Keel line formulation within Gene Hull Sailboat 3.5 - 03 2026

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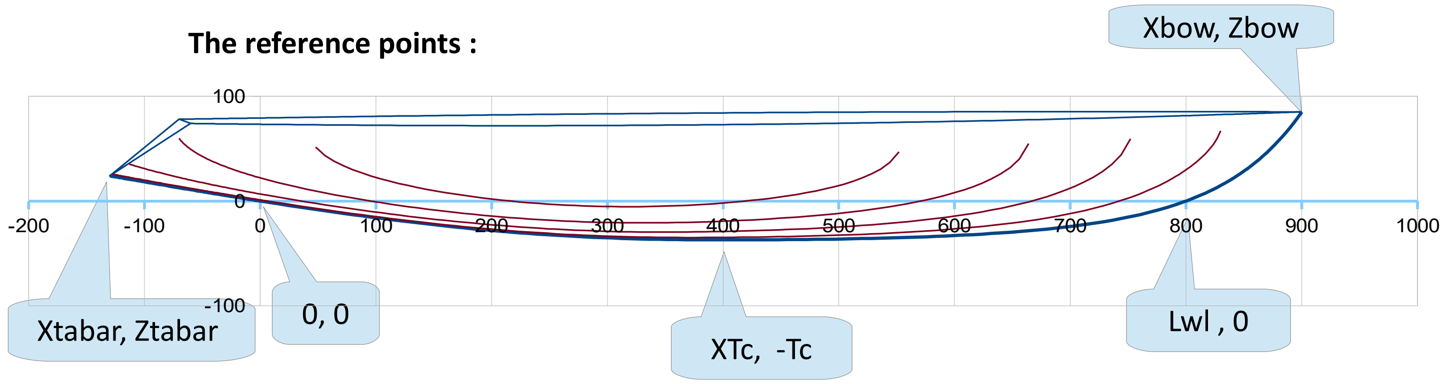
Introduction :

The keel line is defined in the vertical symetrical plan XoZ

Coordinates system :

X = 0 at station C0 (= rear point of the waterline), X positive towards front
Z = 0 at the waterline surface, Z positive towards up

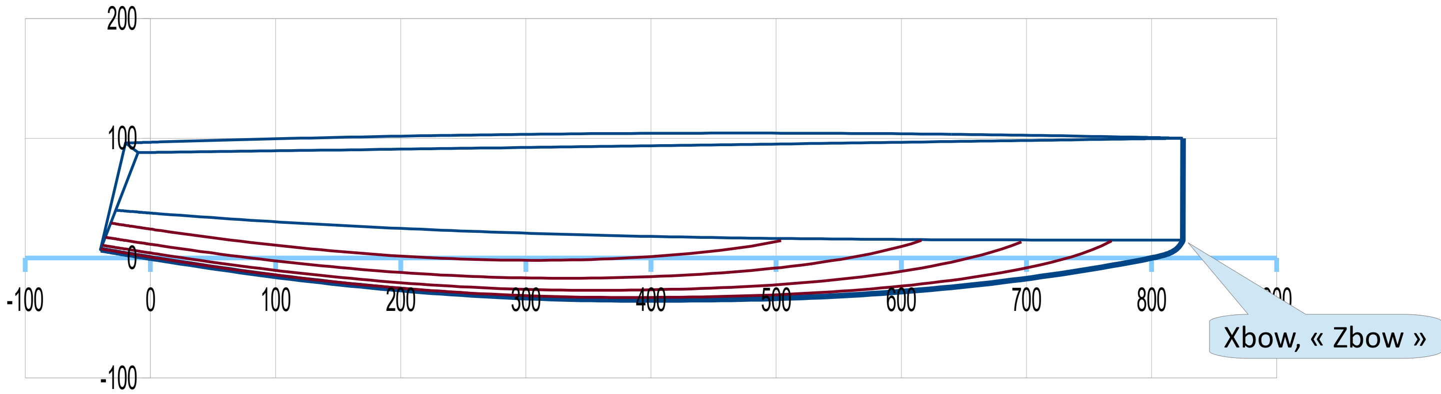
The reference points :



The keel line is defined by 2 functions Z(X) for respectively the fore part (when X > XTc) and the rear part (when X < XTc), XTc being the X coordinate of the hull body maximum draft Tc : XTc is an input data defined by the User (i.e. not necessarly at mid Lwl as shown here above).

