**Sheer line formulation used in « Gene Hull Sailboat 3.5 » - 04 2026**

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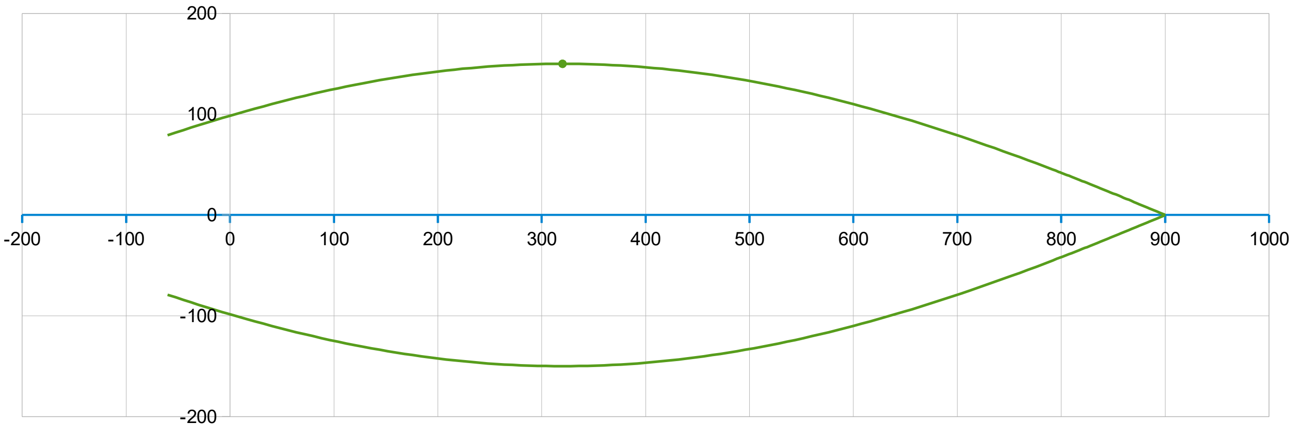
## Introduction :

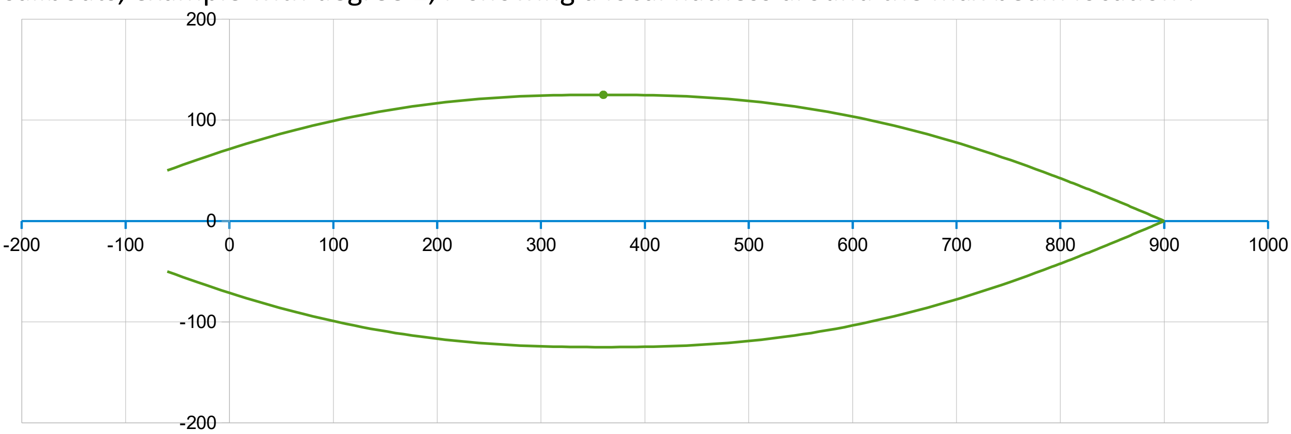
I think it might be interesting to introduce these formulations through my own approach from the beginning of Gene-Hull, to better highlight the reason of each step of complication.

