Aalto University

# Modeling Hull form using offset table

# Contents

# Modelling a Ferry  using offset table

- **In this tutorial we are going to use the offset table in the “T4_hull lines” excel file to model the vessel in Maxsurf.**
  - ➢ Instead, you can also create the model using lines plan in the same excel file, as explained in the presentation “02 Ice Breaker from lines plan“
- **Steps involved in this tutorial**
  - ✓ Importing offset table data as markers from a text file.
  - ✓ Creating surface using markers.
  - ✓ Fairing
  - ✓ Trimming and final preparation for further stability and resistance analysis.
  - ✓ Hydrostatics.

# Offset Table

- **First we need to define the main particulars of the vessel in excel. In this example we have the following particulars**
  - $L_{pp}$ = 362 m
  - B = 65 m
  - T = 9.3 m
  - D = 22.6 m
  - $C_b$ = 0.752
- **Amend the offset table, lines plan, sectional area curve etc. to obtain the desired hull form, refer to " T4_Hull Lines xlsx tutorial" presentation.**
- **The lines should be fair enough before exporting the corresponding offset table to Maxsurf.**

# Offset Table

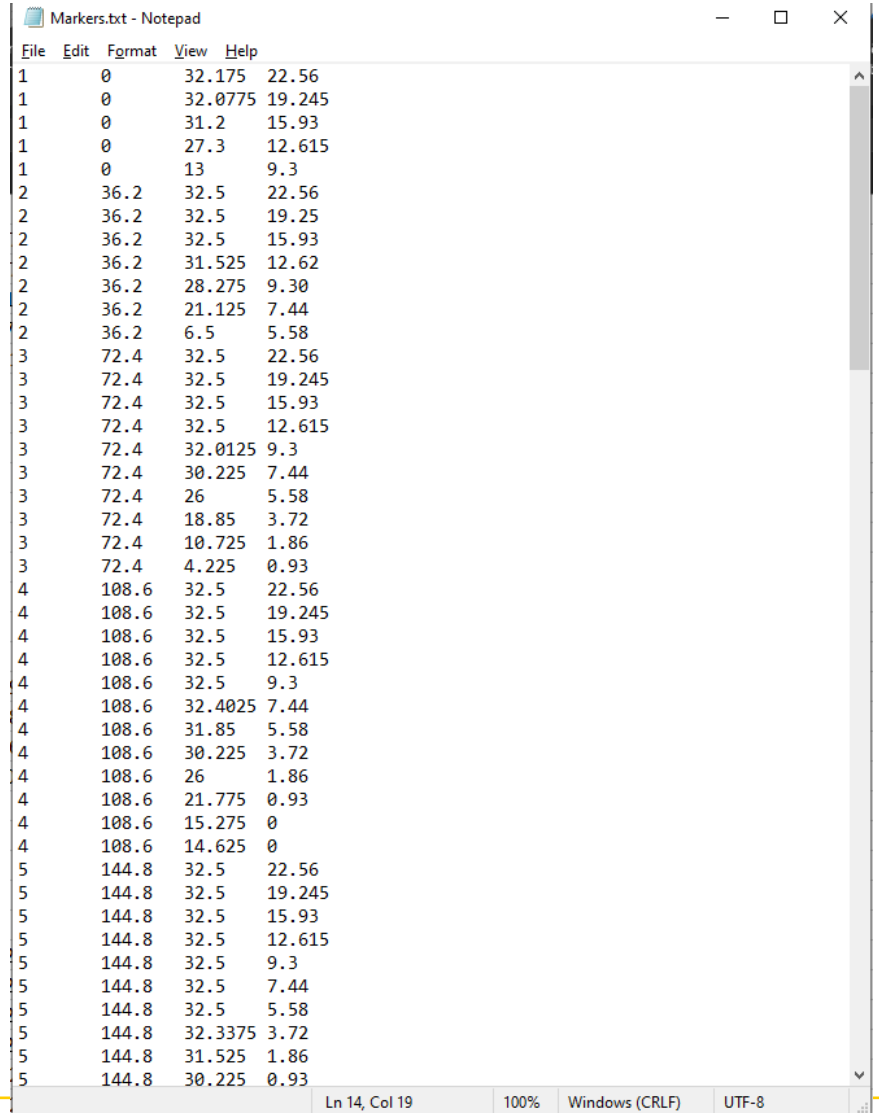
- **To import the offset table into Maxsurf we need to convert it into a text file contains 4 columns:**

| Station index | Longitudinal position (X coordinate) | Offset (Y coordinate) | Height (Z coordinate) |
|---|---|---|---|
| All points locate in the same station have the same index. | From a fixed reference (Aft perpendicular, Forward perpendicular or amidships) | Offset coordinate from center line | Vertical coordinate from a fixed reference (usually from keel) |

