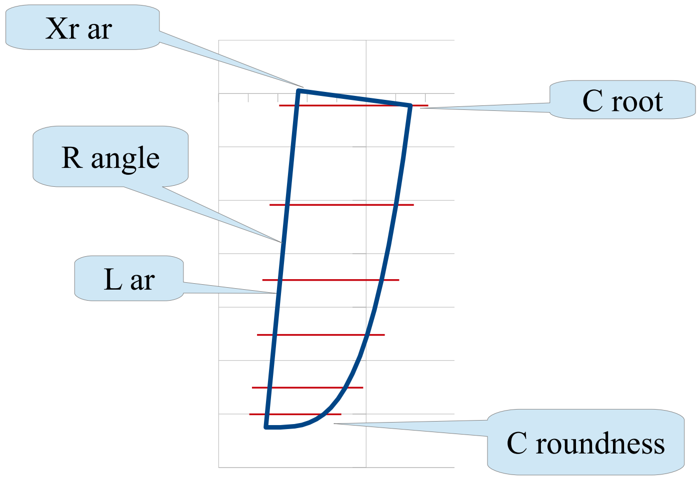


Input data for the suspended rudder :

>>> Data to enter are in column B , cells B76 to B88 :

Rudder data	Suspended
Type	1
Xr ar (m)	-0,28
C root (m)	0,40
t/c (%)	15,00
R angle (°)	85,00
L ar (m)	1,30
C roundness	3,50
naca 00xx	0
naca 63-0xx	1
naca 65-0xx	0
Nb of rudders	1
Offset y (m)	0,00
Angle (°)	0,0

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.

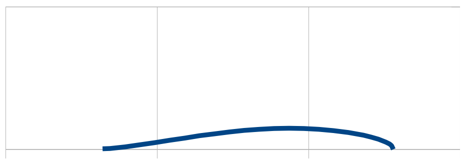


Xr ar (m) : X of the rear upper point
C root (m) : chord of the upper profile
t/c (%) : relative thickness of the horizontal Naca profiles, constant for the rudder.
R angle (°) : trailing edge / horizontal, usually between 75° to 85°
L ar (m) : trailing edge length
C roudness : roundness coefficient of the mlower part of the rudder, usually 2,5 to 5,5

Type de profil Naca : put 1 for the selected profile, 0 for the two others

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

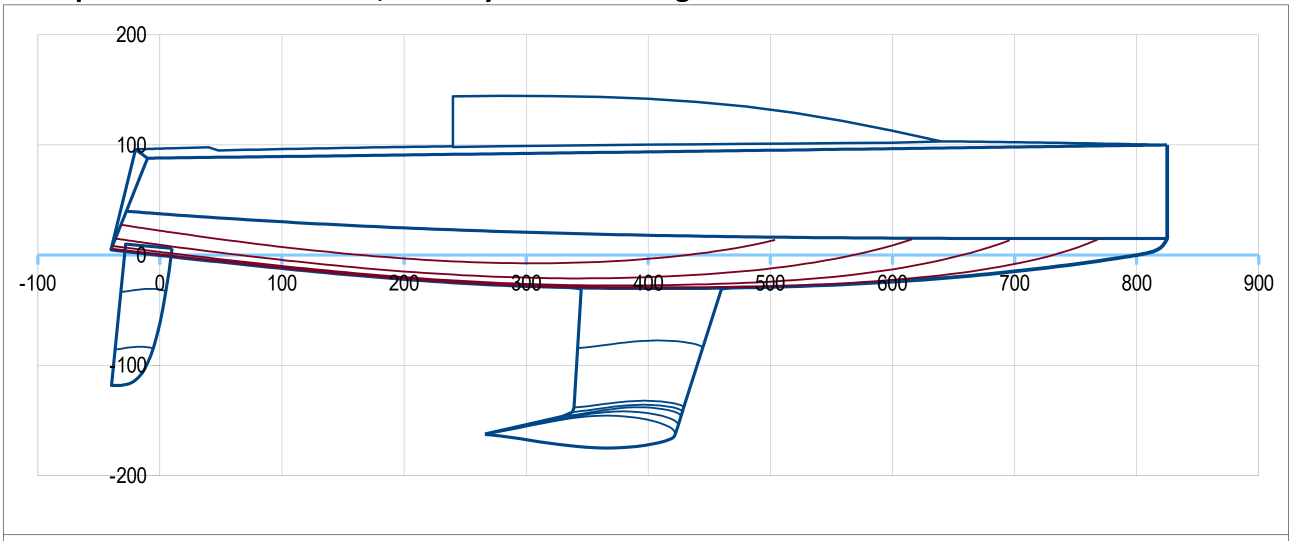
Ex : Profil Naca 63-0xx with Th max at 35% c >>>

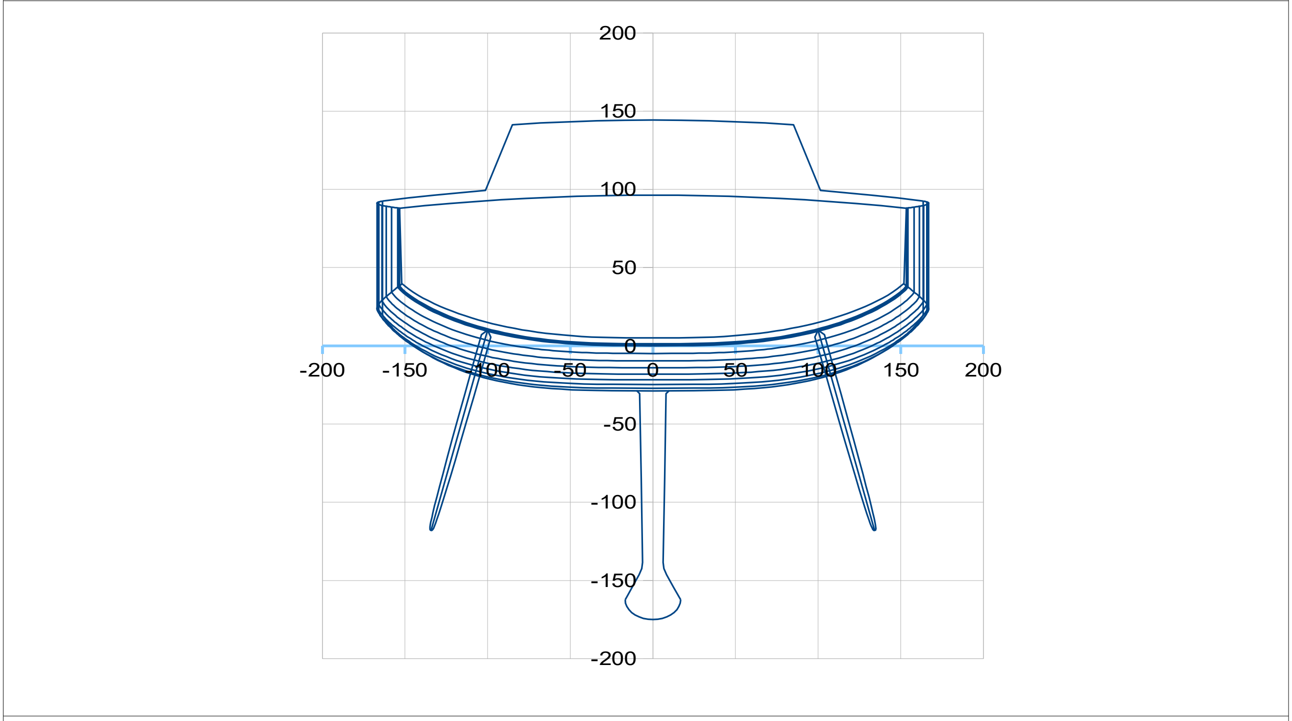


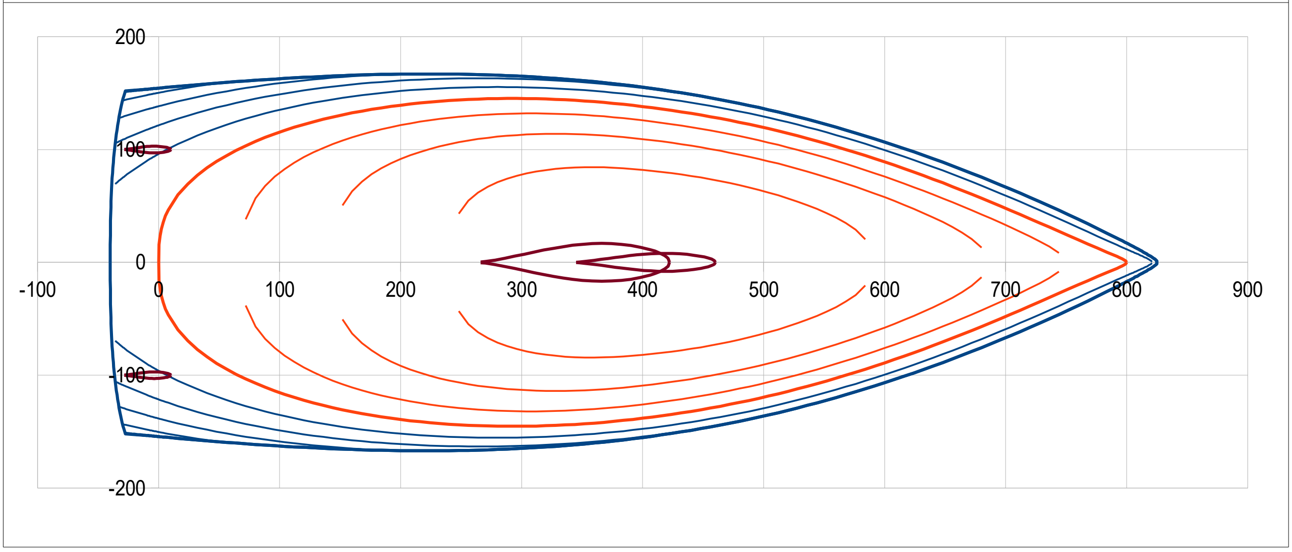
Nota : Profiles are calculated and drawn with a cut-off at 97,5% chord so to avoid trailing edges too tapered and unfeasible. Computed chord c are equal to C/0,975, C being the geometrical chords.

Possibilty to have or twin rudders :
Nb of rudders : Number of rudders, 1 ou 2
Offset y (m) : when Nb = 2, y offset of each rudder axis / ship axis (put 0 when Nb = 1)
Angle (°) : when Nb = 2, angle / vertical of each rudder (put 0 when Nb = 1)

Example with Nb =2 rudders, Offset y = 1 m and angle = 15°







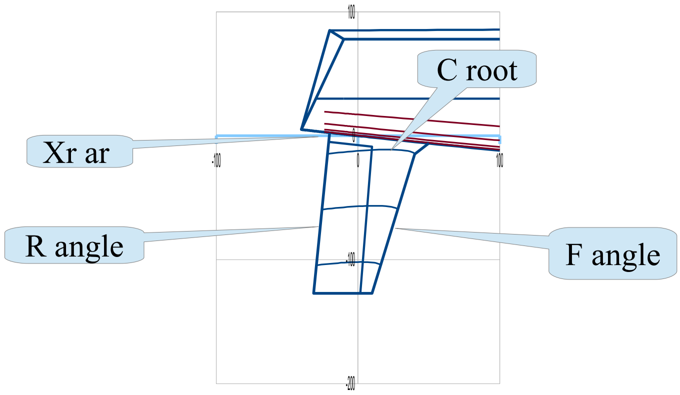
Input data for the rudder with skeg :

>>> Data to enter are in column B , cells B86 to B95 :

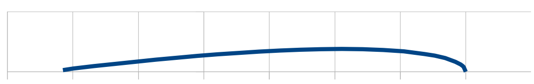
	With skeg
	1
Xr ar (m)	-0,20
C root (m)	0,60
t/c (%)	12,00
R angle (°)	85,00
L ar (m)	1,30
F angle (°)	75,00
naca 00xx	1
naca 63-0xx	0
naca 65-0xx	0

Xr ar (m) : X of the rear upper point
C root (m) : chord horizontal length of the upper profile (inc. rudder + skeg)
t/c (%) : relative thickness of the horizontal Naca profiles, constant for the rudder.
R angle (°) : angle of the trailing edge / horizontal, usually around 85°
L ar (m) : trailing edge length
F angle (°) : angle of the fore edge / horizontal, usually around 75

Type de profil Naca : put 1 for the selected profile, 0 for the two others



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

Example : Profil Naca 00xx with Th max at 30% c >>>	

Nota : Profiles are calculated and drawn with a cut-off at 97,5% chord 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 sheet called **« Hulls storage »** where you can store by copy/paste the input data for your various projects, including your variants of a hull during the iteration process. All the hulls given as examples (detailed in the Examples document) are stored here too. Recommendations for the storage and examples are given at the end of this document.

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. Any modification of one input value leads in real time to an updated version of the hull (drawings and ouput computations).

These output are divided into sections 2 to 5, the User should act in some of them for either just change and fix the scale of the views or to introduce some complementary data for specific study (loading, equilibrium and righting moment with heel, etc …)

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

These hydrostatics data and results are automatically produced for the sailboat displacement at design waterline, no need of intervention by the User.