At first, I wanted a very simple formulation, so I adopted a parabolic curve, that is to say a polynomial of degree 2. But it appears that the line towards the bow (and towards the stern to a lesser extent) was not taut enough compared to the usual designs, so I added a small complication : the degree 2 of the polynomial is slightly decreased as one approaches the forward and aft ends. It is the so-called « generic » sheer line here after.

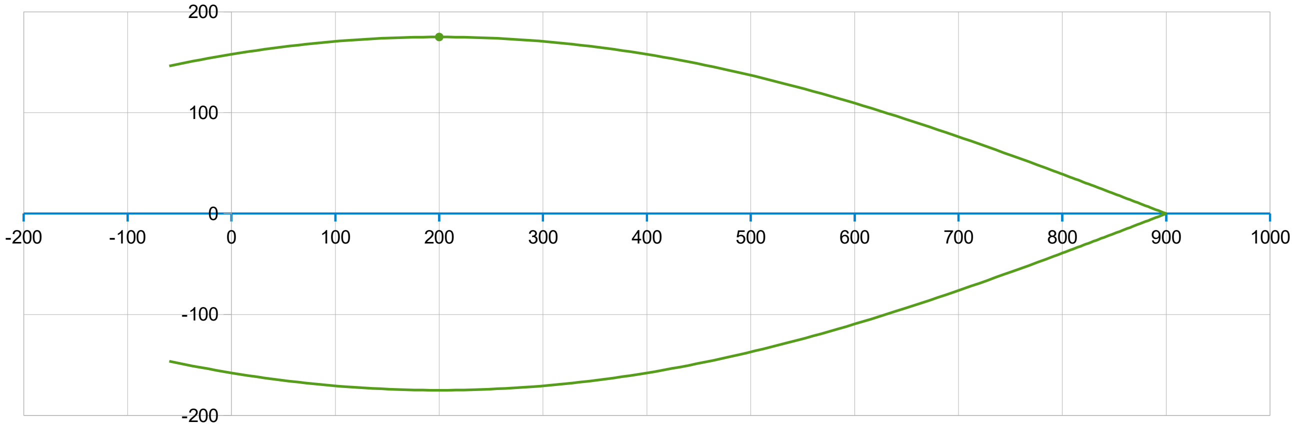
This generic sheer line works quite well for classic keel boat and IOR ones of the 60-70 years, the max beam and the max curvature of the sheer line are at the same X location, example (the point shows the maximum beam & curvature) :



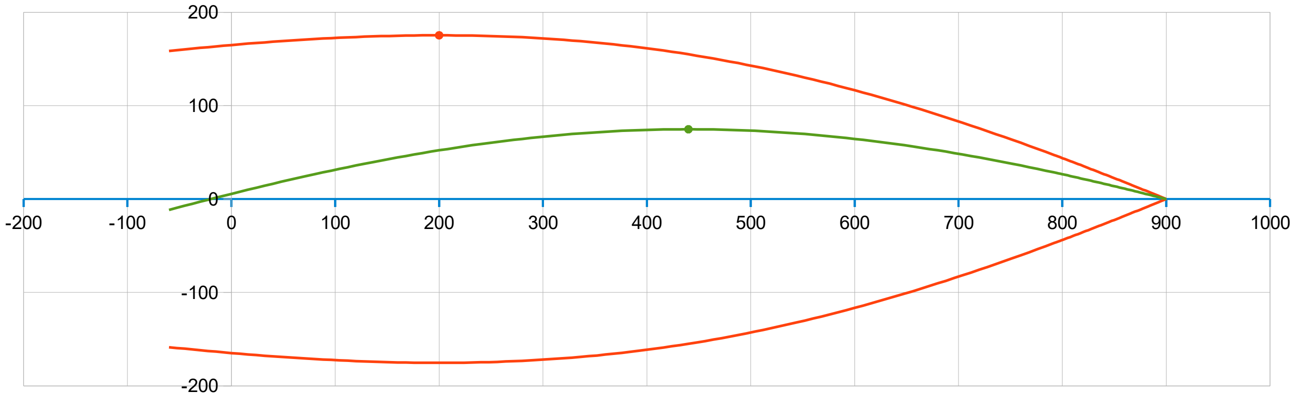

With a degree > 2, the generic formulation can also generate the sheer line of some traditionnal sailboats, example with degree 2,4 showing a local flatness around the max beam location :