| | | | | | Water Line Half Breadths (m) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Stern-profile | | CL-buttock | Fr 0 | Fr 1 | Fr 2 | Fr 3 | Fr 4 | Fr 5 | Fr 6 | Fr 7 | Fr 8 | Fr 9 | Fr 10 | Bow-profile | |
| | z | x | y | | 0 | 36.2 | 72.4 | 108.6 | 144.8 | 181 | 217.2 | 253.4 | 289.6 | 325.8 | 362 | x | y |
| Upper Dk | 22.56 | -14.48 | 30.875 | | 32.175 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 28.925 | 16.25 | 372.86 | 6.5 |
| WL 8 | 19.25 | -13.756 | 30.55 | | 32.0775 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.175 | 26.65 | 11.375 | 369.964 | 3.9 |
| WL 7 | 15.93 | -12.67 | 29.575 | | 31.2 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 31.2 | 24.05 | 6.5 | 366.706 | 1.95 |
| WL 6 | 12.62 | -10.86 | 24.375 | | 27.3 | 31.525 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 32.5 | 29.25 | 20.475 | 2.6 | 364.172 | 0.65 |
| CWL | 9.30 | -9.05 | 0 | -9.05 | 13 | 28.275 | 32.0125 | 32.5 | 32.5 | 32.5 | 32.5 | 31.85 | 26.65 | 15.925 | 0 | 362 | 0 |
| WL 4 | 7.44 | 11.584 | 0 | 14.48 | -13 | 21.125 | 30.225 | 32.4025 | 32.5 | 32.5 | 32.5 | 30.875 | 24.7 | 13.325 | 0.325 | 362 | 0 |
| WL 3 | 5.58 | 13.756 | 0 | 32.58 | -32.5 | 6.5 | 26 | 31.85 | 32.5 | 32.5 | 32.175 | 29.25 | 21.775 | 10.725 | 1.95 | 364.896 | 1.3 |
| WL 2 | 3.72 | 14.48 | 0 | 43.44 | -65 | -6.5 | 18.85 | 30.225 | 32.3375 | 32.3375 | 31.2 | 26.65 | 18.2 | 7.8 | 2.275 | 367.43 | 1.625 |
| WL 1 | 1.86 | 14.48 | 0 | 54.3 | -65 | -16.25 | 10.725 | 26 | 31.525 | 31.525 | 28.6 | 22.425 | 13 | 4.55 | 1.95 | 367.43 | 1.3 |
| WL 1/2 | 0.93 | 14.48 | 0 | 61.54 | -65 | -22.75 | 4.225 | 21.775 | 30.225 | 30.225 | 26 | 17.875 | 9.1 | 2.6 | 1.3 | 366.706 | 0.975 |
| WL 1/10 | 0.00 | 14.48 | 0 | 72.4 | -65 | -32.5 | -4.875 | 15.275 | 27.3 | 27.3 | 21.125 | 11.7 | 4.55 | 0.4875 | 0.325 | 362 | 0.0325 |
| Flat Bottom | 0.00 | 14.48 | 0 | 79.64 | -65 | -32.5 | -6.5 | 14.625 | 26 | 26 | 20.475 | 11.375 | 4.225 | 0.325 | 0 | 354.76 | 0 |
| CL | 0.00 | | | | | | | | | 0 | | | | | | | |

