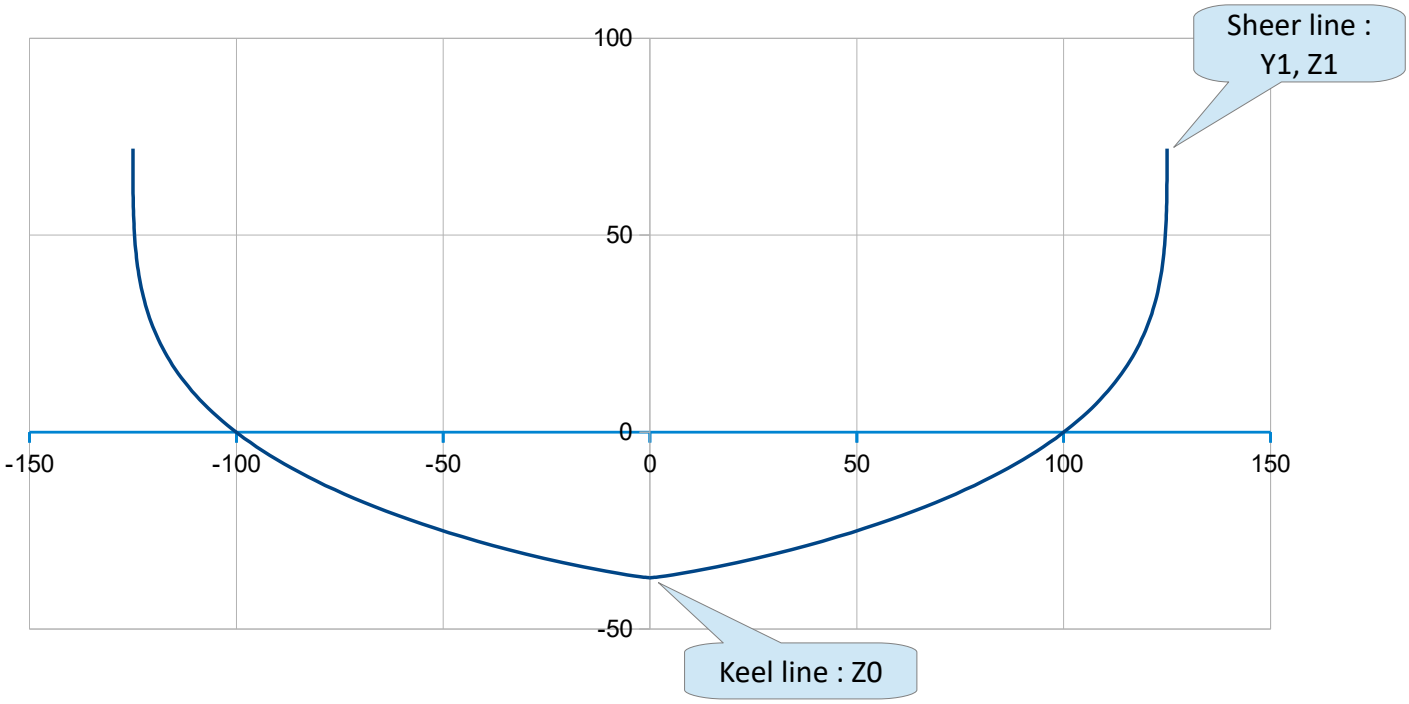
Sections formulation within Gene-Hull Sailboat 3.5 – 03 2026

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 formulation is generalised in order to allow a wide variety of shape.

Introduction :

The section formulation is based on 2 reference points :
--- the one from the keel line, Zkeel(X), here renamed **Z0** for simplification
--- the one from the sheer line, Ysheer(X) and Zsheer(X), here renamed **Y1, Z1** for simplification



, and on 3 adimensional parameters : **PE1, CPE1, PE2** allowing a wide variety of shape.