But the « generic » sheer line has its limit, and this became obvious when I wanted to represent the sheer line of a modern beamy sailboat as inspired by the Imoca class development since the 1990s. If I just increase the beam and put it backward, the sheer line looks not relevant when compared with the usual designs. Example :

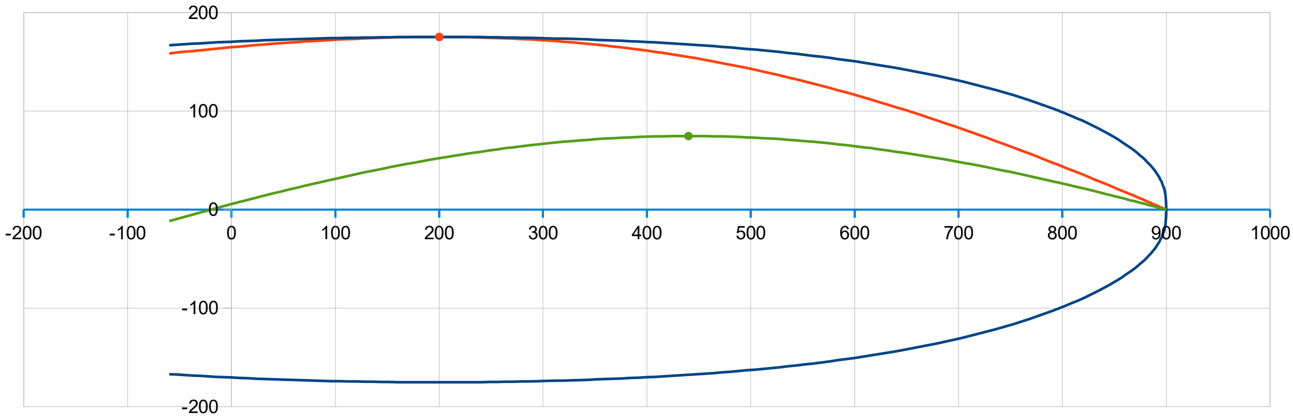



What is not good here above is the maximum curvature kept at the maximum beam, so very far aft. To remedy this, I had the idea of opening the lines like opening scissors, using the front point as the center of rotation, hence the so-called "Alfa" transformation (the angle of rotation). Example, a virtual « generic sheer » line is drawn and then opened with the « Alfa » transformation in oder to have the same max beam at the same location as above :




>>> the maximum beam is at X 200 as for the previous example but here the maximum curvature remains at ~ 440 where was the maximum beam of the virtual sheer line. So the « Alfa » sheer line allows a greater variety of shapes for the sheer line, while with putting Alfa = 0 you still can return to the generic one.

But another family of shapes was still not possible, the scow type. So, I developed a third level of the formulation, so-called the « Alfa + Scow » sheer line, starting from the previous one (with Alfa active or not). Example, in continuity of the previous one :




>>> The Scow transformation keep unchanged the max beam and its location.

**The sheer line, in its horizontal projection xy**

**Coordinates system and notation :**

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

y = 0 in the symmetrical longitudinal plan,

Ysheer(X) is renamed Y1(X) to simplify the formulations, as also done for the sections ones.