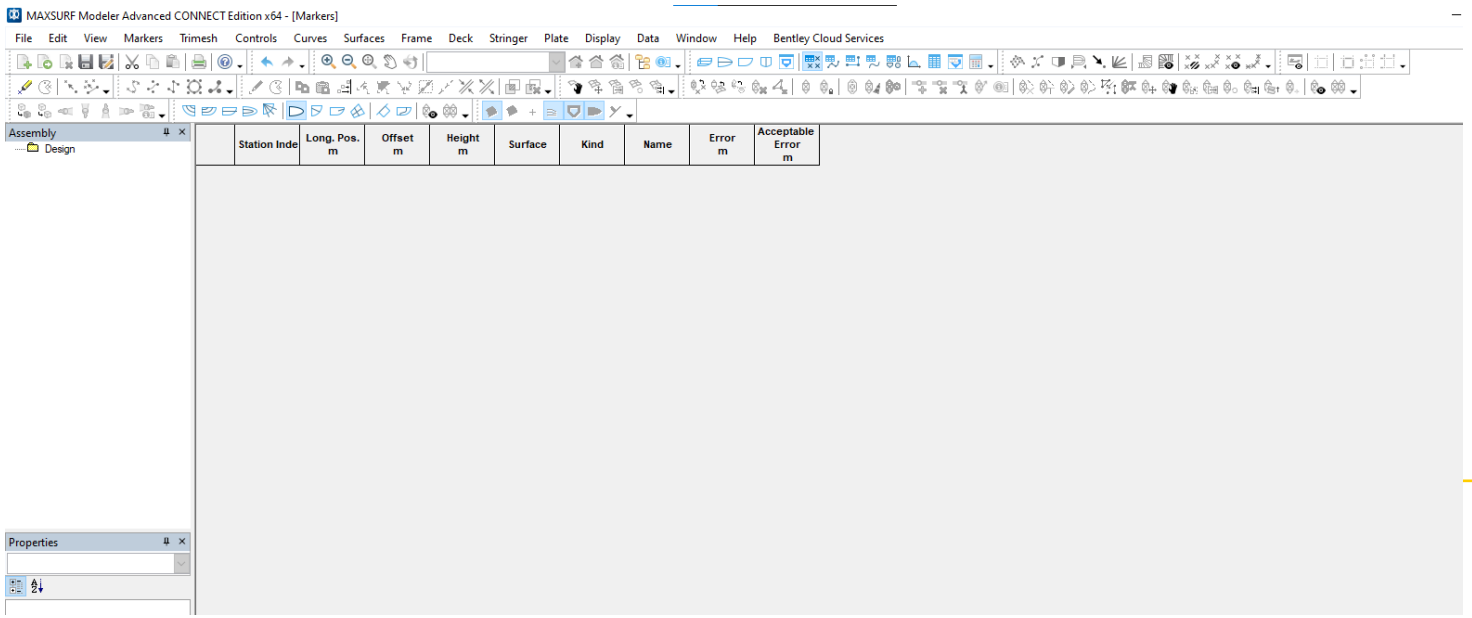
# Offset Table

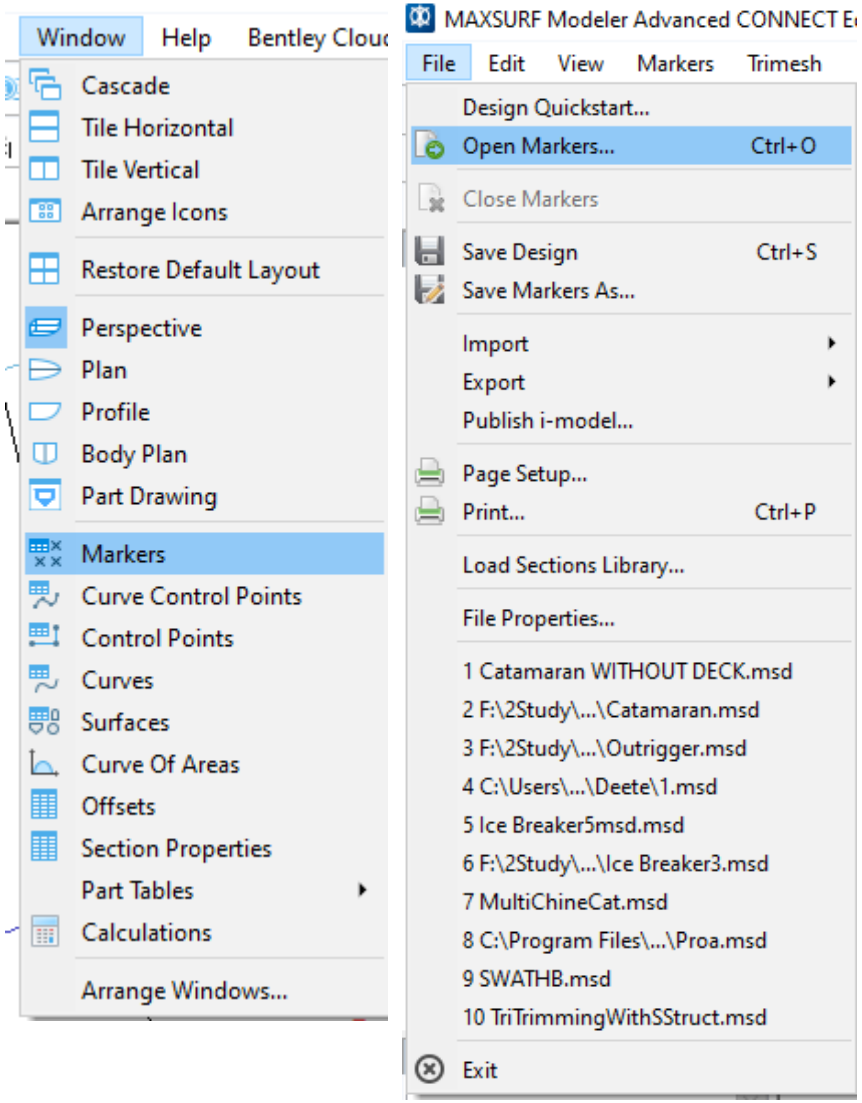
- The text file can also contain the stem and stern profile and/or  buttock markers.
- Markers with negative values or with missing coordinate should be deleted.