Nota : hull maximum draft Tc is a positive data, leading to its coordinate Z = - Tc.

In case of hull with a hard chine line with a vertical bow, the « Zbow » value considered for the keel line computation is then the chine tip, i.e. « Zbow » is then taken equal to Zhc av the input data to define the chine line fore end.



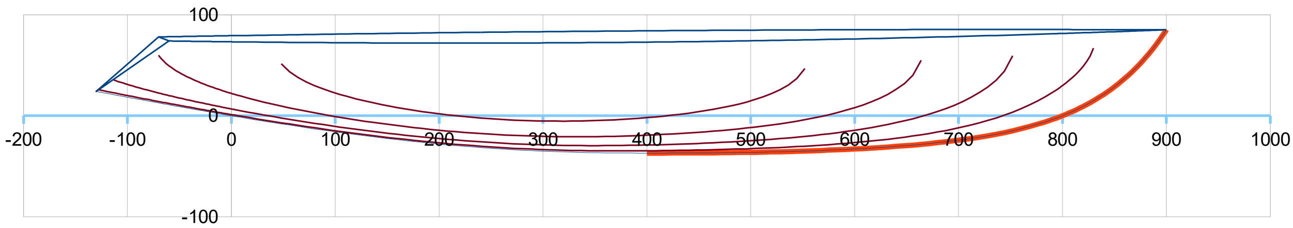
The corresponding geometrical data to input are (example from boat V1) :

Input geom. data (cm)					
Lwl	800,00				
Aft end		At maxi hull body draft		Bow end	
X tab ar	-130,00	X Tc	400,00	X bow	900,00
Z tab ar	24,00	Z = -Tc	-37,00	Z bow	85,00

In addition to the geometrical data, **4 adimensional parameters are also to input in order to shape the keel line** (example from boat V1) :

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**

<u>Fore part of the keel line</u> including the bow stem (for X = XTc to Xbow)



The fore function, including the bow definition, involves a sum of 2 terms in order to cover a wide variety of shape for the bow line :

Zfore(X) = Z1(X) + Z2(X) for X = XTc to Xbow

The first term Z1 is the basic formulation. The second term Z2 is optional, to straighten the bow above the water and to accentuate the fore foot, its influence can be neutralized if the parameter Kbrion = 0 (i.e. Z2 = 0 when Kbrion = 0). <u>Optional is not like fine tuning,</u> meaning that you can design a relevant beautiful hull without using the Kbrion option.

<u>First term Z1(X)</u> :

Z1(X) = -Tc + (1/**Kav**)*(X - XTc)^[**PuiZ0av** + **CorPuiZ0av***((X - XTc)/(Lwl – XTc))^Cet]

, where **Kav, CorPuiZ0av** and **PuiZ0av** are intermediate calculations such as :

Kav = (1/Tc) *(Lwl - XTc)^Puiqav

CorPuiZ0av = [Log(**Kav***(Zbow + Tc))/Log(Xbow – XTc) – Puiqav] / [((Xbow- XTc)/(Lwl - XTc))^Cet - 1]

PuiZ0av = Puiqav - **CorPuiZ0av**

So the input data used for this formulation are :

Geometrical : Tc, XTc, Lwl , Zbow, Xbow

Parametrical : Puiqav, Cet

<u>Second term Z2(X)</u> :

--- For X < XTc : Z2(X) =0

--- For XTc ≤ X < Lwl :

Z2(X) = Kbrion * **brion(X)** * (Z1(X) + Tc) * ((X – XTc)/(Xbow – XTc))^3
, where **brion(X)** is an intermediate calculation such as :

brion(X) = - Cbrion(X) * Xhbrionar * Sin(2 π * X / Lambdaar + Phiar)

with Cbrion(X) = ((X – Lwl/2)/(Lwl/2))^[Max(12-8(Xbow/Lwl-1)*100/11,5 ; 1)]

Xhbrionar = (Lwl – XTc) / (Xbow – Lwl)