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

- Bare hull displacement and its Longitudinal Center of Buoyancy LCB
- Prismatic coefficient of the bare hull Cp
- Waterplane area Sf and its longitudinal center Xf
- Wetted surfaces of the bare hull, the keel, the rudder
- Displacements of the keel and of the rudder, their X,Z center of buoyancy
- For the sailboat as a whole (hull + keel + rudder(s)) :
  >>> Displacement and buoyancy position
  >>> Ballast ratio
  >>> Displacement length ratio DLR, as defined with US units
  >>> Wetted surface and ratio Sw / D^(2/3) for hull + keel + rudder.

… + the curve of the bare hull sections areas

… + to contribute to the mass balance data (these data are also automatically reported to the mass spreadsheet) :

- Shull (surface of the hull) , its center of gravity position X,Z
- Sdeck (surface of the deck inc. the roof if any), its center of gravity position X,Z
- Keel weight and position of the center of gravity X,Z

...+ Longitudinal Center of Resistance LCR (according to Larsson-Eliasson method for fin keel). This data is also automatically reported to the sailplan sheet for the computation of the « Lead ».

…+ on the last line, the recopy of the data coming from the mass spreadsheet : boat light weight and CoG location, allowing the direct comparison of Displacement / Weight and LCB / Xg.

Example (V1 case) :

2. Data sum-up and results of hydrostatic and surfaces calculations															
2.1 Hull															
Loa (m)	**10,30**			**Lwl (m)**	**8,00**					> Hull speed (Knots)	6,89		at Froude 0,4		
>> ft	*33,79*				*26,25*										
Boa (m)	**2,60**			**at X (% Lwl)**	**38,0**		Bsheer (m)		2,60			at X (% Lwl)	38,0		
>> ft	*8,53*														
Bwl (m)	**2,19**			**at X (% Lwl)**	**40,0**		> Bwl / Boa		0,844						
>> ft	*7,20*									**Freeboards (m) >**	**Aft**		**Midship**		**Fore**
Tc (m)	**0,370**			**at X (%Lwl)**	**50**						**0,74**		**0,72**		**0,85**
>> ft	*1,21*									*>> ft*	*2,43*		*2,36*		*2,79*
		Displacement at H0 (m3)	**2,44334**			**at LCB (m)**	**3,765**			**LCB (%Lwl)**	**47,06**			**ZCB (m)**	**-0,130**
		>> lbs	*5521*			*w. seawater*	*1025*		*kg/m3*					*>> ft*	*-0,43*
Cp	**0,545**														
Sf (m2)	**11,85**			**at LCF (m)**	**3,586**			**LCF (%Lwl)**	**44,83**					>>> LCB – LCF (%Lwl)	2,23
>> ft2	*127,51*			*>> ft*	*11,77*										
Angle Freeboard/Half beam			29,1			(°), at section C4 (40% Lwl)						**Half entry angle (°)**	**18,6**		**at 95% Lwl**
Sw (m2)	**12,80**			>Sw/D^(2/3)	7,06										
>> ft2	*137,82*														
Shull (m2)	**29,47**			**at X (m)**	**3,636**			**Z (m)**	**0,093**						
>> ft2	*317,20*			*>> ft*	*11,93*			*>> ft*	*0,30*						
Sdeck (m2)	**20,09**			**at X (m)**	**3,511**			**Z (m)**	**0,79**						
>> ft2	*216,21*			*>> ft*	*11,52*			*>> ft*	*2,59*						
2.2 Keel															
Vol. keel(m3)	**0,14938**			**at X (m)**	**4,019**			**X (%Lwl)**	**50,23**			**Z (m)**	**-1,098**		
				>> ft	*13,18*							*>> ft*	*-3,60*		
Ballast (kg)	**1090,5**			**at X (m)**	**4,019**			**X (%Lwl)**	**50,23**			**Z (m)**	**-1,098**		
>> lbs	*2404*			*>> ft*	*13,18*							*>> ft*	*-3,60*		
Draft oa (m)	**1,75**					**Sw (m2)**	**3,66**					**Sxz (m2)**	**1,36**		
>> ft	*5,74*					*>> ft2*	*39,45*					*>> ft2*	*14,61*		
CLR (m)	**4,34**			**CLR (%Lwl)**	**54,23**		*CLR = Center of Lateral Resistance*								
>> ft	*14,23*			method: keel profile extended to the waterline, CLR at Z 45% draft and									25,00		% chord
2.3 Rudder(s)															
Number	**1**														
Volume (m3)	**0,01486**			**at X (m)**	**-0,12**			**X (%Lwl)**	**-1,47**			**Z (m)**	**-0,54**		
Sw (m2)	**0,91**			*>> ft*	*-0,39*							**Sxz (m2)**	**0,44**		per rudder
>> ft2	*9,80*											*>> ft2*	*4,71*		
2.4 Hull + Keel + Rudder(s)															
		Displacement at H0 (m3)	**2,60757**			**at LCB (m)**	**3,757**			**LCB (%Lwl)**	**46,96**			**at ZCB (m)**	**-0,188**
		(kg)	**2673**			*>> ft*	*12,33*							*>> ft*	*-0,62*
		>> lbs	*5892*												
		, of wich Ballast (kg)	**1090**			**at Xg (m)**	**4,019**			**Xg (%Lwl)**	**50,23**			**at Zg (m)**	**-1,098**
		>> lbs	*2404*			*>> ft*	*13,18*							*>> ft*	*-3,60*
		>> % Ballast	40,8												
		Sw (m2)	**17,38**			>Sw/D^(2/3)	9,17			Lwl/D^(1/3)	5,81				
		>> ft2	*187,07*							***DLR***	***145***		*M(lbs/2240)/(Lwl(ft)/100)^3*		
2.5 Data from the mass spreadsheet															
Light boat:		**M (kg)**	**2673**			**at Xg (m)**	**3,782**			**Xg (%Lwl)**	**47,28**			**at Zg (m)**	**-0,078**

Hull design data and mass spreadsheet data (see here after) should be adjusted so that Displacement (kg) = M (kg), and Xc (center of buoyancy, m) equal or close to Xg (center of gravity, m). Here, the displacement 2673 kg equals the light boat weight 2673 kg, and Xg 3,782 m is close to LCB 3,757 m.

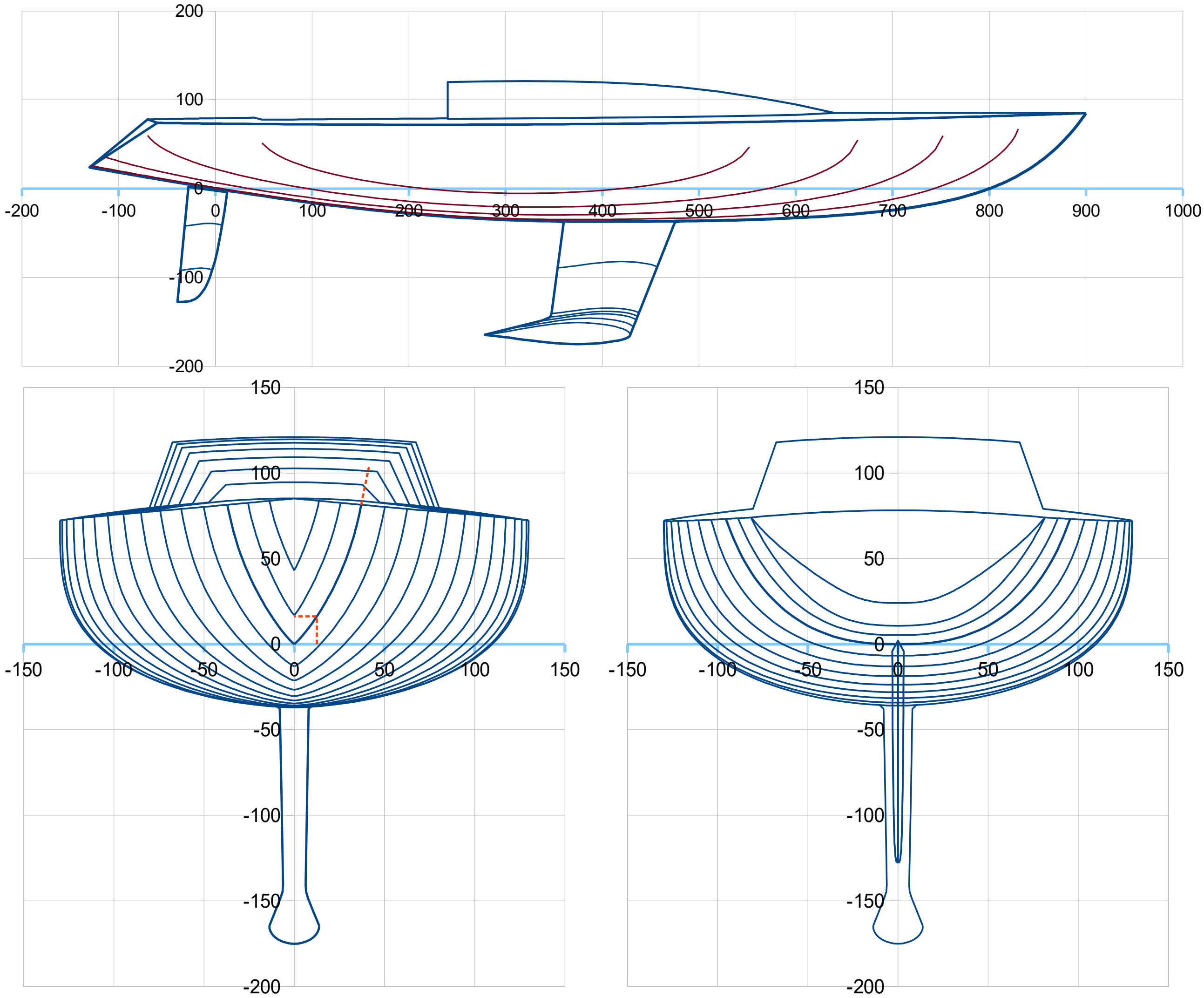
3. The 3 views 2D + a perspective

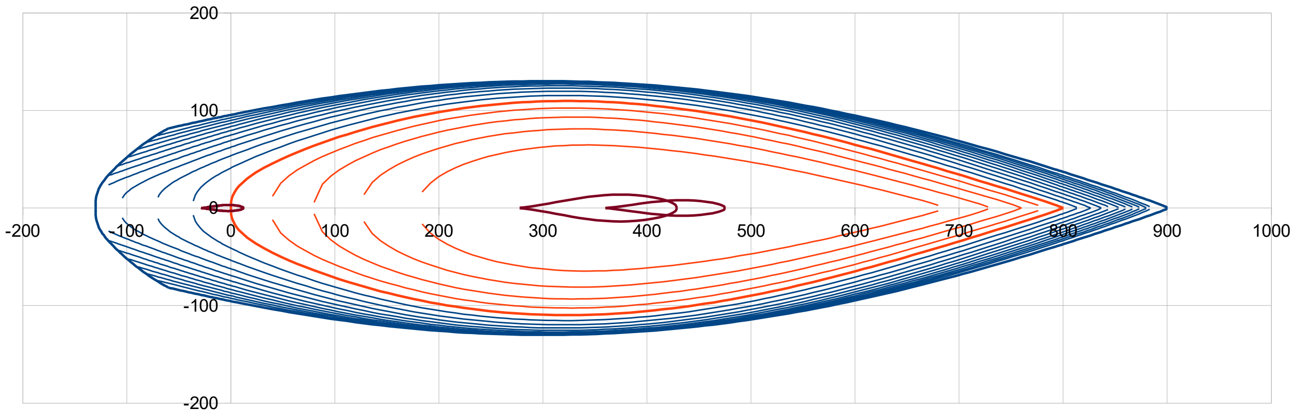
The views are automatically redrawn after every input data modification.