# Importing Markers

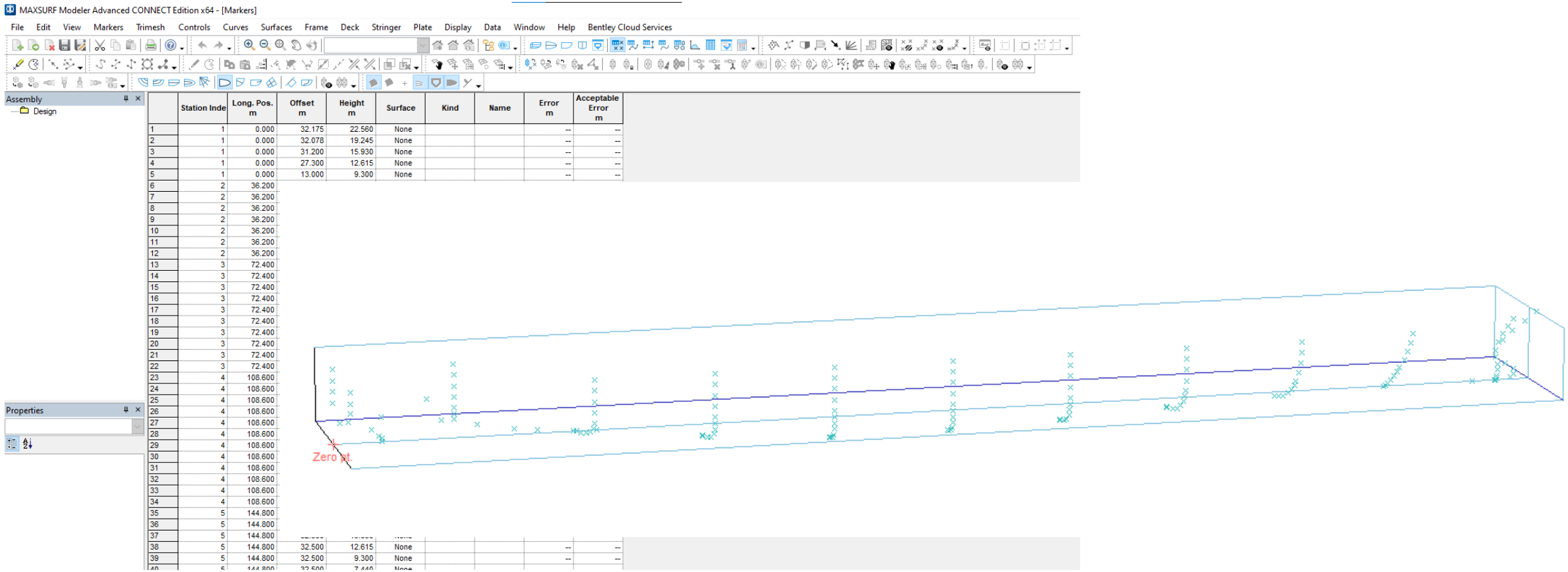
- **Open Maxsurf Modeler and then open Markers window**
  - Window ➛ Markers
- **Import Markers**
  - Go to File ➛ Open Markers… ➛ then open the Markers text file



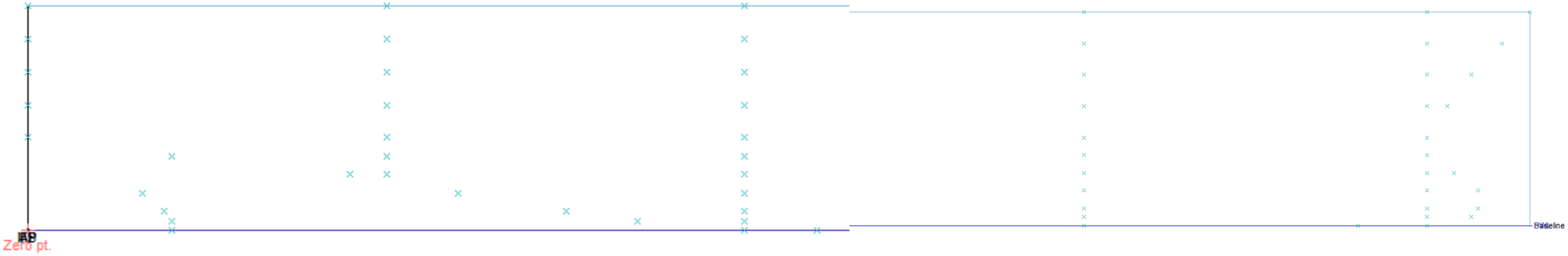
# Importing Markers

- Go to perspective view and check the imported Markers
- The markers should represent the hull surface.
- You can delete markers (for instance wrong and duplicated markers) by selecting them and press delete.