Lambdaar = (Lwl – XTc) * 2

Phiar = - 2 π *XTc / lambdaar

--- For Lwl ≤ X < Xbow :

Z2(X) = Kbrion * **brion(X)** * (Z1(X) + Tc) * ((X – XTc)/(Xbow – XTc))^3

, where **brion(X)** is an intermediate calculation such as :

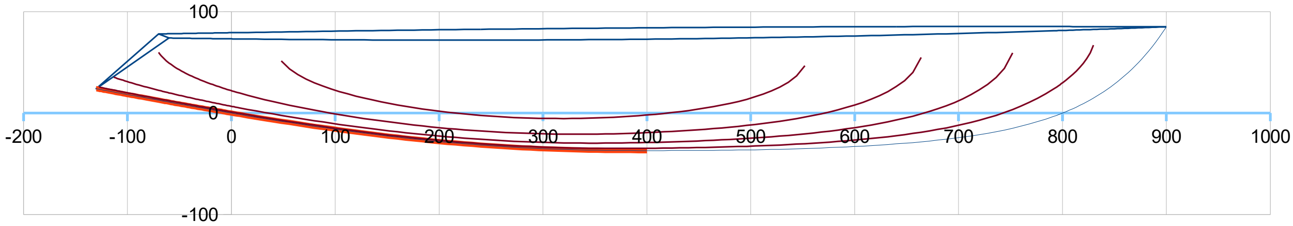
brion(X) = Sin(2 π * X / Lambdaav + Phiav)

with Lambdaav = (Xbow – Lwl) * 2

Phiav = - 2 π *Lwl / lambdaav

So the input data used for this Z2(X) formulation are :
Geomotrical : Xtc, Tc, Lwl , Xbow,
Parametric : Kbrion

Rear part of the keel line (for X = XTabar to XTc)



Zrear(X) = -Tc + (1/**Kar**) * (XTc - X)^[**PuiZ0ar** + **CorPuiZ0ar** * (XTc – X) / XTc]

, where **Kar**, **PuiZ0ar** and **CorPuiZ0ar** are intermediate calculations such as :

Kar = (1/Tc) * XTc^Puiqar

CorPuiZ0ar = [Log(Kar * (Ztabar + Tc))/Log(XTc – Xtabar) – Puiqar] / [(XTc -Xtabar)/XTc - 1]

PuiZ0ar = Puiqar – CorPuiZ0ar

The input data used for this formulation are :

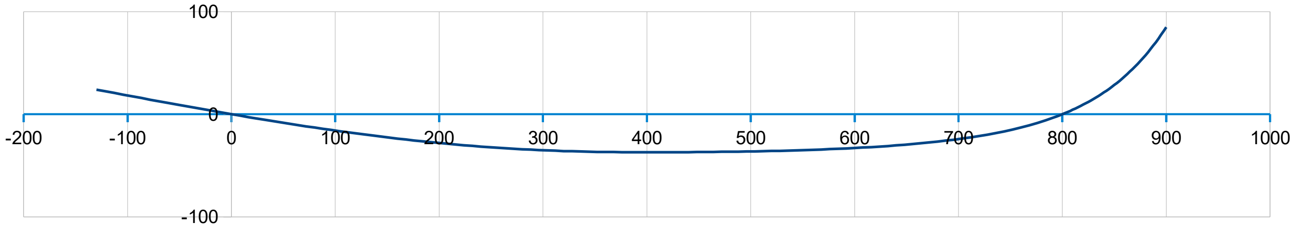
Geometrical : XTc, Tc, Xtabar, Ztabar

Parametric : Puiqar

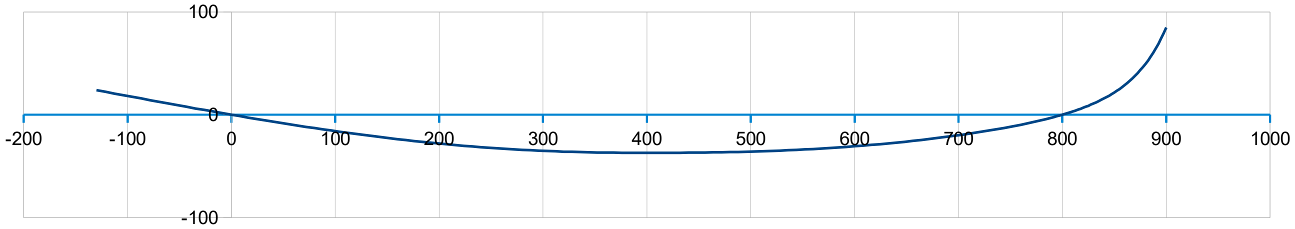
Some typical examples done with the .ods file also proposed to illustrate the formulations