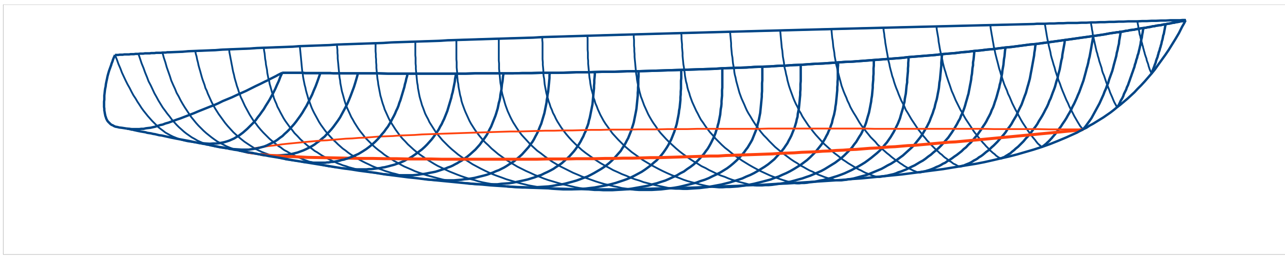
View of the front sections include sections ≥ C4 (= 40% Lwl), with a half section pitch : C4, C4,5, C5, ..., C10 (Fore perpendicular station) + 2 complementary sections Cav1 and Cav2 at respectively 1/3 and 2/3 of the bow overhang.
View of the rear sections includes sections ≤ C4, with a half section pitch : C4, C3,5, C3, C2,5, ... , C0 (Aft perpendicular station) + 2 complementary sections Car1 and Car2, 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 p 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 set automatically, with 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 in order to have the orthonormal views (i.e. square grids). Example (V1 boat) :







4. Curves of control

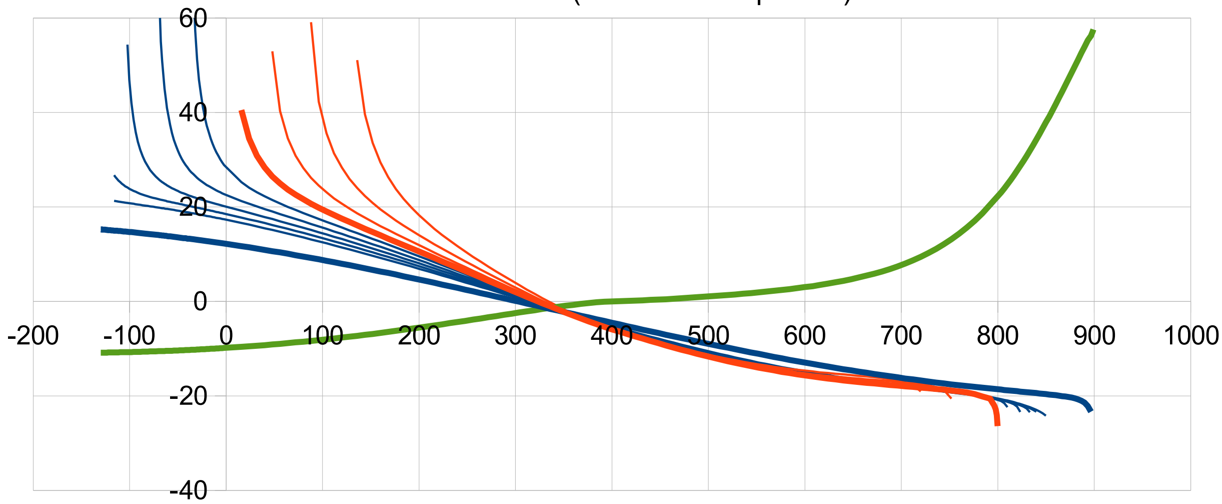
These curves are proposed to assess some complementary characteristics of the hull :

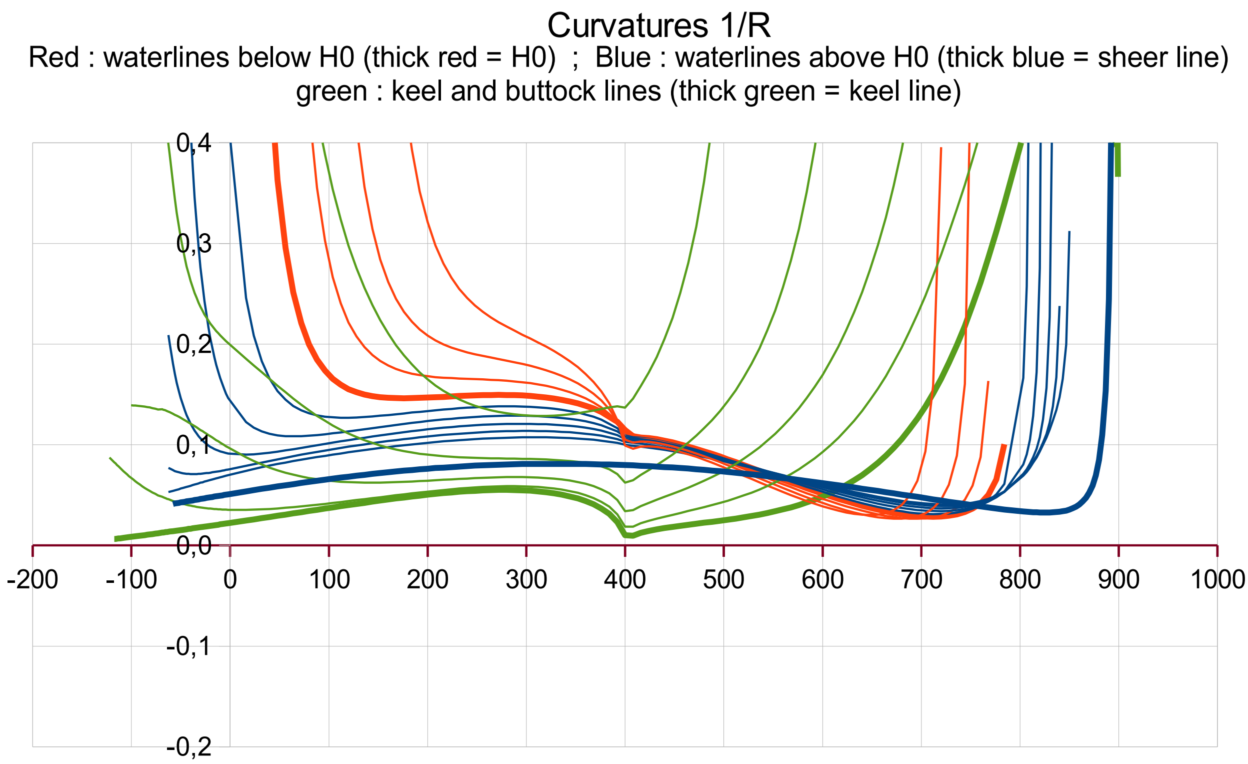
- Waterlines angles in the horizontal plan xy, with the same color code blue/red as for the bottom view, and the keel line angle in the vertical plan xz, in green.
- Curvature 1/R of :
  - Waterlines and sheer line (in the horizontal plan xy) with idem color code blue/red,
  - Keel line and Buttocks lines (vertical longitudinal cuts) in green, keel line being the thick one
- As already mentioned, for the Sections shape : PE1, C PE1 and PE2 parameters in function of the X location.

Examples :

Angles of the water lines (in horizontal plan xy)

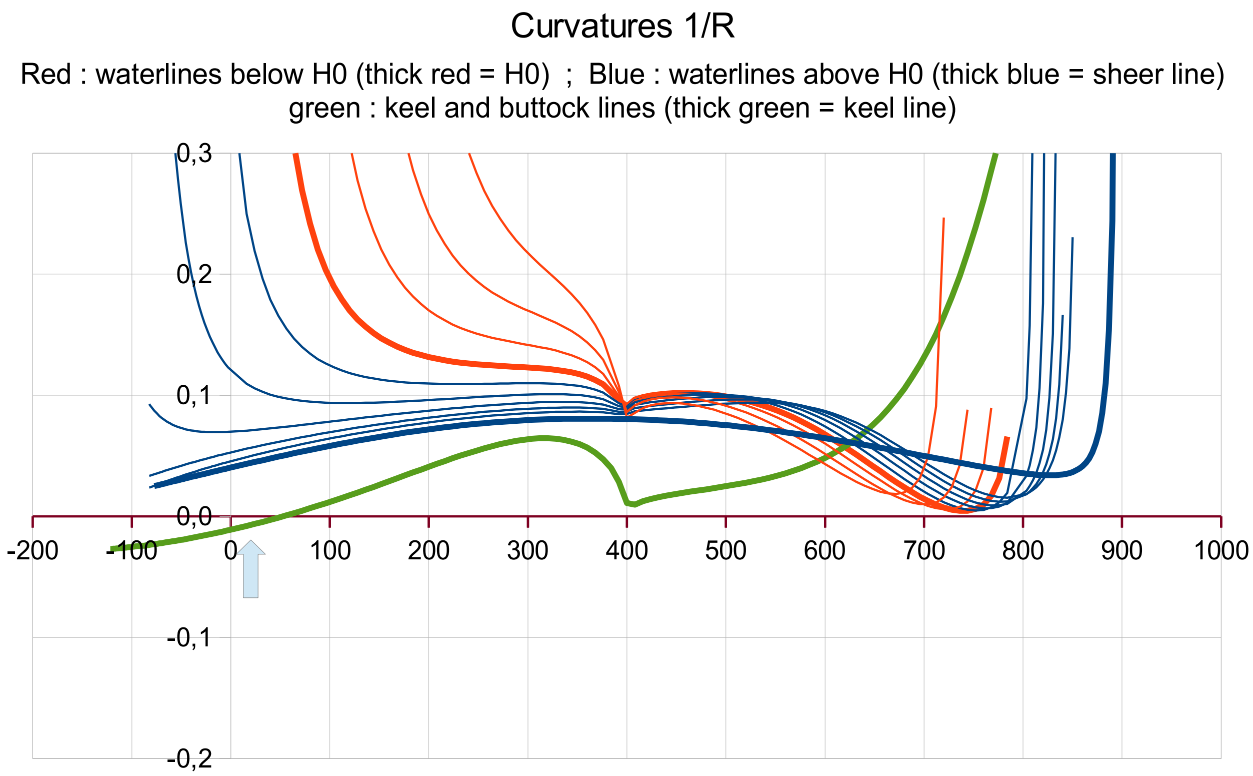
Red : waterlines below H0 (thick red = H0) ; Blue : waterlines above H0 (thick blue = sheer line)
Green : keel line (in the vertical plan xz)



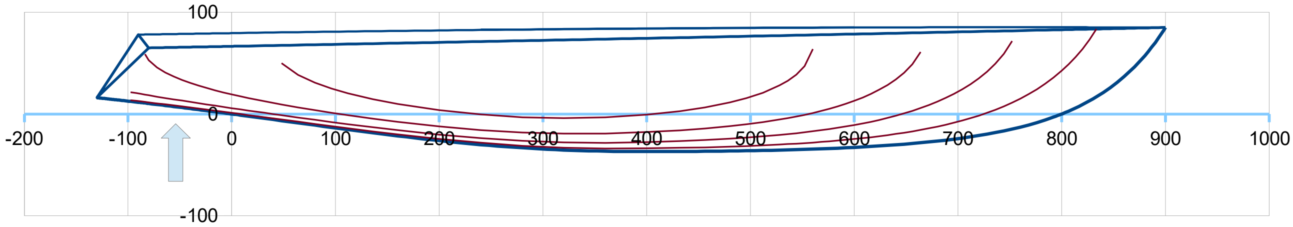


>>> 1/R = or close to zero means no local curvature, it is usually the case for the waterlines (red and blue lines) at the bow (before the small final roundness), and for the keel line (green line) at midship and at the end of the rear vault.

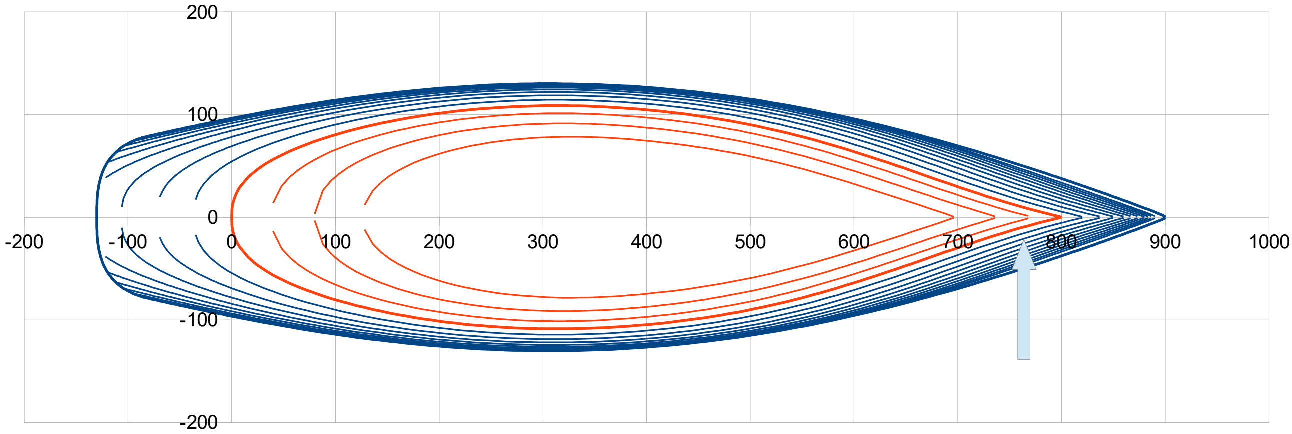
>>> 1/R is given algebric, **when 1/R < 0 that means a concave line, example :**