## 1) The generic sheer line

**This first sheer line does not use the parameters Alfa and Scow (Alfa =0 ; Scow = 0) :**

Y1(X) = Bg/2 – C * ABS(X - XBg)^[Puilivy - Corpuiliv * (ABS(X -XBg)/(Xbow - XBg))^Puicorpui]

, where C = (Bg/2) / (Xbow – XBg) ^(Puilivy – Corpuiliv)

XBg = XBg (% Lwl) * Lwl / 100

Valid for X = Xlivar to Xbow ; ABS is the function « Absolute value of ... »

Data used for this formulation are :

Geometrical : Bg, Lwl, Xbow, XBg (%Lwl) (+ Xlivar for the range of X for the computation)

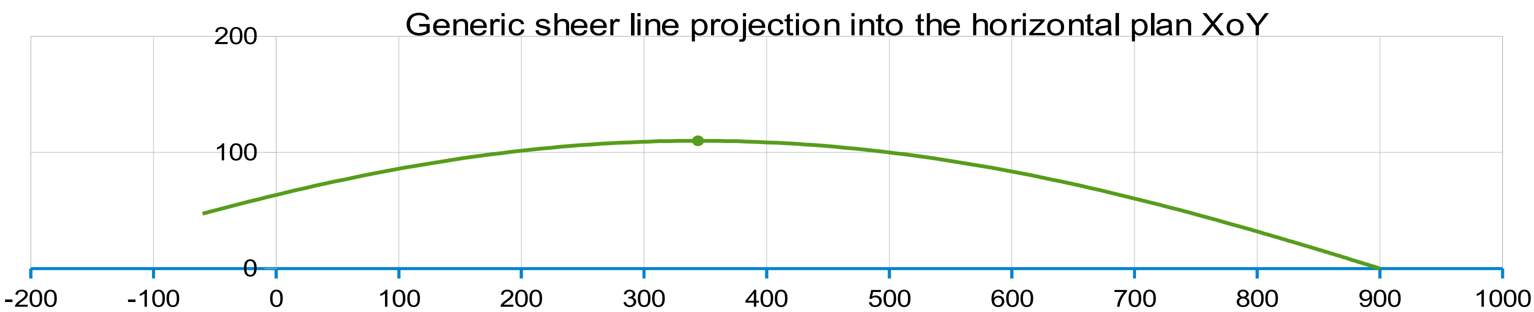
Adimensional parameter : Puilivy, Corpuilivy, Puicorpui

Example with (from Boat V1) :

| | |
|---|---|
| **Lwl** | **800,0** |
| **Xbow** | **900,0** |
| **X liv ar** | **-60,0** |

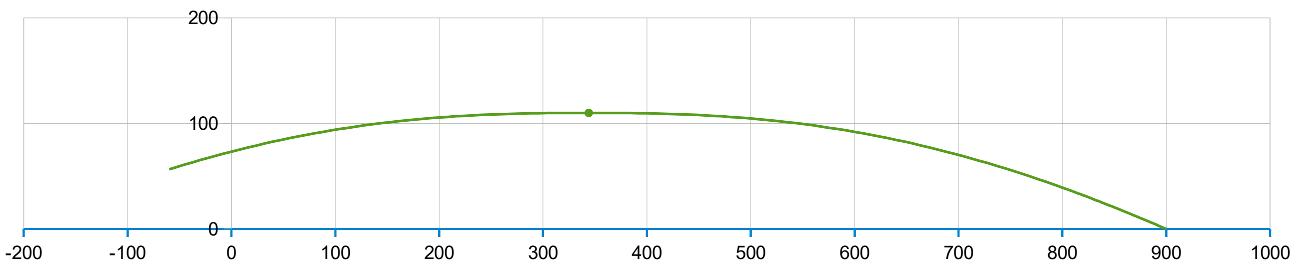
| | |
|---|---|
| **Bg** | **219,9** |
| **X Bg (% Lwl)** | **43,0** |

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




**The green point** is to show the location of the max Beam.

Puilivy = 2 is strongly recommended to have a smooth regularity of the curvature evolution, but you can also adopt Puilivy >2 to have some sheer line that we can see for traditionnal sailboat. **Another example with Pui liv y = 2,5 ,** here you have a small flatness around the max beam position. In such case, you have no need to use the Alfa transformation described here after.