The influence of Cet (in combination with more or less fore overhang)

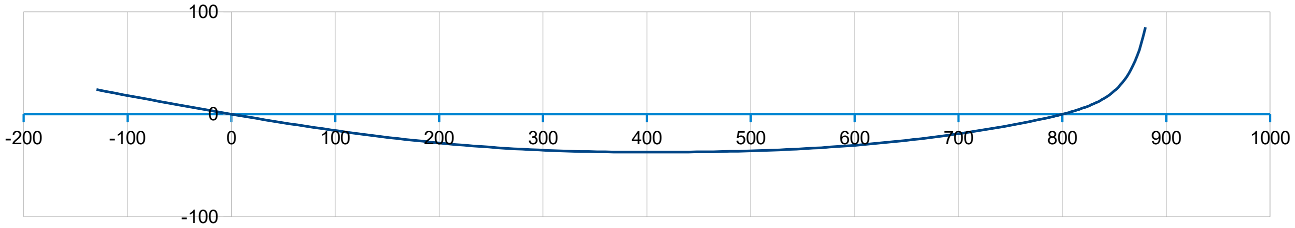
X bow 900,00 Cet 3,00



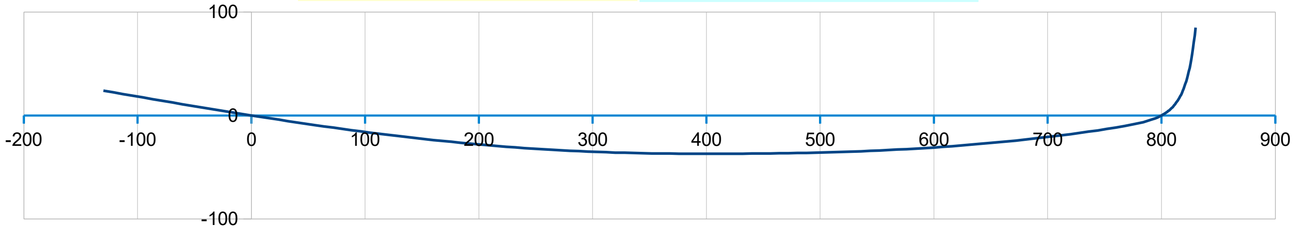
X bow 900,00 Cet 10,00



X bow 880,00 Cet 20,00

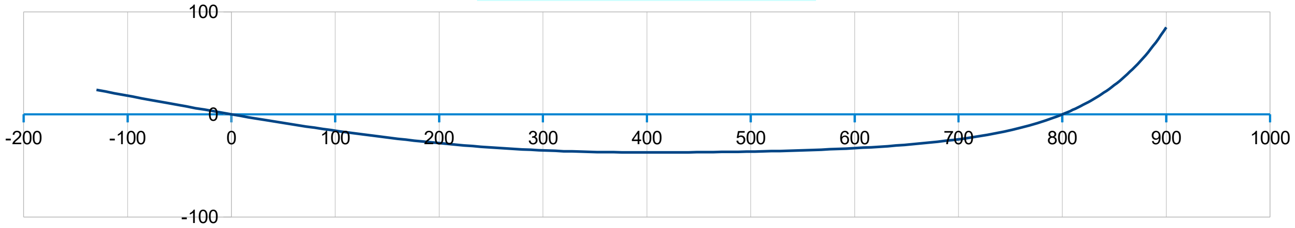


X bow 830,00 Cet 30,00

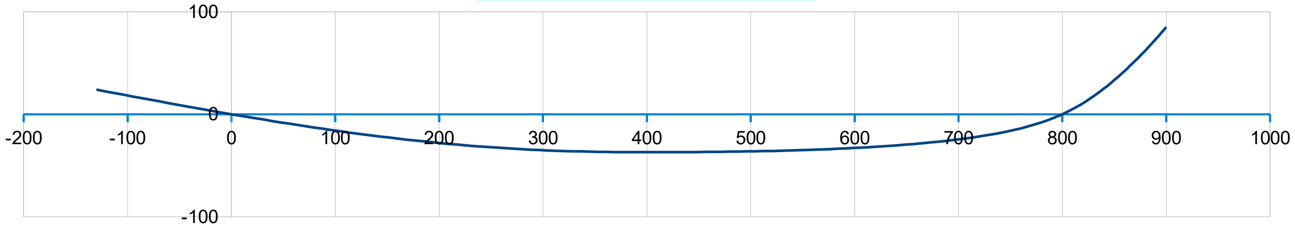


The influence of Kbrion :