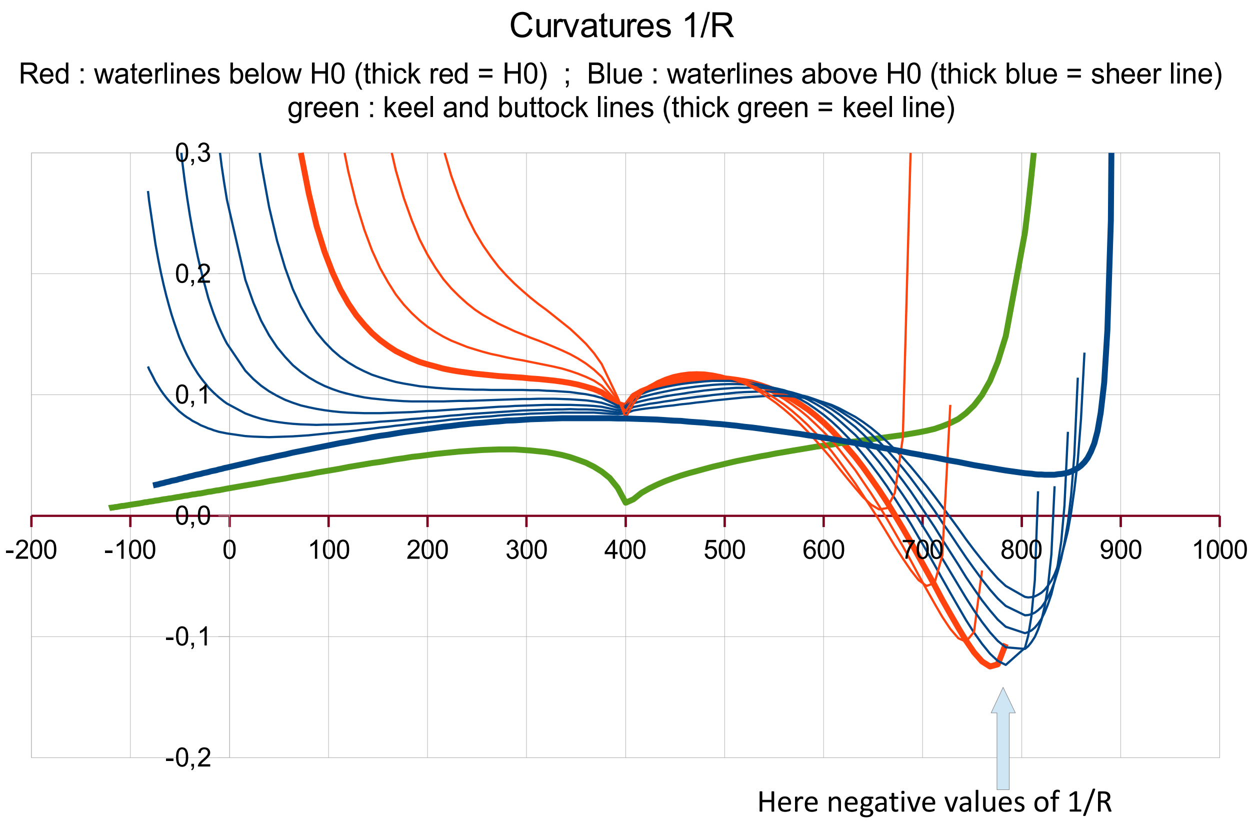


… which corresponds to a concav line of the rear vault :



Another example about concavity of fore waterlines :





5. Stability and righting moment with a loading

This section allows several investigations of first importance :

- to input a loading (weight and its location) and to see the consequence (sinkage, trim) on the hydrostatics data when upright (at heel = 0°)
- to estimate the transversal GM (from the equilibrium at heel = 1°) >> GM1°
- to determine the righting moments for heel angles up to 30° (usual range for sailing) + some other output like the trim , the wetted surface Sw, the remaining free-board FP mini, ...
- to compute the GZ curve for heel up to 180° (although Gene-Stab is more adapted and recommended for this task)
- to prepare data for the VPP (Gene-VPP)

In the design loop, it is usually the step 4 to do after step 1 (Hull and appendages generation), step 2 (Sailplan, see here after) and step 3 (Mass spreadsheet, see here after). An example of this design loop is given in the examples document for the boat V1.

In the sub-section 5.1, a design loading can be introduced : the User input data for a load and its location (in the yellow cells), here below an example :

Load = 300 kg
Xg = 2,00 m
Yg = 0 m Crew at center) & **Zg** 0,85 m and **Yg** = 1,0 m (Crew sit windward) & **Zg** 0,85 m
(used only for GM1° computation) *(used for the other cases)*

5.1 Mass spreadsheet with input of a load

Data to enter : yellow cells	Mass (kg)	Xg (m)	Zg (m)	Yg (m)	(in the coordinates of the 2D
Displacement of ref. (kg)	*2672,61*	*3,782*	*-0,078*	*0*	*from the mass spreadsheet*
Load (kg)	**300,00**	**2,00**	**0,85**	**0,00**	Crew at center
			0,85	**1,00**	Crew sit windward
Total >>> Mass (kg)	**2972,61**	**3,602**	**0,015**	**0,000**	**Crew at center**
Disp. (m3)	**2,90011**		**0,015**	**0,101**	**Crew sit windward**

The data in the grey cells comes from the mass spreadsheet (see here after). The resulting data (in dark red) are used in the computation of the hydrostatic equilibrium in the following sub-section 5,2.

In the sub-section 5,2, computation of the hydrostatic equilibrium : here, the user can input an heel angle and then iterates on height and trim up to reach the « hydrostatics » equilibrium, i.e. both Weight = Displacement and Xc (LCB) = Xg. Example with Boat V1 :

To input the Heel angle

Then to input and to iterate on Height and Trim ...

Heel (°)	**20**
Height (cm)	**3,2629**
Trim (°)	**0,170**

Results

Disp. (m3)	**2,90011**	**/ Disp. (m3)**	**2,90011**
Xc heel (m)	**3,602**	**/ Xg (m)**	**3,602**

… up to equilibrium

>>> the User should iterate on the values of Height and Trim up to :

- *Displacement with heel = Displacement from the mass spreadsheet*
- *Xc heel = Xg*

This sub-routine can be used for various investigations :

The case Heel = 0° informs on the sinkage and the trim at rest for the given loading. Example :

5.2 Computation, by input of an Heel angle, and iteration on Height and Trim up to Displacement equality and Xc (LCB) = Xg

Data to enter : yellow cells		Results				Specific results			
Heel (°)	0	Disp. (m3)	2,90012	/ Disp. (m3)	2,90011	Relevant only when heel = 0°		DLR	147
Height (cm)	-2,1799	Xc heel (m)	3,602	/ Xg (m)	3,602	Lwl (m)	8,26	Z fore (cm)	1,7
Trim (°)	0,520	Yc heel (m)	0,000	Yg heel (m)	0,101	Bwl (m)	2,24	Z aft (cm)	-5,6
		Zc heel (m)	-0,190	> GZ (m)	0,101	Tc (m)	0,39	Trim (°)	0,52
		Sw heel(m2)	18,25	RM (kN.m)	2,943	Cp Hull	0,537	LCB Hull (%)	47,34
		Bwl heel (m)	2,24	FB mini (cm)	67,5	Relevant only when heel = 1°			
		LCB – LCF (%Lwl)	2,07	Obliquity (°)	0,0	Yg heel (m)	0,000	with crew at center	
						Gz (m)	0,000		
						> GM1° (m)	#DIV/0 !		

>> the relevant results are the ones in black + in blue (when heel = 0°) >>> under this loading :

** Lwl = 8,26 m ; Bwl 2,24 m ; Trim = 0,52° (> 0 = nose up) leading to an elevation at fore perpendicular Z fore = +1,7 cm and a sinking at aft perpendicular Z aft = - 5,6 cm (Z<0 = sinking).

** Sw = 18,25 m2 ; Free-Booard minimum = 67,5 cm ; DLR = 147 in charge

The case Heel = 1° give the metacentric center GM1° representative of the initial stability when the loading is Y-centered (the pink results are with Yg = 0) . Example :

5.2 Computation, by input of an Heel angle, and iteration on Height and Trim up to Displacement equality and Xc (LCB) = Xg

Data to enter : yellow cells		Results				Specific results			
Heel (°)	1	Disp. (m3)	2,90011	/ Disp. (m3)	2,90011	Relevant only when heel = 0°		DLR	147
Height (cm)	-2,1650	Xc heel (m)	3,602	/ Xg (m)	3,602	Lwl (m)	8,26	Z fore (cm)	1,7
Trim (°)	0,520	Yc heel (m)	-0,018	Yg heel (m)	0,101	Bwl (m)	2,24	Z aft (cm)	-5,6
		Zc heel (m)	-0,190	> GZ (m)	0,119	Tc (m)	0,39	Trim (°)	0,52
		Sw heel(m2)	18,26	RM (kN.m)	3,472	Cp Hull	0,537	LCB Hull (%)	47,33
		Bwl heel (m)	2,24	FB mini (cm)	65,6	Relevant only when heel = 1°			
		LCB – LCF (%Lwl)	2,07	Obliquity (°)	0,1	Yg heel (m)	0,000	with crew at center	
						Gz (m)	0,018		
						> GM1° (m)	1,04		

>>> **Here, the relevant result is in pink : GM1° = 1,04 m**

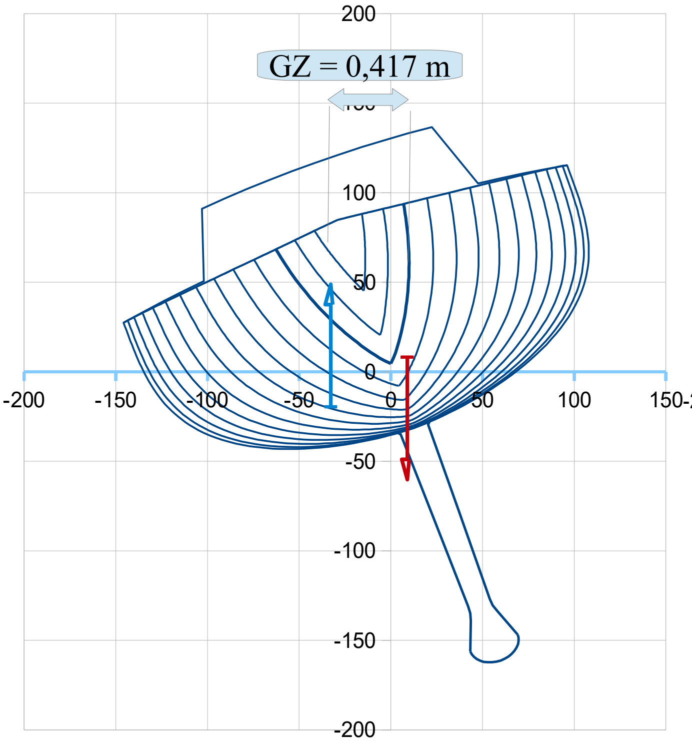
The case Heel = 20° can give the boat attitude and the RM for an usual sailing. Example :

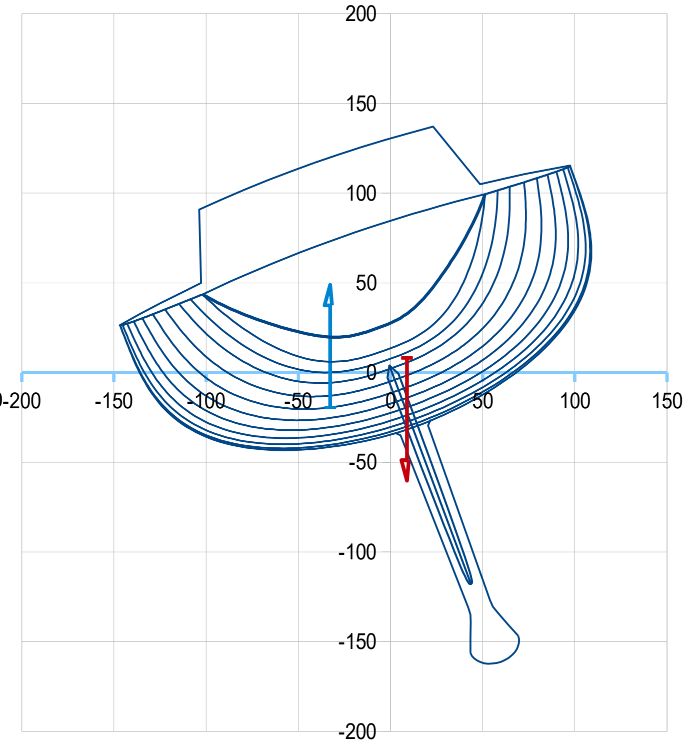
Data to enter : yellow cells		Results			
Heel (°)	20	Disp. (m3)	2,90011	/ Disp. (m3)	2,90011
Height (cm)	3,2629	Xc heel (m)	3,602	/ Xg (m)	3,602
Trim (°)	0,170	Yc heel (m)	-0,327	Yg heel (m)	0,090
		Zc heel (m)	-0,196	> GZ (m)	0,417
		Sw heel(m2)	17,51	RM (kN.m)	12,158
		Bwl heel (m)	2,04	FB mini (cm)	26,2
		LCB – LCF (%Lwl)	0,81	Obliquity (°)	2,7

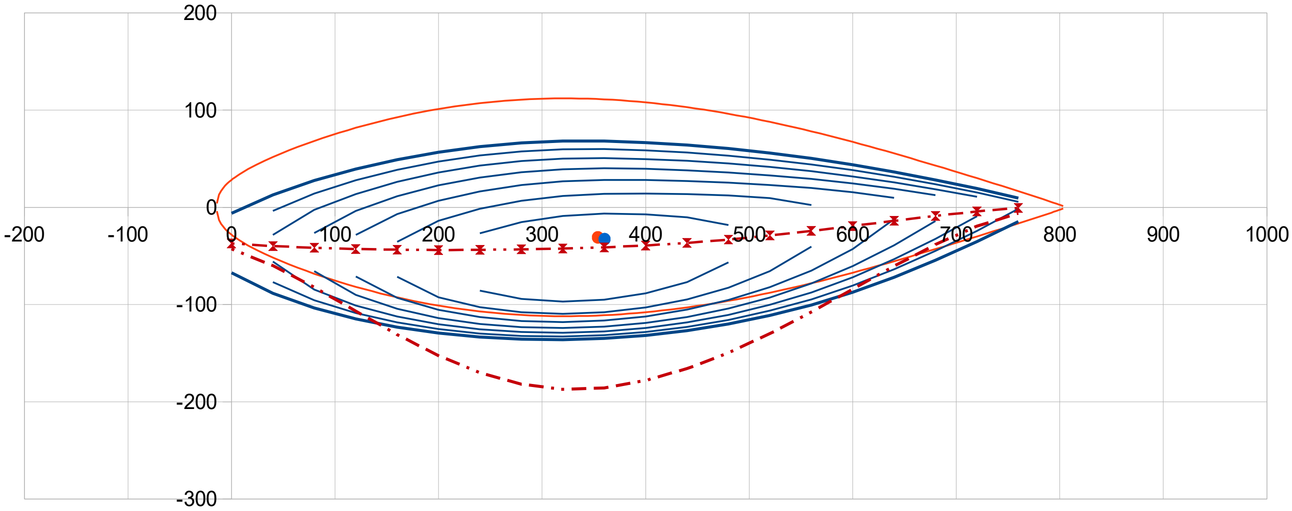
Equilibrium is obtained with Height 3,3629 cm and Trim = + 0,17° (nose-up)

>>> here the relevant results are only those in black :

>>> GZ = 0,417 m ; RM = 12,158 kN.m ; Sw = 17,51 m2 ; Free-board minimum : 26,2 cm







>>> The red line is the floatation waterline when upright with the loading

>>> The blue lines are the waterlines of the heeled hull,

>>> The blue point is the center of buoyancy, the red point is the center of floatation.