Z0 = Zkeel(X) will be defined in the document « Keel line formulation »

Y1, Z1 = Ysheer(X), Zsheer(X) will be defined in the document « Sheer line formulation »

The 3 parameters PE1(X), CPE1(X), PE2 (X) are also function of X, their formulation are given at the end of the present document, based on the User input for 3 locations (hull bow end, midship, transom aft end) . Exemple for the boat V1 :

	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

- PE1 (should be ≥ 0,5 , usual values 1 to 4) mostly acts on the upper part of the section line,
- PE2 (should be > 0 , usual values 0,5 to 4) mostly acts on the lower part of the section line,
- C PE1 is a fine tuning of PE1 influence :

C PE1 < 1 >>> generate a tumblehome shaping of the section
C PE1 = 1 >>> neutral value, no influence on the basic formulation using PE1 and PE2
C PE1 > 1 >>> accentuate the flare shaping of the section

The half section formulation y = f(z)

$$y = (Y1/CPE1) * [1 - ((Z1 - z)/(Z1 - Zo))^{PE1}]^{(1/PE2)} * [1 + (CPE1-1)*((z-Zo)/(Z1 - Zo))^{CPE1}]$$

Basic formulation using PE1 & PE2 — Correction factor using CPE1

for z = Z0 to Z1 , so a function describing a line starting from the keel point Z0 and going up to the sheer point Y1,Z1.

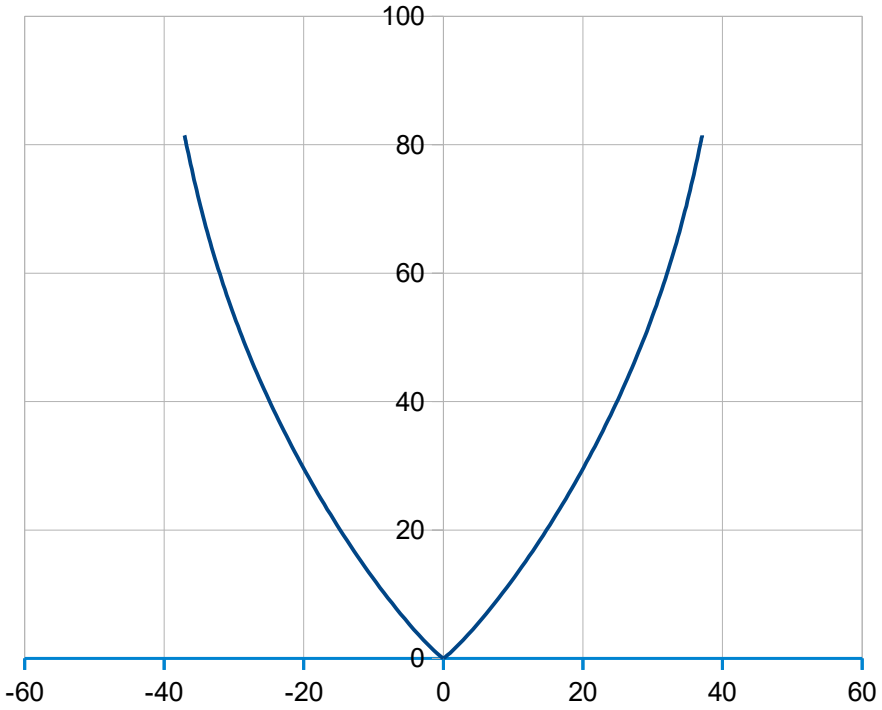
An .ods file is also given for you to test the formulation for various set of data and to see the resulting drawing :

Here are some typical examples, from boat V1 design :

Fore section at C10 station (Fore perpendicular) :