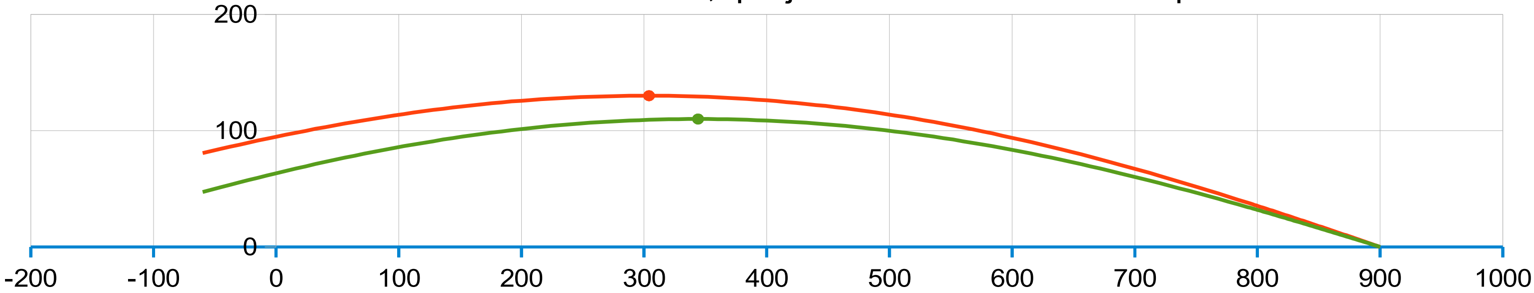
## 2) The sheer line transformed by Alfa

Y1 Alfa (X) = - (X-Xbow) * sin(Alfa) + Y1(X) * cos(Alfa)    for X = Xlivar to Xbow

The complementary data used is only Alfa (°)

**Example with Alfa (°) = 2** , other above data being unchanged (from Boat V1) :

In red : sheer line with Alfa = 2°, projection into the horizontal plan XoY

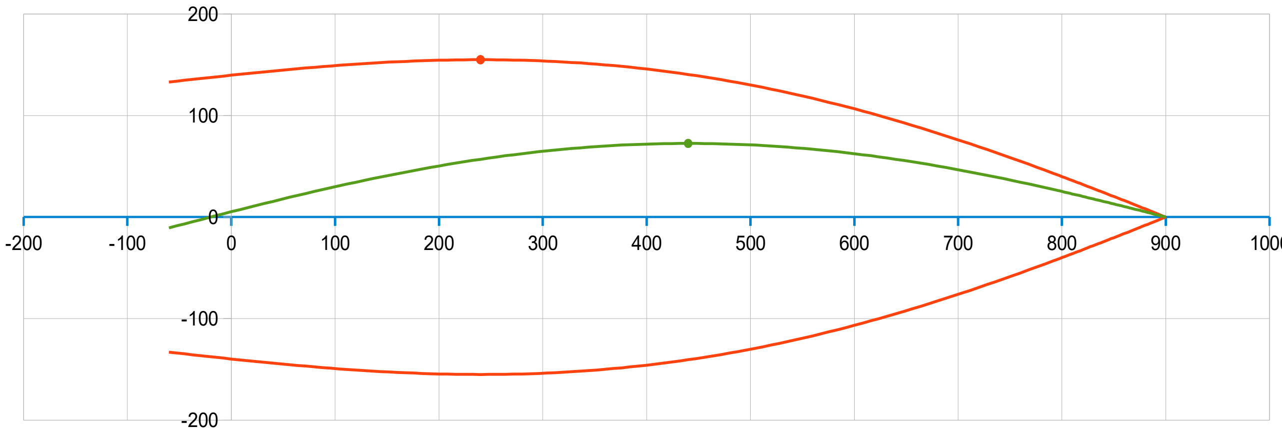



**The red point** shows the new location of the max Beam, of which value et position are output :

| >>> Output data (cm) | | | |
|---|---|---|---|
| Bmax | 260,0 | at Xb(%Lwl) | 38,0 |