New for this 3.5 Version :

>>> two lines are added :

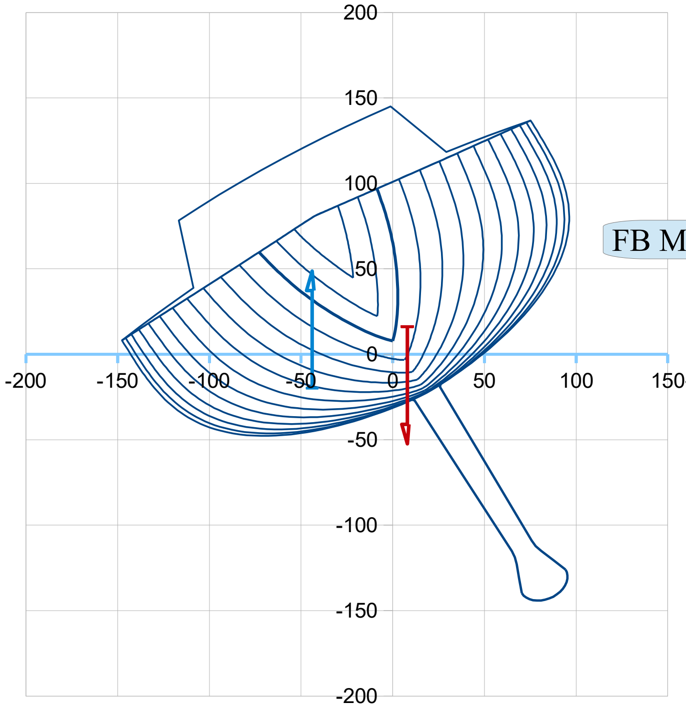
** the one connecting the centers of the immesed sections of the heeled hull : this line is very important to check, it is a bit like the spine of the heeled hull, should be regular with as much as possible a slight general curvature, especially without undulation.

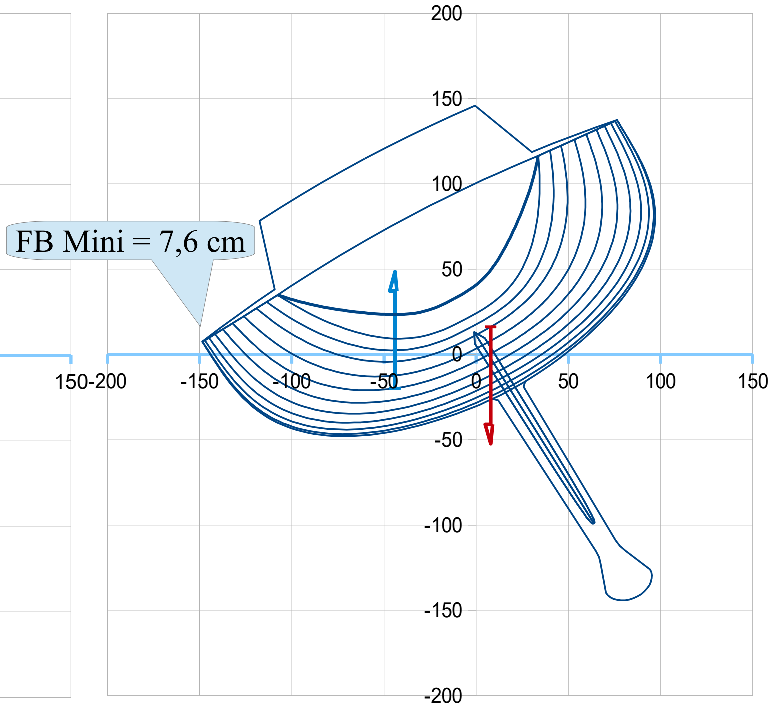
** the lower dashed line, showing the evolution from fore to aft of the areas of these immersed sections

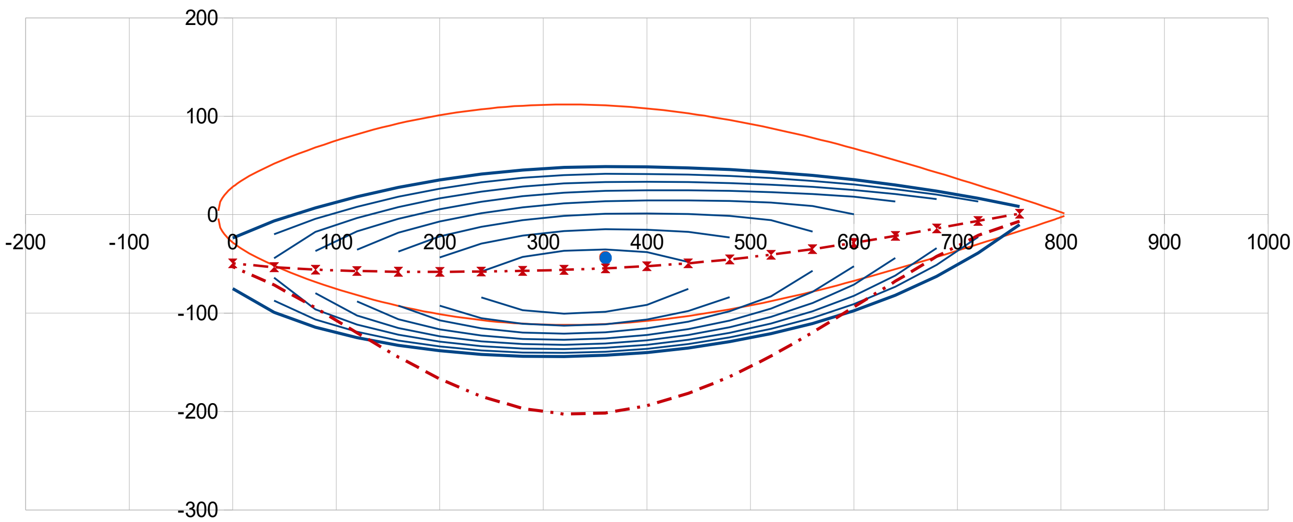
The case Heel = 30° give the design RM30° useful to dimension the rig, and the minimum free-board to preserve for the sheer line. **Example :**

Data to enter : yellow cells		Results			
Heel (°)	30	Disp. (m3)	2,90011	/ Disp. (m3)	2,90011
Height (cm)	9,6824	Xc heel (m)	3,602	/ Xg (m)	3,602
Trim (°)	-0,253	Yc heel (m)	-0,440	Yg heel (m)	0,080
		Zc heel (m)	-0,198	> GZ (m)	0,519
		Sw heel(m2)	17,08	RM (kN.m)	15,144
		Bwl heel (m)	1,92	FB mini (cm)	7,5
		LCB – LCF (%Lwl)	0,06	Obliquity (°)	3,8

>>> RM30° = 15,144 kN.m ; Sw = 17,08 m2 ; Free-board minimum : 7,5 cm







In the sub-section 5,3 (on the right side from the column L) : the data preparation for the Gene-VPP application

The whole set of input data for Gene-VPP is prepared within this sub-section 5.3 of Gene-Hull sheet, example :

For Gene-VPP, hull body data with loading and at equilibrium upright (put Heel = 0°)							From the Sailplan sheet :							
Lwl (m)	Bwl (m)	Tc (m)	Bmax (m)	Cp hull	LCB hull(%)	Sf (m2)	Main (m2)	Jib (m2)	ZCE (m)	Zdeck (m)	Zmast (m)	Spi (m2)	ZCE spi (m)	Reefing
8,26	2,24	0,39	2,60	0,54	47,34	12,50	23,06	24,04	5,26	0,85	13,23	70,00	6,31	1,00
Keel wing			Keel bulb (if no bulb, put Vol. = 0 and Sw = 0)				Rudder			Displacement and draft at design load			sym0 asym1	Flat mini
Vol. (m3)	Sw (m2)	Chord (m)	Vol. (m3)	Sw (m2)	L (m)	D (m)	Vol. (m3)	Sw (m2)	Chord (m)	Disp. (kg)	Draft (m)		0	0,75
0,09749	2,37	1,15	0,05190	1,30	1,55	0,28	0,01486	0,91	0,40	2973	1,77			
Righting Moment RM (kN.m)				Wetted surface Sw (m2)										
RM0°	RM20°	RM30°		Sw0°	Sw20°	Sw30°								
2,943	12,158	15,144		18,25	17,51	17,08								

The process to fulfill this table :

1) At first the data of the third line, i.e. related to the Righting moment and the wetted surface, are to enter by the user : for each equilibrium at respectively Heel 0°, 20° and 30° , the resulting RM and Sw values should be copy/special paste into the table by the User :

Righting Moment RM (kN.m)				Wetted surface Sw (m2)		
RM0°	RM20°	RM30°		Sw0°	Sw20°	Sw30°
2,943	12,158	15,144		18,25	17,51	17,08

2) Secondly, to fulfill the hull body data, the equilibrium at heel = 0° should be set within the sub-section 5.2 : then, these data are automatically fulfilled in the table :

For Gene-VPP, hull body data with loading and at equilibrium upright (put Heel = 0°)						
Lwl (m)	Bwl (m)	Tc (m)	Bmax (m)	Cp hull	LCB hull(%)	Sf (m2)
8,26	2,24	0,39	2,60	0,54	47,34	12,50

3) All the other data of this table are automatically fulfilled, except the « Reefing » (a value ≤ 1) and the « Flat mini » (a value between 1,0 and 0,5) to enter by the User.

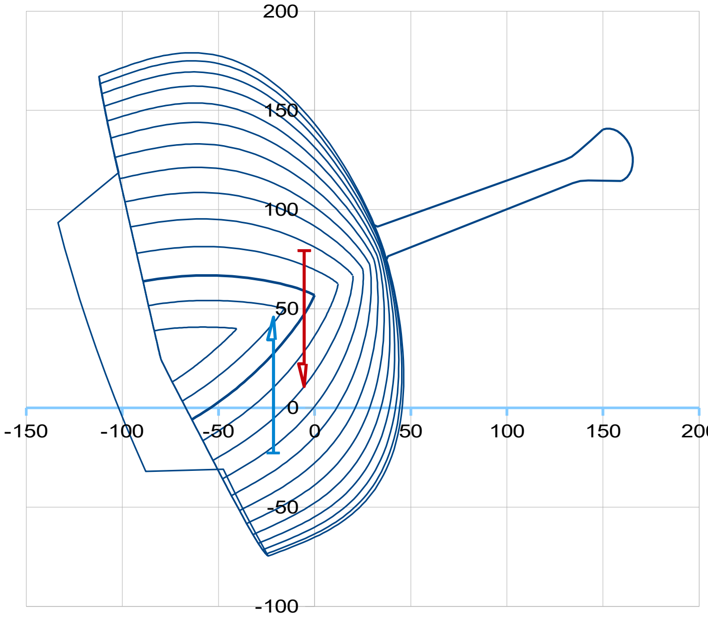
4) The table is then ready for a copy/special paste into the Gene-VPP application. The Gene-VPP User guide explained in details the why and how of this table of data.