Input geom. data (cm)	
Sheer : Y1	37,09
Sheer : Z1	81,45
Keel : Z0	0,00

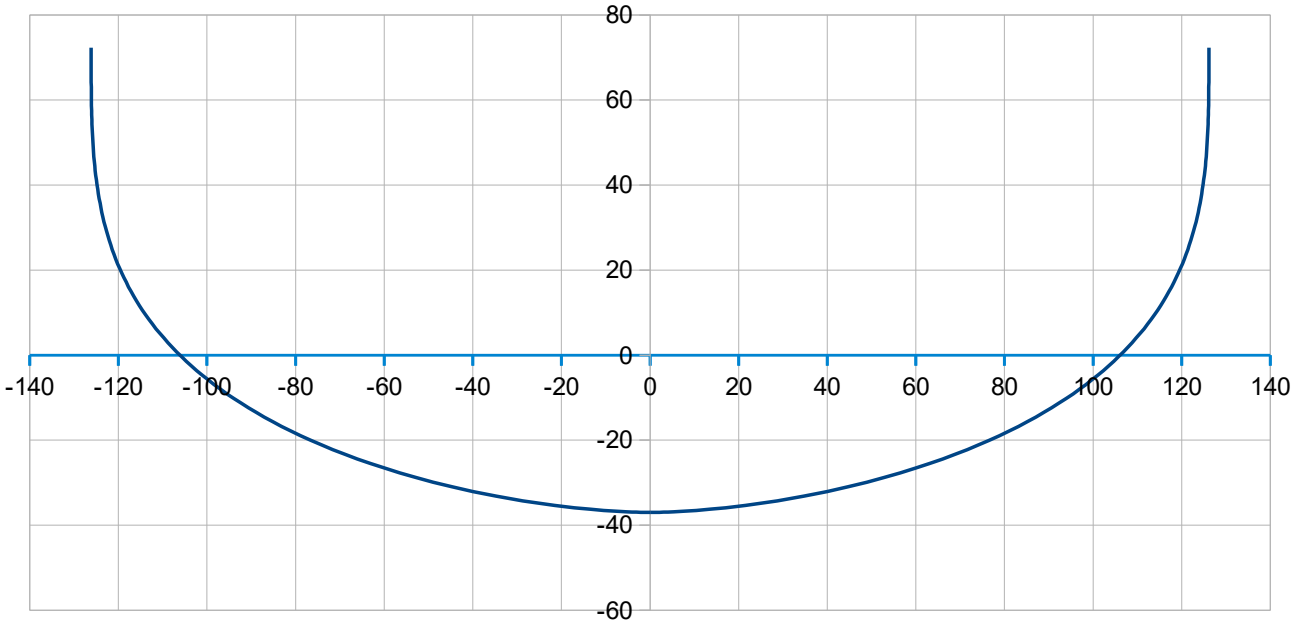
Input adimensional parameter		
PE1	C PE1	PE2
2,460	1,424	1,114



Mid section at C5 station :

Input geom. data (cm)	
Sheer : Y1	126,13
Sheer : Z1	72,34
Keel : Z0	-37,00

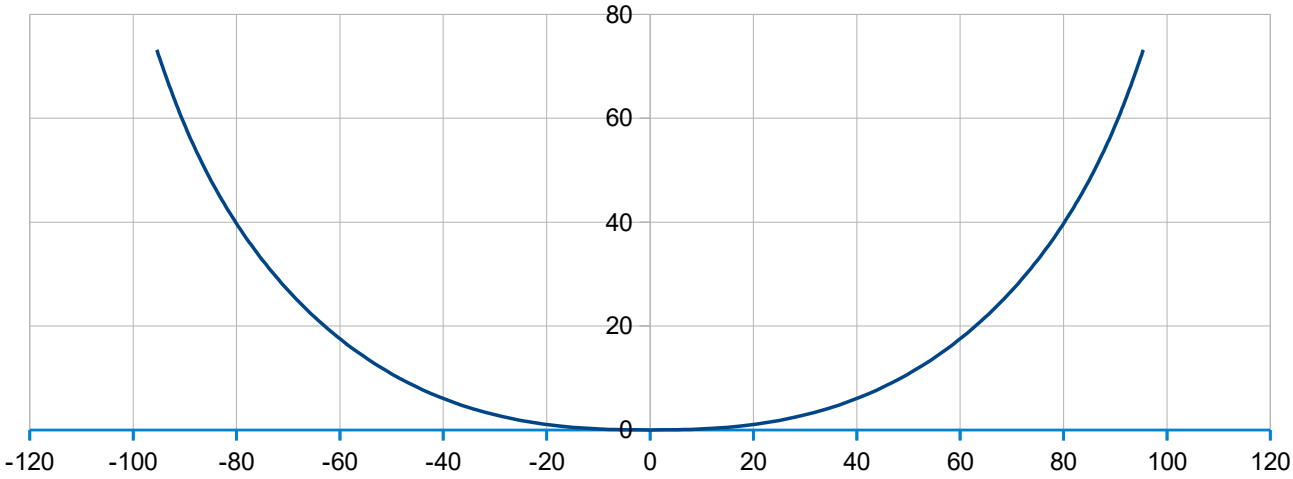
Input adimensional parameter		
PE1	C PE1	PE2
3,310	1,000	1,700



Aft section at C0 station (aft perpendicular) :