**Another example with :**

| | |
|---|---|
| **Bg** | **145,1** |
| **X Bg (% Lwl)** | **55,0** |
| **Alfa (°)** | **8,60** |




| >>> Output data (cm) | | | |
|---|---|---|---|
| Bmax | 310,0 | at Xb(%Lwl) | 30,0 |

## 3) The sheer line transformed by Alfa and Scow

Y1 Alfa+Scow(X) = Y1 Alfa(X) + Scow(X) * [Bmax/2 – Y1 Alfa(X)] * [(Xbow – X)/(Xbow – XBmax)]^Puiscow

where :

Scow(X) = Scow * [1 – 0,5 . ((Xbow – X)/(Xbow – Xtabar))^2]

Bmax is the maximum beam issued from Y1 Alfa(X) formulation

XBmax is the X location of Bmax

(*No formulation for these two last data, you should recover them by exploiting the Y1 Alfa(X) formulation , as done in the .ods file joined for test, cells P167 and Q169*)

The complementary data used are :

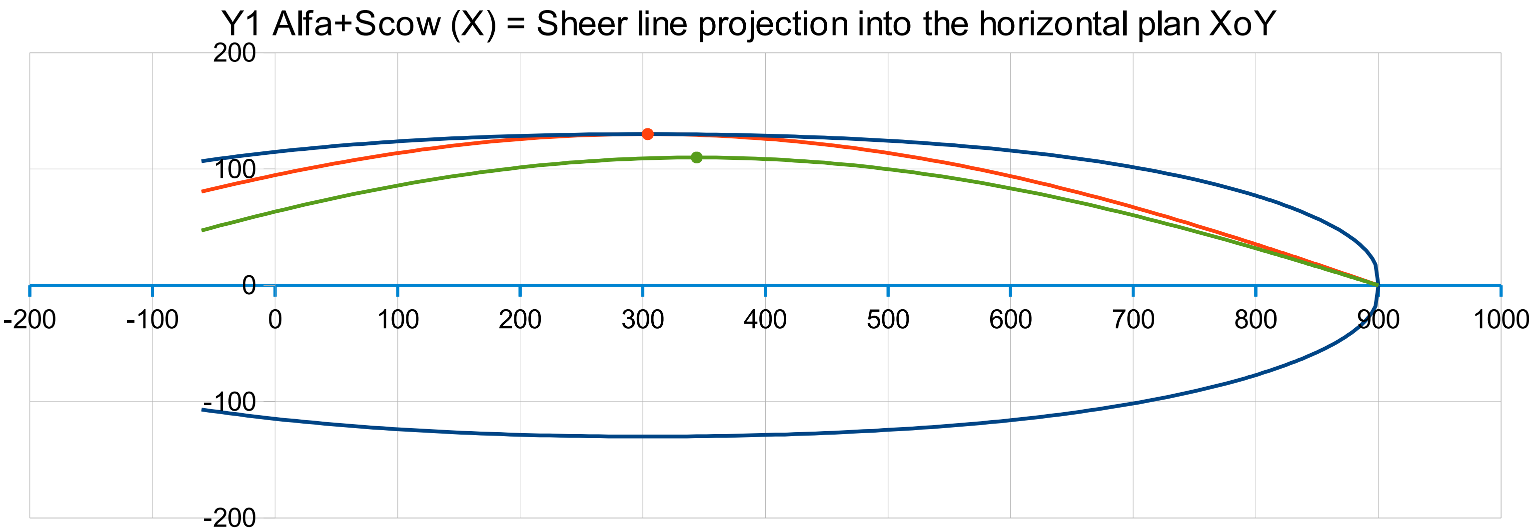
Geometrical : Xtabar

Adimensional parameters ; Scow, Pui Scow

Example , with (in addition to the above data) :