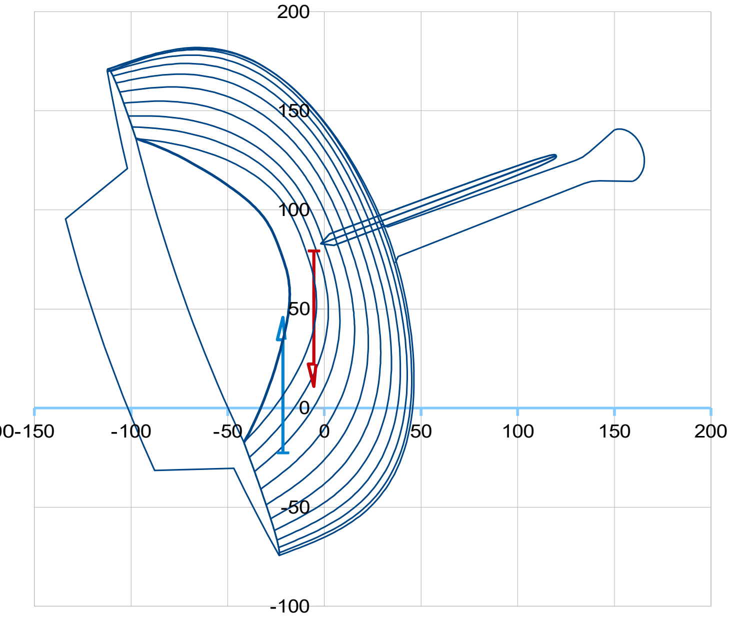
The computation beyond 30° of heel angle :

It is possible to compute the equilibrium beyond 30°, up to 180°. However, due to the need of manual iterations for each equilibrium, it is a long task to build the Gz Curve with process. It is why the Gene-Stab post-application has been developed, to make easy and faster this task with a direct use of the data provided by Gene-Hull, so we recommend to use it instead (see its specific User Guide).

Nevertheless, the current subroutine within the sub-section 5,2 of Gene-Hull is operational up to 180° and can be used to explore some of the « beyond 30° » cases, still with manual iterations on height and trim to reach the equilibrium. Here is an example with heel 110° :

Data to enter : yellow cells		Results			
Heel (°)	110	Disp. (m3)	2,90008	/ Disp. (m3)	2,90011
Height (cm)	70,5398	Xc heel (m)	3,602	/ Xg (m)	3,602
Trim (°)	-1,850	Yc heel (m)	-0,214	Yg heel (m)	-0,049
		Zc heel (m)	-0,226	> GZ (m)	0,165
		Sw heel(m2)	17,77	RM (kN.m)	4,807
		Bwl heel (m)	1,48	FB mini (cm)	-74,6
		LCB – LCF (%Lwl)	-1,58	Obliquity (°)	-2,0





Sailplan input and ouput

This sheet can provide an early stage definition of the sailplan, with output inc. the sail area, the so-called « Lead » and other ratios usually considered by naval architects. It is the usual step 2 in the design loop, after the Hull + appendages generation.

Data to input by the User for a 2D Sailplan early stage definition are in cells B3 to B11. Example :

Data to enter :		*>> in feet*
Xmast (m)	4,78	*15,68*
Zboom(m)	1,88	*6,17*
I (m)	11,00	*36,09*
J (m)	3,55	*11,65*
P (m)	11,30	*37,07*
E (m)	3,40	*11,15*
Jib LP (m)	4,35	*14,27*
Main Roach	2,00	Coeff ≥1
Fat head (m)	0,00	*753,47*
Spi (m2)	70,00	
sym0 asym1	0	
Extra Top(cm	0	0 by default
Luff top (cm)	0	0 by default

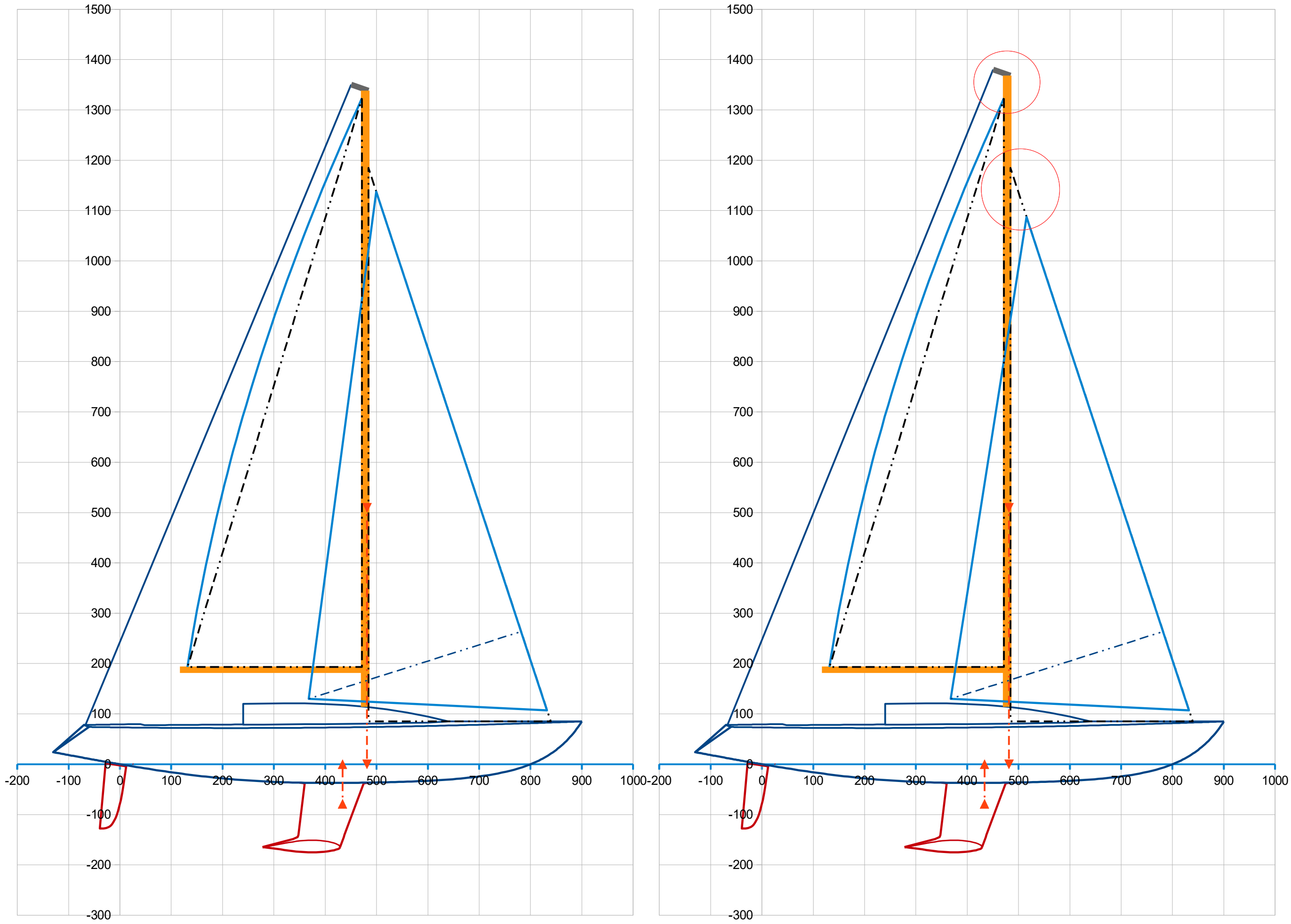
Xmast (m) : X position of the mast **(cell B3)**
Zboom (m) : Z position of the boom / waterline **(cell B4)**
I (m) , J (m) : Fore triangle height and foot lengths **(cells B5, B6)**
P (m), E (m) : Mainsail triangle height and foot lengths **(cells B7, B8)**
(the triangles are drawn in black dot-dashed lines in the sailplan view)
Jib HLP (m) : luff perpendicular as the shortest distance from the clew point to the luff **(Cell B9)**
Main Roach : coefficient for define the roach mainsail profile : =1 triangle profile, >1 with a roundness in proportion of this coefficient **(Cell B10)**
Spi (m2) : Spi area **(Cell B11)**

sym0 asym1 : = 0 means a symetric spi ; = 1 means an asymetric spi. The application Gene-VPP Sailboat was upgraded to take into account such different type of spi.

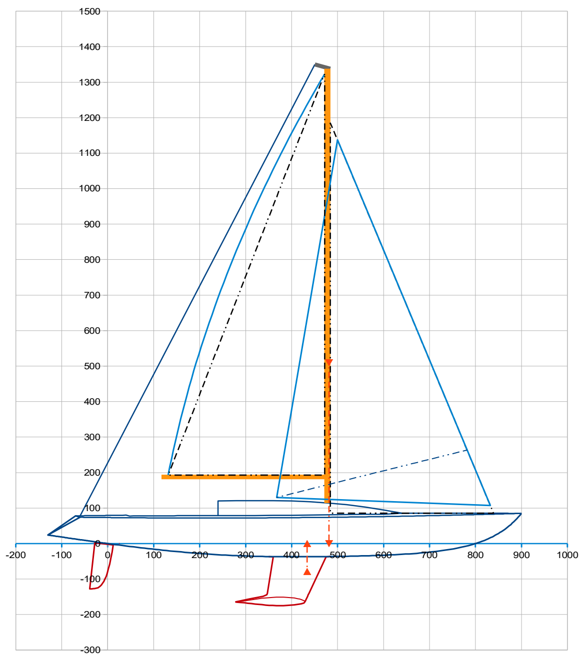
Extra top (cm) : can be used to have an extra height between the top of the mainsail and the top of the mast. Extra top = 0 means a default value is used.

Luff top (cm) : can be used to reduce the height between the top of the foresail and the top of the forestay. Luff top = 0 means a default value is used.

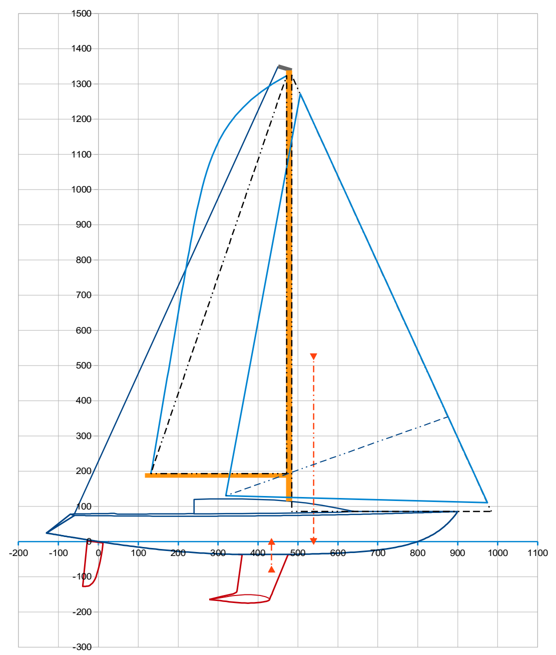
Example : Extra top = 0 Luff top = 0 Extra top = 30 cm Luff top = 50 cm



In particular, with various I , J and HLP, you can generate either a Jib or a Code 0 on bowsprit, and with various Roach, you can generate different mainsail. Example :



I=11,0m ; J=3,55m ; HLP=4,35m ; Roach=2



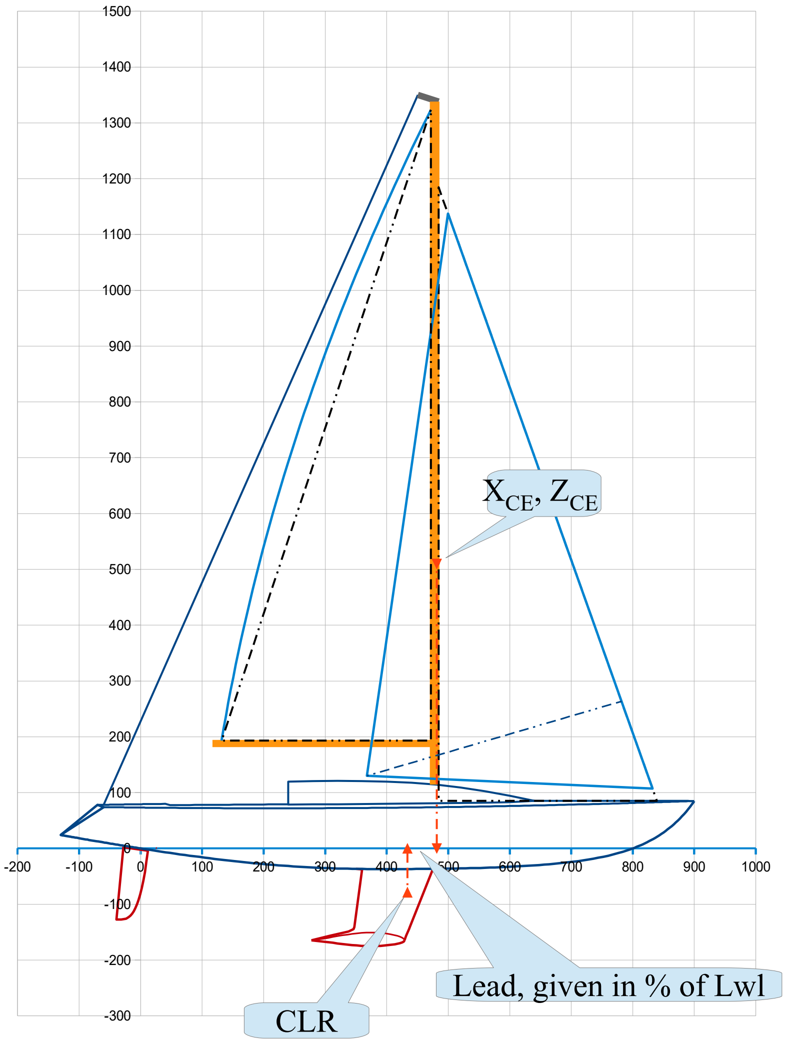
I=12,4m ; J=5,0m ; HLP=6,0m ; Roach=10

The output data automatically generated, in 3 sub-sections :

- Data related to the fore and main triangles
- Data considering the real jib and mainsail
- Data which are used and automatically recopy to fulfill the table of input data for Gene-VPP (in sub-section 5.3, as described here above)

Results considering St = fore + main triangles and its geometrical center CE for the Lead estimation								
	Surface triangles St (m2)	38,7	*416,94*	*sqft*	Main (%)	49,6		
	XCE (m)	4,81	ZCE (m)	5,10	Fore (%)	50,4		
	Lead (CE – CLR) (% Lwl)	**6,0**	CE geometrical center of the 2 triangles, CLR see Gene-Hull sheet					
	Skeel / St (%)	3,50	ratio keel surface / triangles surface			**St/Sw**		**2,23**
	Srudder / St (%)	1,13	ratio rudder surface / triangles surface			**St/D^(2/3)**		**20,45**
Results considering SA = jib + mainsail for an upwind sailing								
	SA (m2)	**47,10**	*507,03*	*sqft*	**Mainsail(m2)**	**23,06**		
	Xsa (m)	4,59	Zsa (m)	5,26	**Foresail(m2)**	**24,04**		
	>> SA/Sw	2,71	*ratio sails area/wetted area*		Overlap (%)	122,5	HLP/J	
	>> SA/D^(2/3)	24,86	*ratio sails area/displacement^(2/3)*					
ır Gene-VPP :	**Main (m2)**	**Jib (m2)**	**ZCE (m)**	**Zdeck (m)**	**Zmast (m)**	**Spi (m2)**		**ZCE spi (m)**
	23,06	**24,04**	**5,26**	**0,85**	**13,23**	**70,00**		**6,31**
								sym0 asym1
								0

The output drawing :



Some extra information on the sailplan output data :

Main (%) and Fore (%) : it is the distribution between the two triangles, 50/50 being an average value.