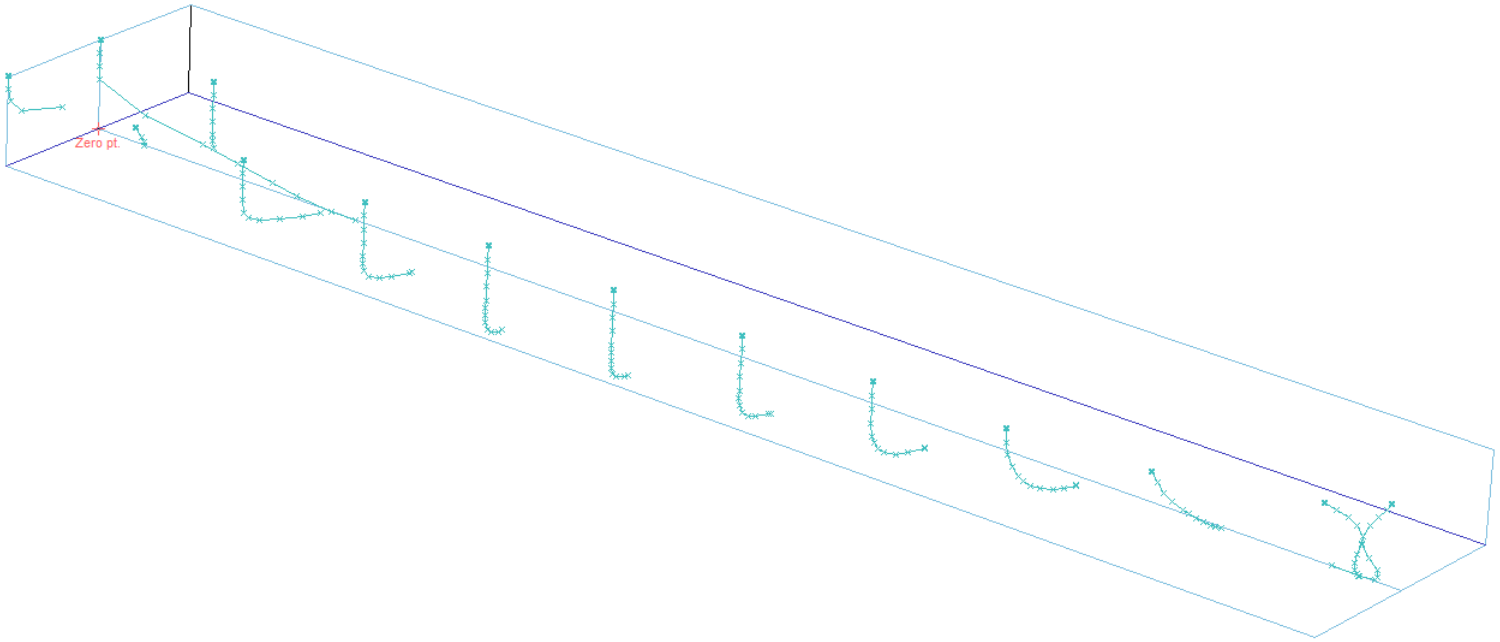
# Surface from markers

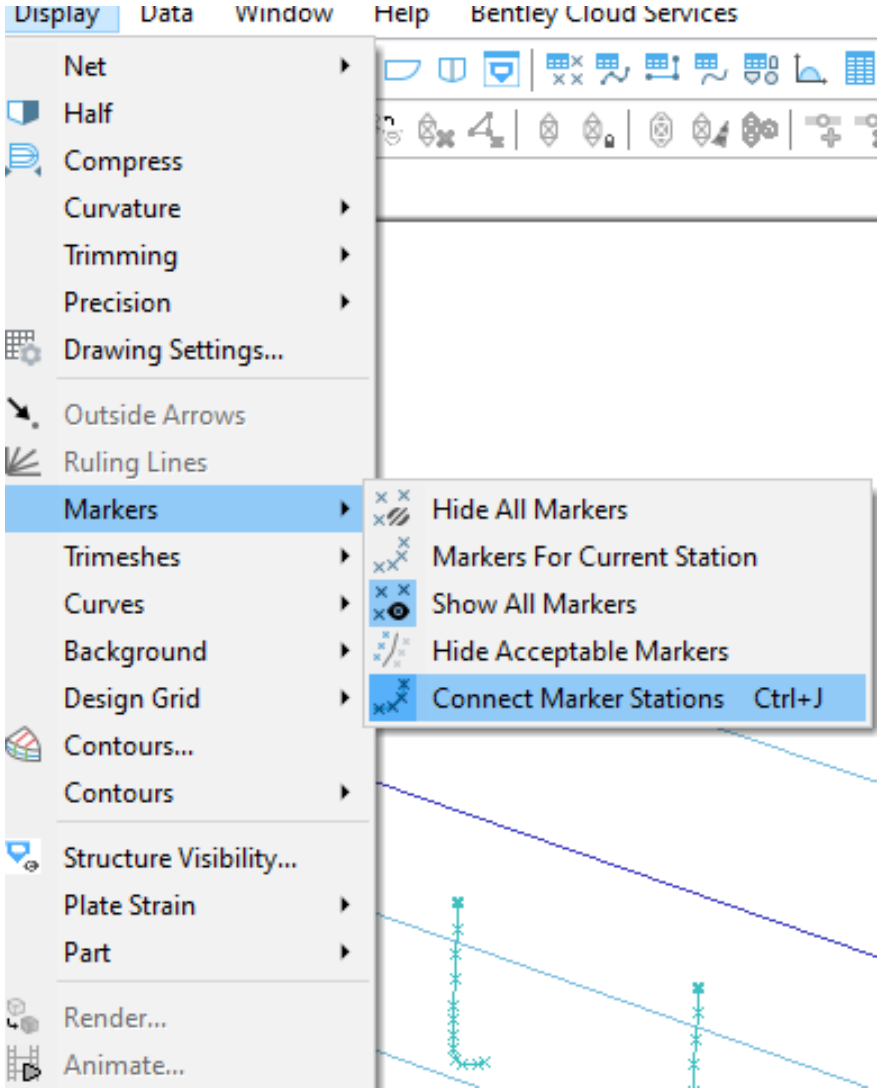
- **The first trial to create a surface from markers should be as simple as possible, unless you may spend much time to get fair hull.**
- **Markers represent skeg and pulpous bow are not important at this stage, as they complicate the NURBS surface generation and may induce errors.**