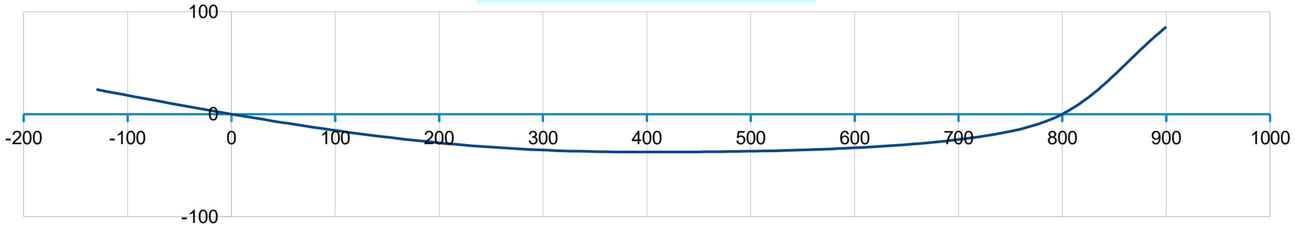
Kbrion 0,00



Kbrion 0,10

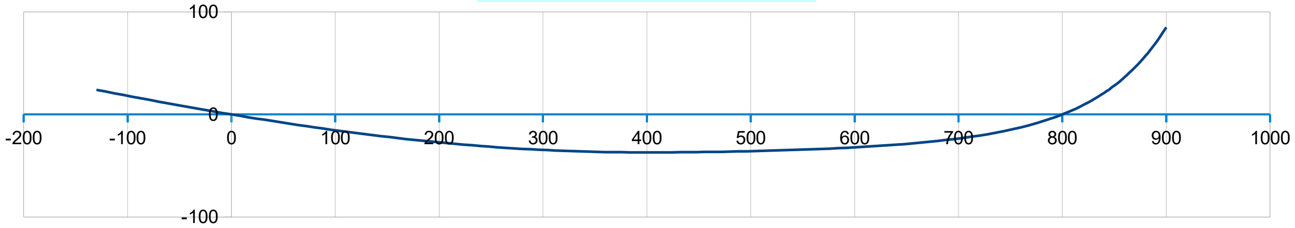


Kbrion 0,20

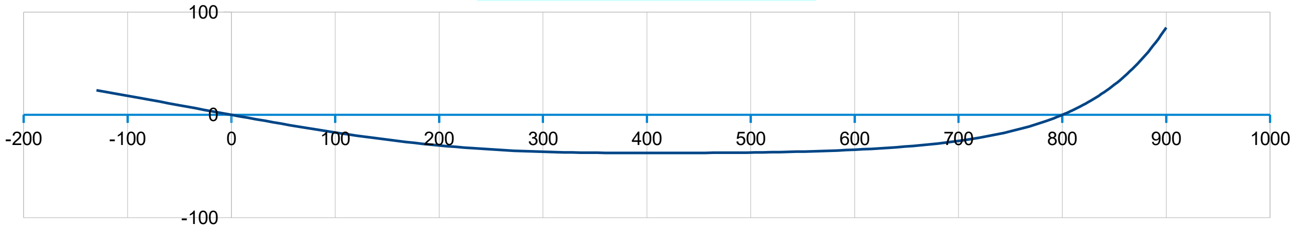


The influence of Pui q av and Pui q ar

Pui q av 2,1
Pui q ar 2,1

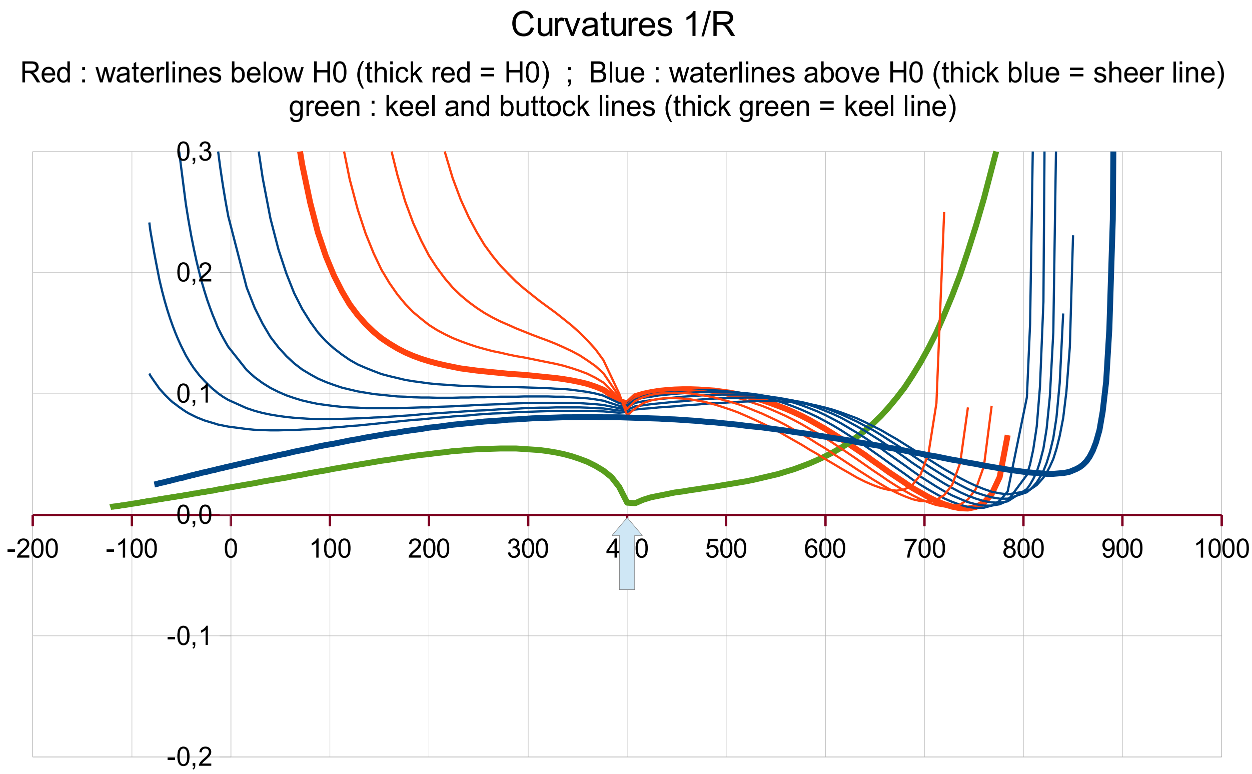


Pui q av 3,00
Pui q ar 3,00



Annex : About the connection of the two half parts

There is of course tangential continuity at the connection point (XTc, -Tc), and also curvature continuity when using values of Puiqav and Puiqar > 2 which is recommended. Because the two Z(X) functions behave as polynomes of degrees Puiqav (fore) / Puiqar (rear) in the vicinity of Xtc, and with usual values of >2 to 3, the curvature 1/R curve shows a downward oriented peak towards zero at Xtc (**see the green line here below**) : **it is an analytical result, not an anomaly.**



Demonstration with a polynome of degree 2,3 :

$Z = X^{2,3}$ >> $Z' = 2,3 \cdot X^{1,3}$ & $Z'' = 2,3 \cdot 1,3 \cdot X^{0,3}$

>>> curvature $1/R = |Z''| / (1 + Z'^2)^{(3/2)} = 2,3 \cdot 1,3 \cdot X^{0,3} / (1 + 2,3^2 \cdot X^{2,6})^{1,5}$