Lead (CE – CLR) (%Lwl) : it is the criteria to consider for a good balance when heeled sailing, to avoid either too much weather helm or lee helm.Pratically, that guides the relative position of the mast and the sailplan with regard the keel wing. According to L. Larsson and Rolf E Eliasson in « Principles of yacht Design », for the extended keel method, the recommeded range of values is :

Sloop with Masthead rig : 5% - 9%

Sloop with Fractional rig : 3% - 7%

To note that, to take into account the low aspect ratio of heavy fin keel shape typical of some cruising yachts, the center of effort can be move from 25% to 35% to better suits with experimental experiences done on models. This value is ouput in the hydrostatics data.

Skeel / St (%) ratio : Skeel is the projected area Sxz of the keel profile in the vertical plan of symmetry, given in the hydrostatics data. St is the area of the two sail triangles main and fore. This ratio is used in order to appreciate if there is enough keel area to provide the lateral resistance. An average of 3,5% ± 0,75 % is proposed for this ratio by L. Larsson and Rolf E Eliasson in « Principles of yacht Design ».

Srudder / St (%) ratio : Srudder is the projected area Sxz of the rudder profile in the vertical plan of symmetry, given in the hydrostatics data. St is the area of the two sail triangles main and fore. This ratio is used in order to appreciate if there is enough rudder area to provide the lateral resistance. An average of 1,4% (inc. the skeg area if any) is proposed for this ratio by L. Larsson and Rolf E Eliasson in « Principles of yacht Design », with 1% the lower limit and 2% the upper limit. In case of twin rudders, the area of one rudder is taken into account for this criteria.

St/Sw (%) or SA/Sw (%) ratio, is the Sail area (St triangles or SA real main + jib) versus wetted surface ratio. When considering St, according to L. Larsson and Rolf E Eliasson in « Principles of yacht Design », statistics give a value between 2 and 2,5, with an average at 2,25. When considering SA, it is ~ 2,5 to 3,0.

St/D^(2/3) or SA/D^(2/3) ratio, is the Sail area (St triangles or SA real main + jib) versus Displacement ratio. When considering St, according to L. Larsson and Rolf E Eliasson in « Principles of yacht Design », statistics give a value between 15 and 22, with an average at 19. When considering SA, it is ~ 18,5 to 27,5.

Overlap (%) : defined by the ratio HLP /J

For the line of data automatically prepared for Gene-VPP, they are detailed and explained on its specific User Guide.

Mass spreadsheet input and output

This mass speadsheet can provide 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. It is the usual step 3 of the design loop.

Mass and Xg, Zg position – early stage estimation	**Input data**		**Results**					
	L or S or V	**mass unit**	**Mass**	**Xg**	M Xg	**Zg**	M Zg
Data to enter : in yellow cells	m or m2 or m3	**or % Disp.**	**(kg)**	**(m)**		**(m)**	
Hull (skin, structure, keel interface)	29,47	**19,00**	559,91	3,64	2035,61	0,02	13,02
, with S, Xs and Zs from Gene-Hull sheet		(kg/m2)					
Deck – roof – cockpit (skin and structure)	20,09	**13,50**	271,17	3,51	951,97	0,79	214,22
, with S, Xs and Zs from Gene-Hull sheet		(kg/m2)					
Rig, sails and deck fittings		**8,60**	229,86	4,40	1010,82	3,21	738,22
		(% Disp.)					
Cabin accomodation and motor		**18,00**	481,10	3,60	1731,95	0,09	44,57
		(% Disp.)					
Keel			1090,49	4,02	4382,17	-1,10	-1197,40
Rudder		**1,50**	40,09	-0,12	-4,71	-0,54	-21,73
		(% Disp.)					
		Results : Light weight boat >>>	**2672,6**	**3,782**	10107,83	**-0,078**	-209,11

The input data to enter by the User and based on his experience, are in black bold police in the yellow cells, including :

- **(cell C5)** average mass per m2 for « Hull » at large : hull skin, structure, reinforcements, ... , based on the hull surface data in cell B5 and coming from the Gene-Hull sheet
- **(cell C7)** average mass per m2 for « Deck » at large : deck skin, roof, cockpit, reinforcements, ..., based on the hull surface data in cell B5 and coming from the Gene-Hull sheet
- **(cell C9)** average mass, in % of the Displacement, for « Rig » at large : mast, boom, sails and deck fittings, ...
- **(cell C11)** average mass, in % of the Displacement, for cabin accomodation and motor,
- **(cell C15)** average mass, in % of the Displacement, for the rudder system

All the other necessary input data comes automatically from either the Gene-Hull sheet or the Sailplan sheet (they are in blue), including some position data adjusted by default :

- Zg for Hull (by default, it takes into account the skin of the bottom thicker than the one at top),
- Zg for Rig-Sails-Deck fittings sub-system,
- Xg and Zg for the Accomodation.

>>> the User can change them if he does not agree with these proposed default values.

The output data are in dark red, are the light weight boat mass and position Xg, Zg, these data are automatically reported in the Gene-Hull sheet, in section 2. under the hydrostatics data and in section 5.1 to be completed with a loading for the stability study.

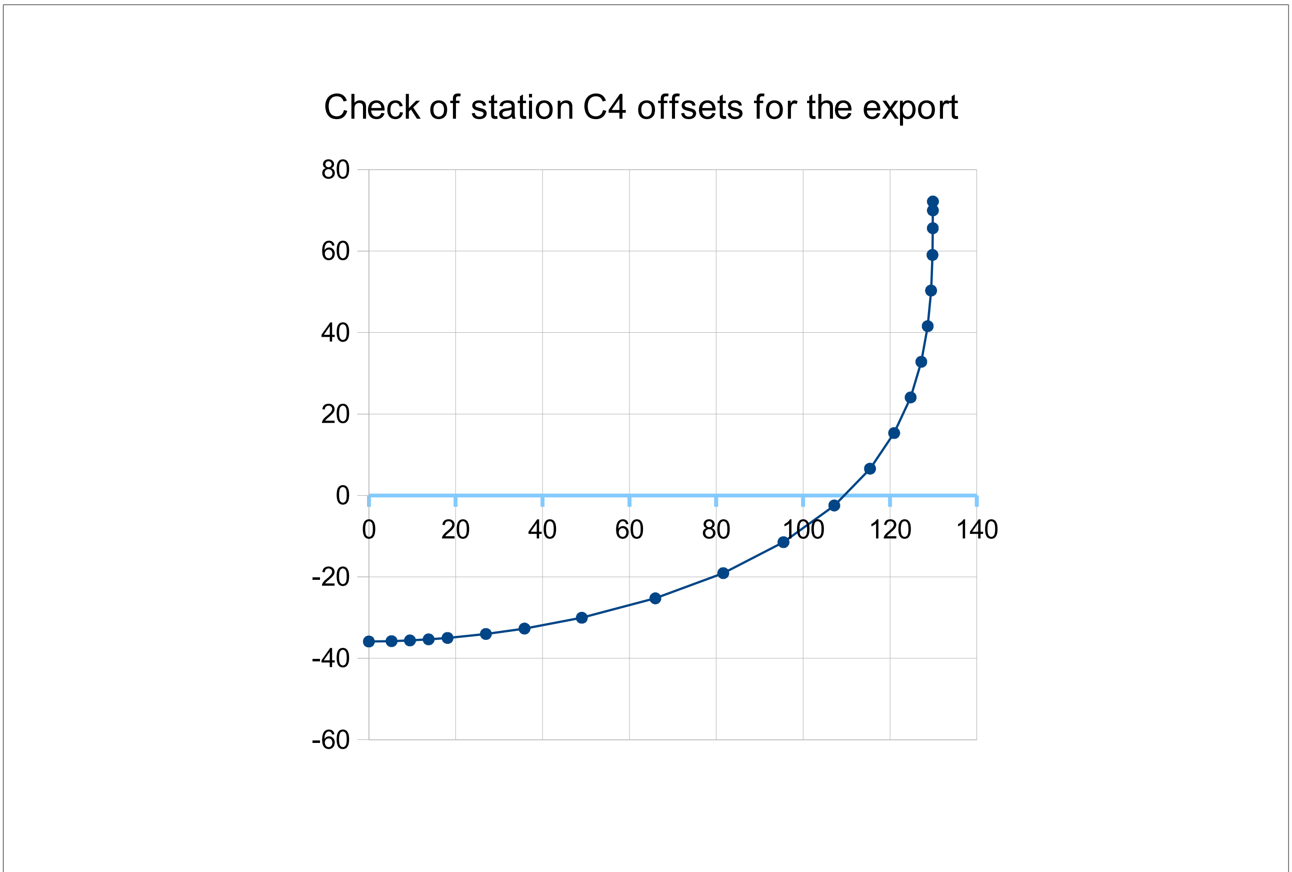
	Results Mass	Xg	M Xg	Zg	M Zg
ults : Light weight boat >>>	2672,6	3,782	10107,83	-0,078	-209,11