# Connect Markers

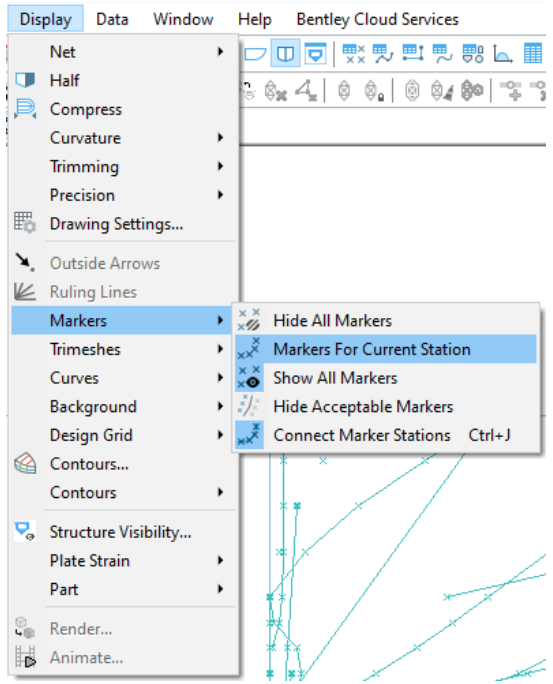
- **Check Markers orders are defined correctly.**
  - Go to Display ➛ Markers ➛ Connect Marker Stations

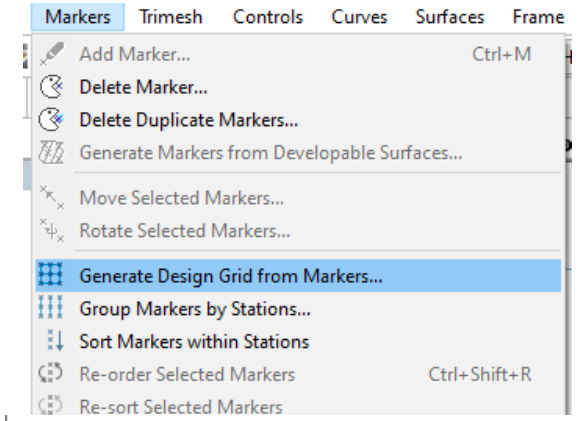


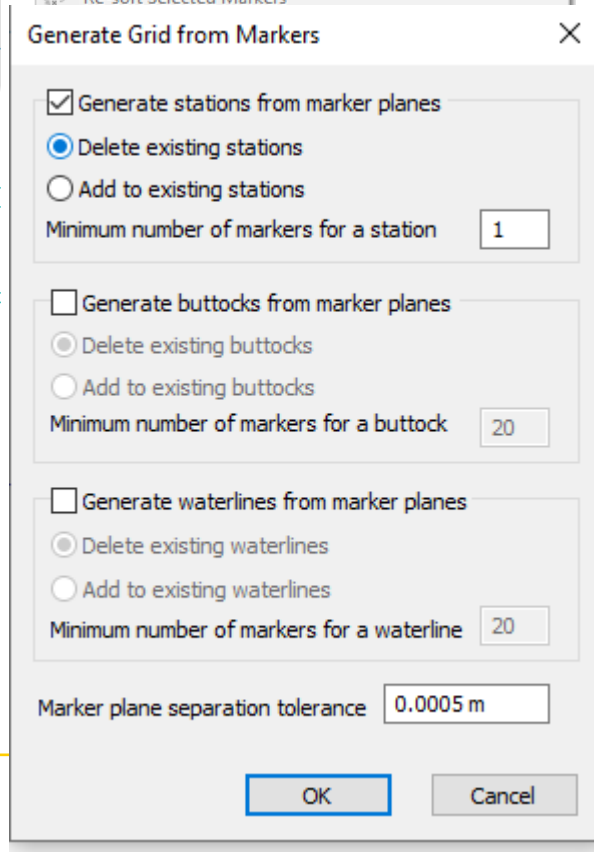



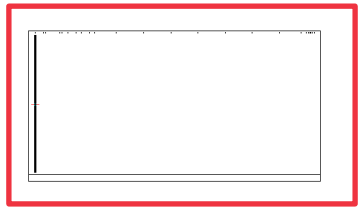
# Surface from markers

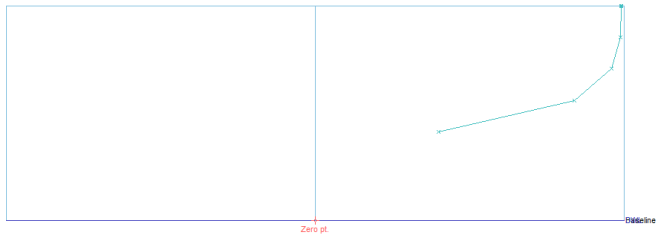
- **Generate design Grid from Markers**
  - Go to Markers ➛ Generate design grid from markers ➛ Ok
- **Check markers of each station**
  - Switch to body plan and then go to Display ➛ Markers ➛ Markers for current station.
- **Select the station you want to view from the window at the upper left side**