Input geom. data (cm)	
Sheer : Y1	95,43
Sheer : Z1	73,18
Keel : Z0	0,00

Input adimensional parameter		
PE1	C PE1	PE2
2,578	1,264	2,496

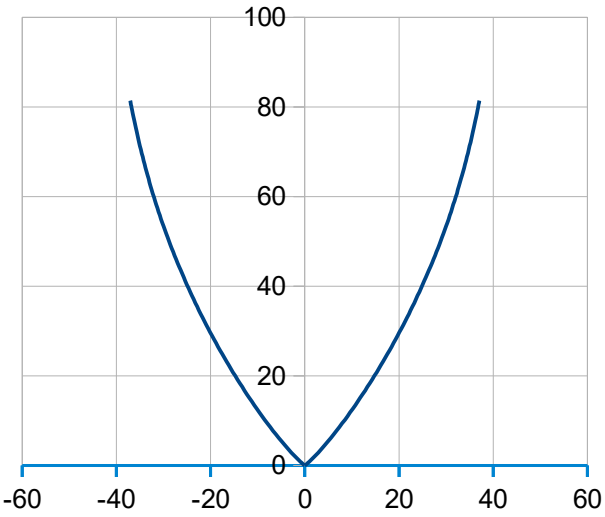


Check of the convexity :

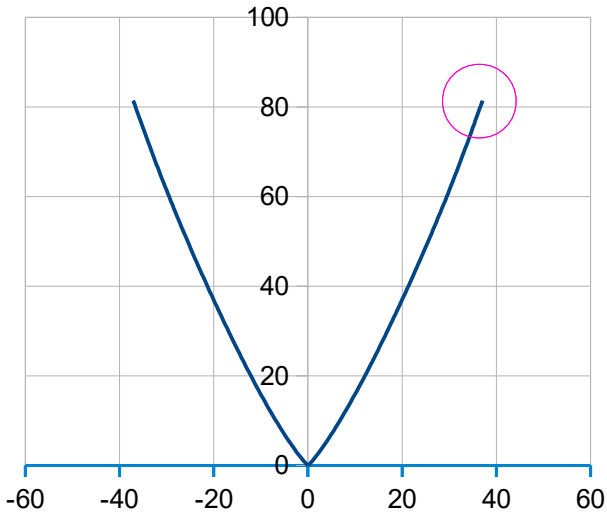
In the test file as in Gene-Hull Sailboat 3.5, I added a check of the convexity of the line at its top because with a too high value of CPE1 you can generate a slight concavity not always visible by eyes : this could be either intentional (then you can keep it) or it is undesired (then you should input a lower value of CPE1) . Examples for the typical fore section showed above, with various CPE1 all other data unchanged :

At first, with the initial **CPE1 = 1,424** , the check is Ok. But if we increase to say **CPE1 = 1,75**, the check gives a slightly negative value, of only -0,01° , so not visible by eyes but real numerically :

Check :
Diff angle min (°)
0,00
Positive or 0 = Ok convex
Negative = slight concavity at top

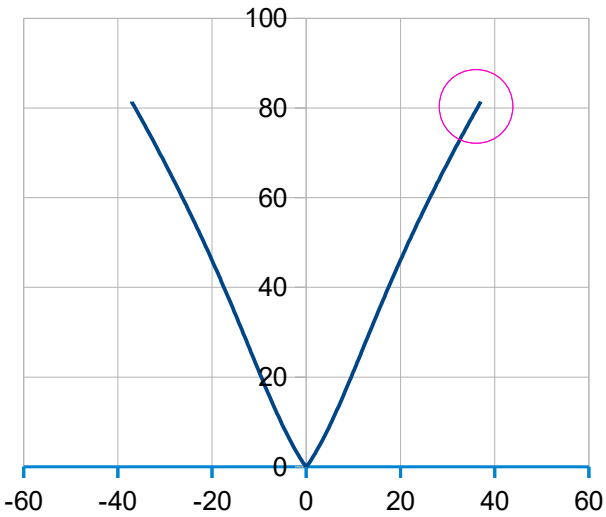


Check :
Diff angle min (°)
-0,01
Positive or 0 = Ok convex
Negative = slight concavity at top