| | |
|---|---|
| **X tab ar** | **-130,0** |

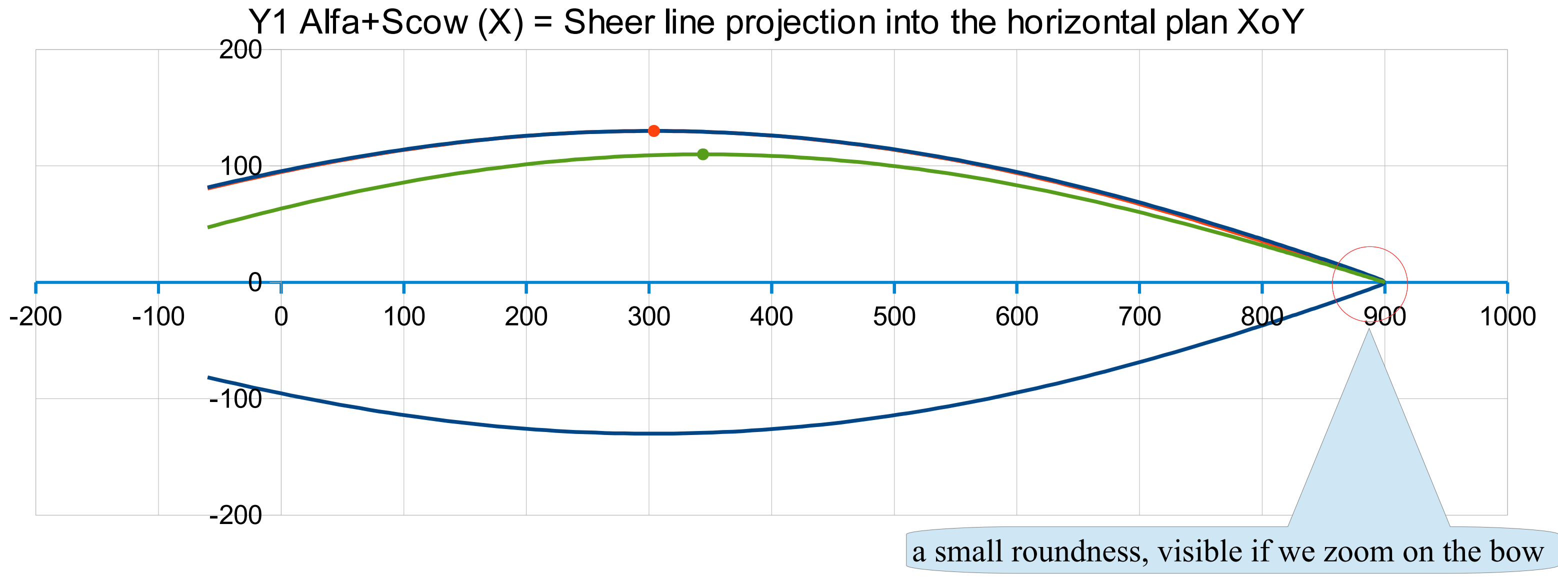
| | |
|---|---|
| **Scow** | **0,80** |
| **Pui Scow** | **0,33** |




Nota : The max beam and its position is not modified by the Scow transformation

**Another example : Scow parameter can be used at minima** for just representing the small roundness of the bow due to the construction process, example (from boat V1) :