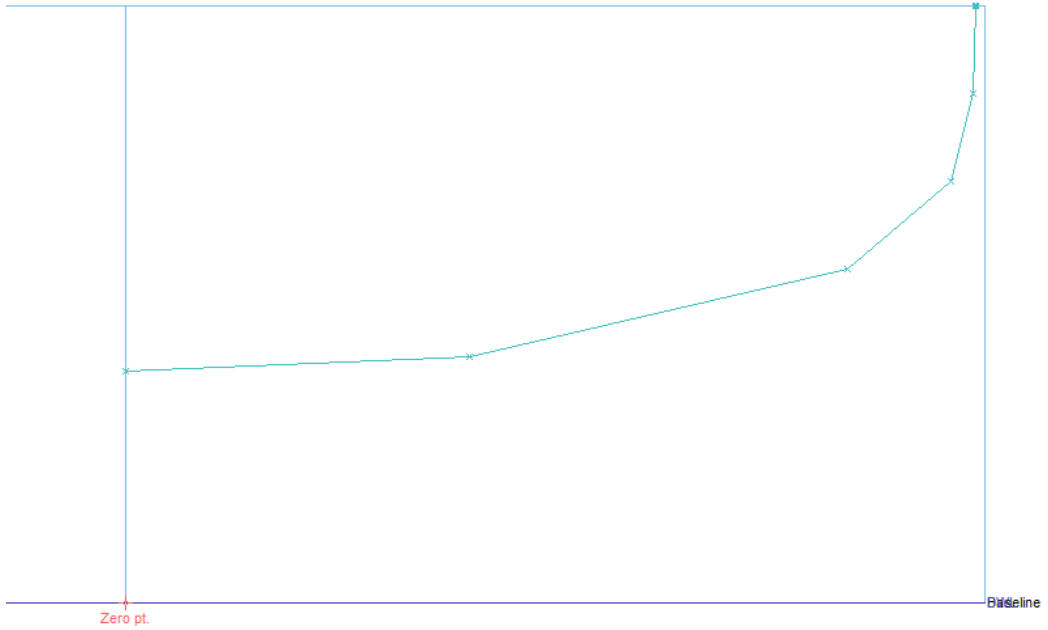



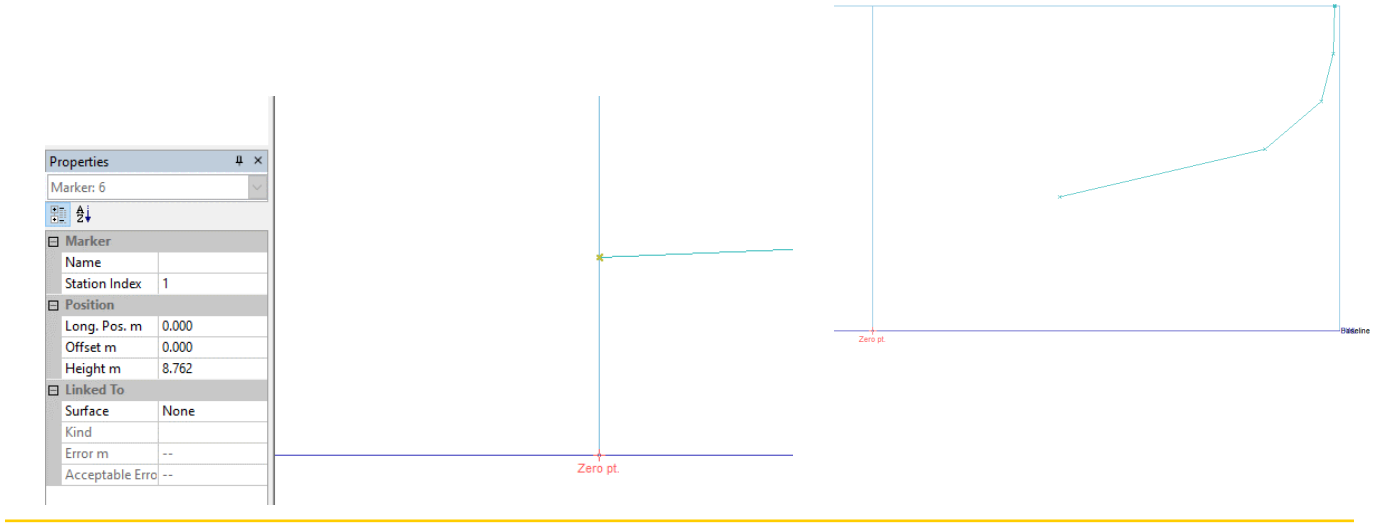





# Surface from markers

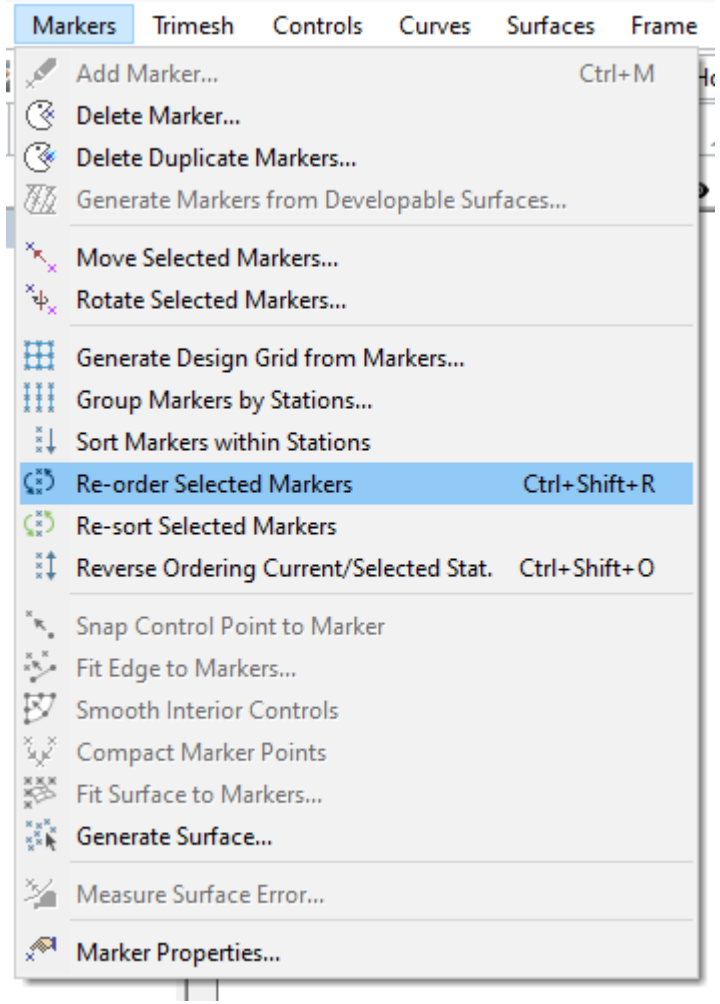
- **Define the missing markers as the ones at the center line for each station**
  - Press Ctrl +A to add markers
  - Change the Marker coordinates (offset, height and longitudinal position from properties window

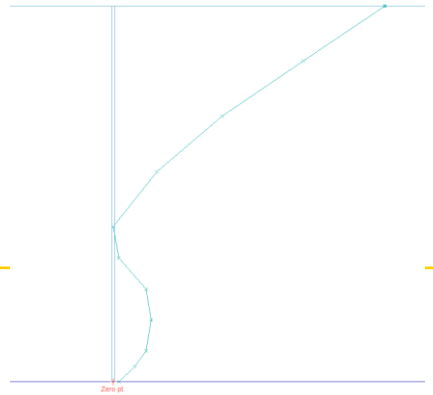


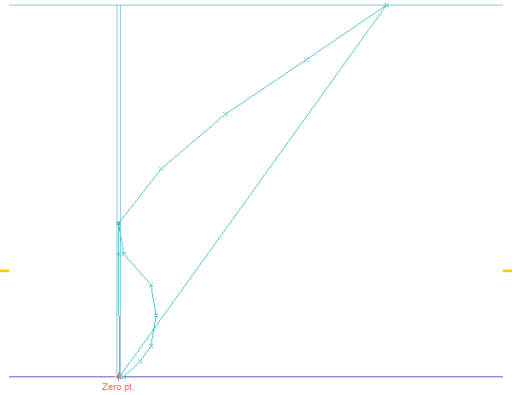