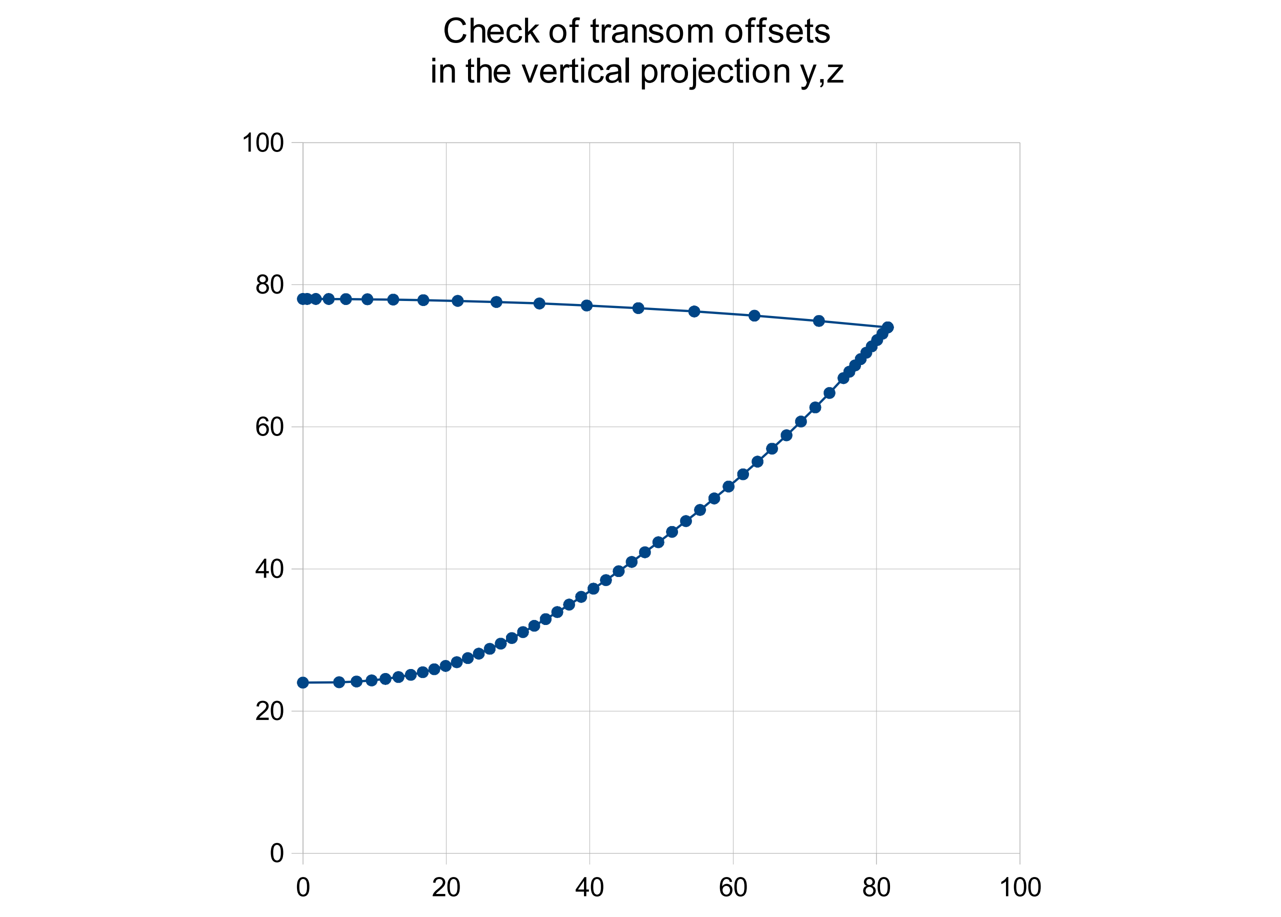
Offsets x,y,z outputs

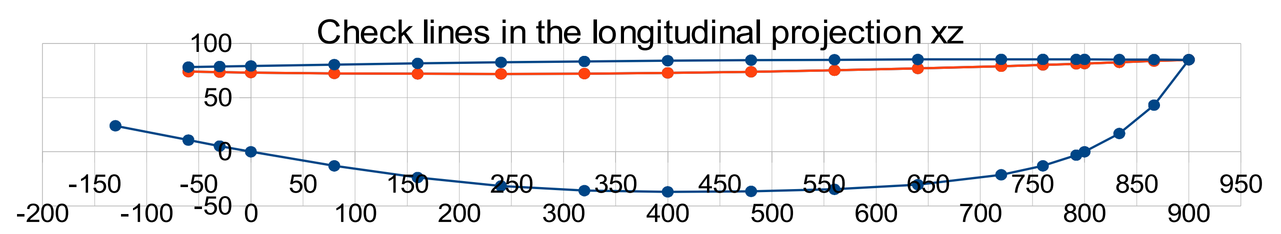
All the data reported in this sheet are automatically produced. They are provided to facilitate a transfer towards a 3D modeller like Multisurf or equivalent. It includes :

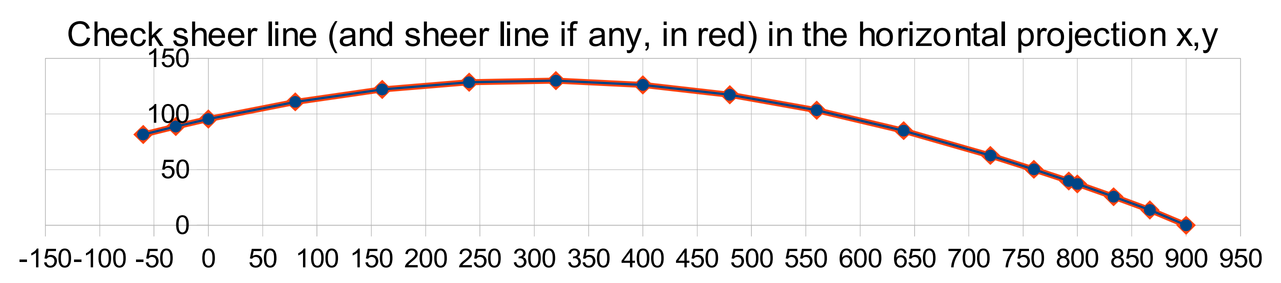
- **1. Hull sections :** x,y,z data for each section : Car1, C0, C0,5, ...etc ..., C9,5, C10, Cav1, Cav2.
- **2. Rear transom** intersection line with the hull and with the deck : x,y,z data of the intersection curves,
- **3. Keel line, Hard chine line (if any), sheer line and deck central line :** x,y,z data of these lines
- **4. Keel :** x,z data of the longitudinal profile of the keel, data of the naca profiles in various horizontal sections, for each type :
  type inverted L : in columns A to AE
  type inverted T : in columns AG to BL
  type fin keel without bulb : in columns BN to CP
- **5. Rudder :** x,z data of the longitudinal profile of the rudder, data of the naca profiles in various horizontal sections
  type suspended : in columns A to AE
  type with skeg : in columns AG to BI
- 6. Roof : roof sections, yet it is just a preliminary design ....

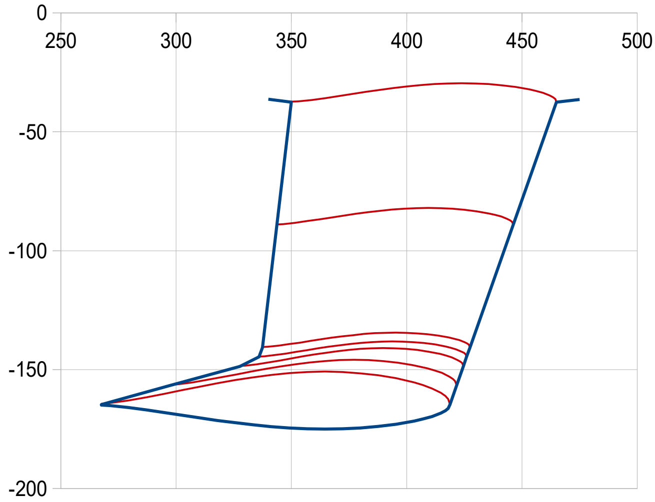
Within each sections, drawings are given, a way to check that the data are right. Examples :

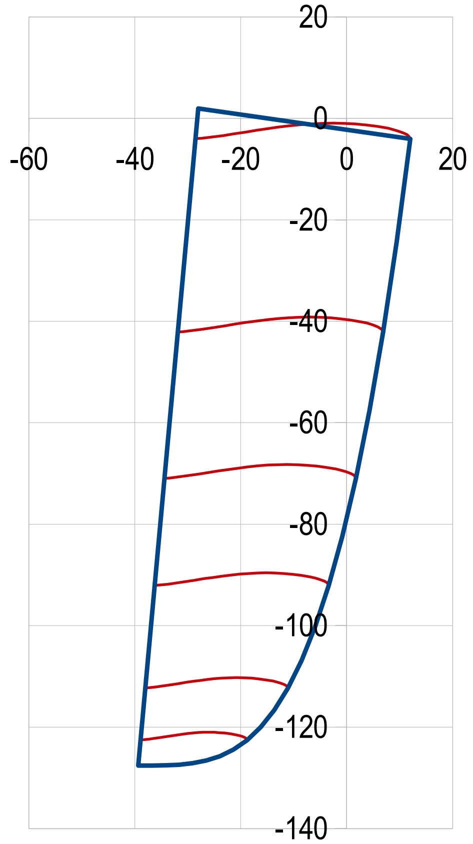



Check of transom offsets
in the vertical projection y,z
100
80
60
40
20
0
0 20 40 60 80 100


Check lines in the longitudinal projection xz
100
50
0
-50
-150 -50 50 150 250 350 450 550 650 750 850 950
-200 -100 0 100 200 300 400 500 600 700 800 900


Check sheer line (and sheer line if any, in red) in the horizontal projection x,y
150
100
50
0
-150 -100 -50 0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950


0
250
300
350
400
450
500
-50
-100
-150
-200


20
0
-60
-40
-20
0
20
-20
-40
-60
-80
-100
-120
-140

About the « Hull storage » sheet :

Here you are free to store all the input data and some main results at your convenience. All the data of the Examples document are stored there. I recommend the following way of storage allowing a direct copy/paste with the other sheets, example V1 :

Hull data		*feet conversion*		
Lenght of waterline :			Type of geometrical data	
Lwl (m)	8,00	*26,25*	<<< Length	
Maximum draft of the hull body :				
Tc (m)	0,3700	*1,21*	<<< Height	
X Tc (%Lwl)	50,0			
Hull bow :				
Xbow (m)	9,00	*29,53*	<<< Length	
Zbow (m)	0,85	*2,79*	<<< Height	
Shape coefficient of the bow :				
Cet	3,00			
Kbrion	0,00			
Polynomials of the keel line, front part and rear part :				
Pui q av	2,45			
Pui q ar	2,35			
Rear end of the transom :				
X tab ar (m)	-1,30	*-4,27*	<<< Length	
Z tab ar (m)	0,24	*0,79*	<<< Height	
Sheer line, in horizontal projection xy :				
Bg (m)	2,199	*7,21*	<<< width	
X Bg (% Lwl)	43,0			
Alfa (°)	2,00			
Pui liv y	2,00			
Cor Pui liv	0,025			
Pui Cor Pui	2,00			
X liv ar (m)	-0,60	*-1,97*	<<< Length	
Scow	0,03			
Pui Scow	0,25			
Option Hard Chine line, in vertical projection xz :				
Type	0	Bratio fore		
1,2 Zhc av (m)	0,75	1,00		
2 Zhc m (m)	0,20	Bratio aft		
1,2 Zhc ar (m)	0,42	1,00		
Pui hc z	2			
Sheer line, in vertical projection xz :				
Z liv m (m)	0,72	*2,36*	<<< Height	
Z liv ar (m)	0,74	*2,43*	<<< Height	
Deck / central line rear end				
Z p m (m)	0,83	*2,72*	<<< Height	
X p ar (m)	-0,70	*-2,30*	<<< Length	
Z p ar (m)	0,78	*2,56*	<<< Height	
Kroof (%B)	29,0			
Sections :				
	PE1	C PE1	PE2	
Fore	2,000	1,630	1,000	
Mid	3,310	1,000	1,700	
Aft	2,000	1,490	2,800	

Keel data	Inverted L		Inverted T		Without bulb
Type	1	Type	0		0
Xq ar (m)	3,60	Xq ar (m)	3,55	Xq ar (m)	3,45
C root (m)	1,15	C root (m)	1,00	C root (m)	1,20
C tip (m)	0,90	C tip (m)	0,70	C tip (m)	0,90
Th keel (%)	13,50	Th keel (%)	14,65	Th keel (%)	14,65
F angle (°)	70,00	F angle (°)	75,00	F angle (°)	75,00
C bulb (m)	1,55	C bulb (m)	1,815	H ballast (m)	0,3680
Th bulb (cm)	27,60	Th bulb(cm)	26,00		
		Lf bulb(m)	0,47		
Draft oa (m)	1,75	Draft oa (m)	2,00	Draft oa (m)	1,75
naca 00xx	0	naca 00xx	0	naca 00xx	0
naca 63-0xx	1	naca 63-0xx	1	naca 63-0xx	1
naca 65-0xx	0	naca 65-0xx	0	naca 65-0xx	0
Density Wing	7,30	DensityWing	7,30		
Density Bulb	7,30	Density Bulb	7,30	D Ballast	7,30
Rudder data	Suspended		With skeg		
Type	1		0		
Xr ar (m)	-0,28	Xr ar (m)	-0,20		
C root (m)	0,40	C root (m)	0,60		
t/c (%)	15,00	t/c (%)	12,00		
R angle (°)	85,00	R angle (°)	85,00		
L ar (m)	1,30	L ar (m)	1,30		
C roundness	3,50	F angle (°)	75,00		
naca 00xx	0	naca 00xx	1		
naca 63-0xx	1	naca 63-0xx	0		
naca 65-0xx	0	naca 65-0xx	0		
Nb of rudders	1				
Offset y (m)	0,00				
Angle (°)	0,0				

Sailplan data	with Jib	with Code 0 and Roach
Xmast (m)	4,78	4,78
Zboom(m)	1,88	1,88
I (m)	11,00	12,40
J (m)	3,55	5,00
P (m)	11,30	11,30
E (m)	3,40	3,40
Jib HLP (m)	4,35	6,00
Main Roach	2,00	10,00
Fat head (m)	0,00	0,00
Spi (m2)	70,00	70,00
sym0 asym1	0	0
Extra Top(cm	0	0
Luff top	0	0

Mass spreadsheet data	
Hull (skin, structu	**19,00**
(kg/m2)	(kg/m2)
Deck – roof – co	**13,50**
(kg/m2)	(kg/m2)
Rig, sails and dec	**8,60**
(% Disp.)	(% Disp.)
Cabin accomoda	**18,00**
(% Disp.)	(% Disp.)
Rudder-Helm	**1,50**
(% Disp.)	(% Disp.)

5,1 Load - input data				
	Mass	Xg	Zg	Yg
	(kg)	(m)	(m)	(m)
Load (kg)	**300,00**	**2,00**	**0,85**	**0,00**
			0,85	**1,00**

>>> And in the following, you can also store your main results , example :

>> 5.2 Hull-Keel-Rudder with heel – Some input/output data at equilibrium			
Heel (°)	**0**		**1**
Height (cm)	**-2,1799**		**-2,1650**
Trim (°)	**0,520**		**0,520**
>> RM (kN.m)	2,943	**> GM1° (m)**	**1,04**
>> Sw (m2)	18,25		
Heel (°)	**20**		
Height (cm)	**3,2629**		
Trim (°)	**0,170**		
>> RM (kN.m)	12,158		
>> Sw (m2)	17,51		
Heel (°)	**30**		**110**
Height (cm)	**9,6824**		**70,5398**
Trim (°)	**-0,253**		**-1,850**
>> RM (kN.m)	15,144		4,807
>> Sw (m2)	17,08		17,77