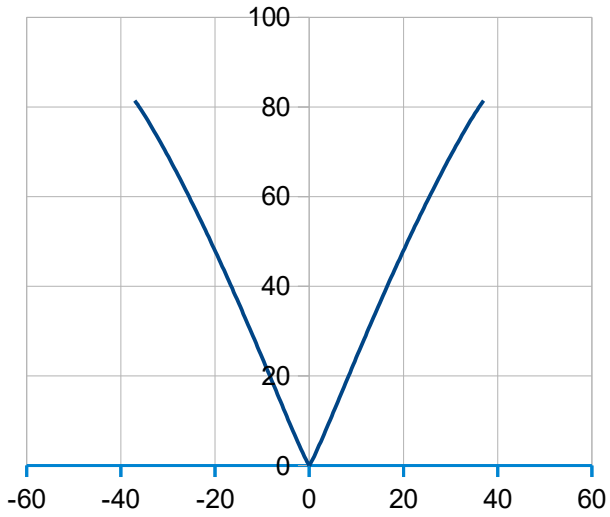
With a greater value say **CPE1 = 2,20** then the check gives -0,02° and the concavity is visible, giving a shape that you can accept or not :

Check :
Diff angle min (°)
-0,02
Positive or 0 = Ok convex
Negative = slight concavity at top



But if that kind of concav shape is your intention, I recommend you to rather use a PE1 < 1 associated with a lower value of CPE1, you will have a better shape. Example :

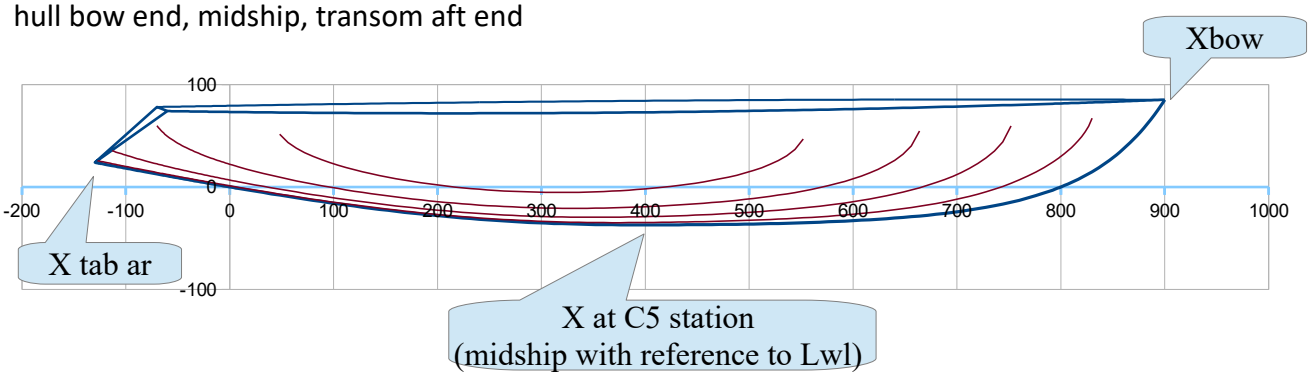
PE1	C PE1	PE2
0,900	1,200	1,114



So this proposed check is especially a warning when a full convex shape is your intention.

The formulation with X of the parameters PE1, C PE1, PE2

As it was said in the introduction, the User input the values of PE1, CPE1 , PE2 at 3 locations : hull bow end, midship, transom aft end



Example for the boat V1 :

	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

Formulation with X of each parameter allow to have their values for any X in order to draw any section. Here, we just use a quadratic formulation, i.e. a second degree polynome based on 3 values. Example for PE1 :

Data :

PE1fore at X = Xbow , renamed « Fore » at « Xb » in the formulation below
PE1mid at X = XC5 , renamed « Mid » at « Xc » in the formulation below
PE1aft at X = Xtabar , renamed « Aft » at « Xa » in the formulation below

Formulation :

$PE1(X) = A X^2 + B X + C$

with :

$A = ((Mid – Fore)*(Xa – Xc) – (Aft – Mid)*(Xc – Xb)) / ((Xc^2 – Xb^2)*(Xa – Xc) – (Xa^2 – Xc^2)*(Xc - Xb))$

$B = ((Mid – Fore) – A*(Xc^2 – Xb^2)) / (Xc - Xb)$

$C = Mid – A*Xc^2 - B*Xc$

Here to be complete, another subtility automatically adressed within Gene-Hull : when the User « neutralised » the CPE1 effect in two consecutive locations by putting 1 , for example :

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

In such case the formulation above gives some values of C PE1 < 1 between Aft and Mid, i.e. a slight tumblehome shape, which is clearly not the intention of the User. So Gene-Hull slightly increases the value of C in order that the CPE1(X) formulation gives ≥ 1 everywhere.