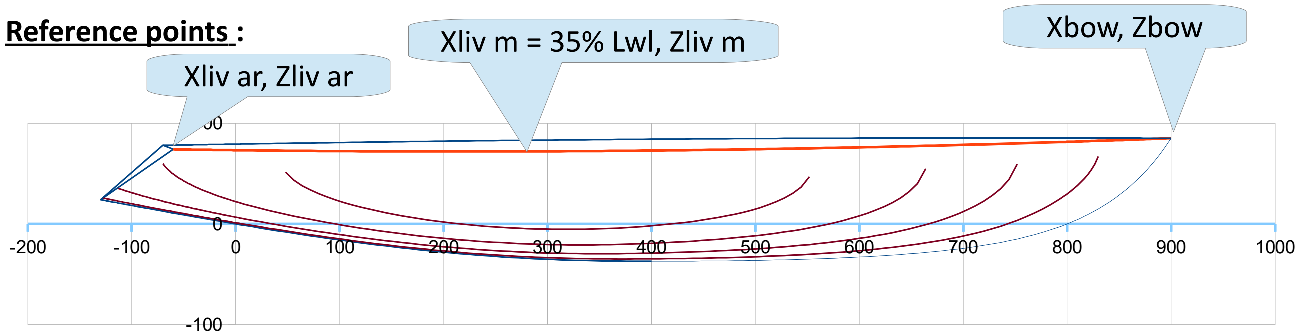
| | |
|---|---|
| Scow | 0,03 |
| Pui Scow | 0,25 |




And also, Scow can be used while Alfa kept = 0 , the two parameters can act independently.

**Sheer line / in its vertical projection xz**

**Reference points :**




The sheer line in its vertical projection is defined by 3 reference points and a degree 2 polynome :

Z1 (X) = a . X^2 + b . X + c

Where
a = [(Zlivm – Zbox) * (Xlivar – Xlivm) – (Zlivar – Zlivm) * (Xlivm – Xbow)] / [(Xlivm^2 – Xbow^2) * (Xlivar – Xlivm) – (Xlivar^2 – Xlivm^2) * (Xlivm-Xbow)]

b = [(Zlivm – Zbow) – a * (Xlivm^2 – Xbow^2)] / (Xlivm - Xbow)

c = Zlivm – a * Xlivm^2 – b * Xlivm

The input data for this formulation :
Geometrical : Xlivar, Zlivar, Xlivm = 0,35 * Lwl, Zlivm, Xbow, Zbow

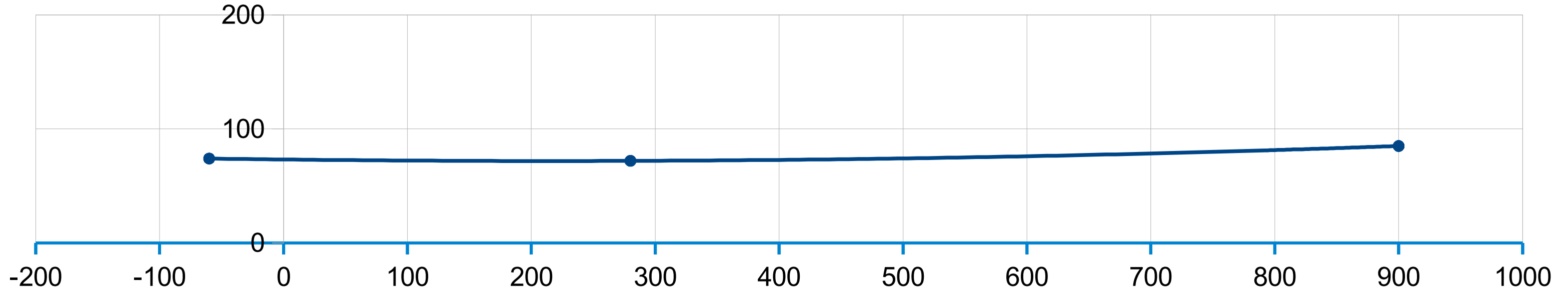
Example (from boat V1) :

| | |
|---|---|
| **X liv ar** | **-60,0** |
| **Z liv ar** | **74,0** |

| | |
|---|---|
| **Lwl** | **800,0** |
| **Sheer line at 35% Lwl** | |
| **Z liv m** | **72,0** |

| | |
|---|---|
| **Xbow** | **900,0** |
| **Zbow** | **85,0** |

Zsheer (X) = Sheer line projection in the vertical plan XoZ (based on the free-boards input)




The points show the 3 free-boards which are the input data .

In case of a vertical chine as adopted in most modern designs, the hard chine line becomes the « sheer line equivalent » for the generation of the hull body under the chine .

Example from boat U1 :