# Surface from markers

- **All markers withing each station should be connected by virtual lines have the same shape of the station, if not or if there are disturbances in the connection (like the one in the figure) :**
  - Select the Marker that are not defined correctly, preferably you should select them one by one in each station from the highest marker to the lowest one, and then order them by going to **Markers ➛ Re-order selected markers**

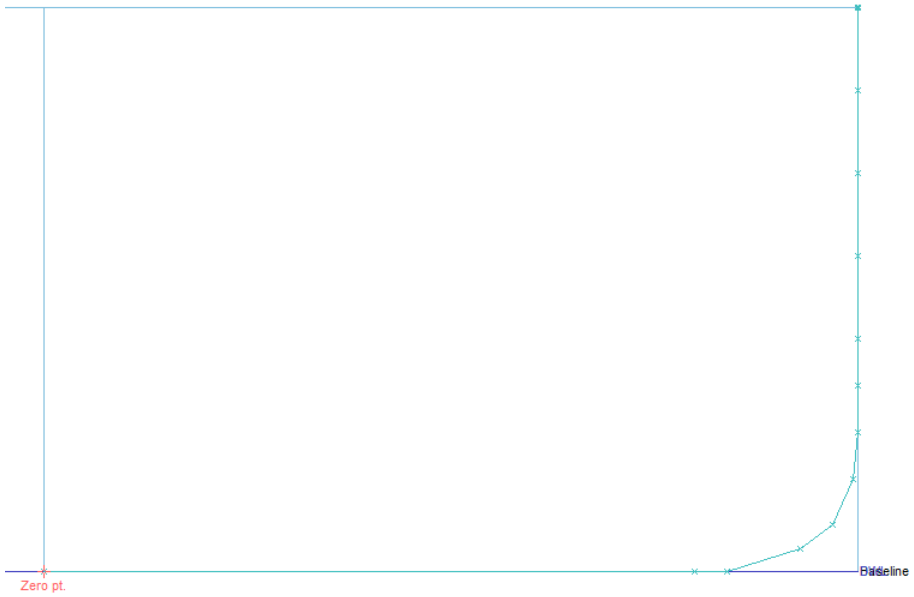


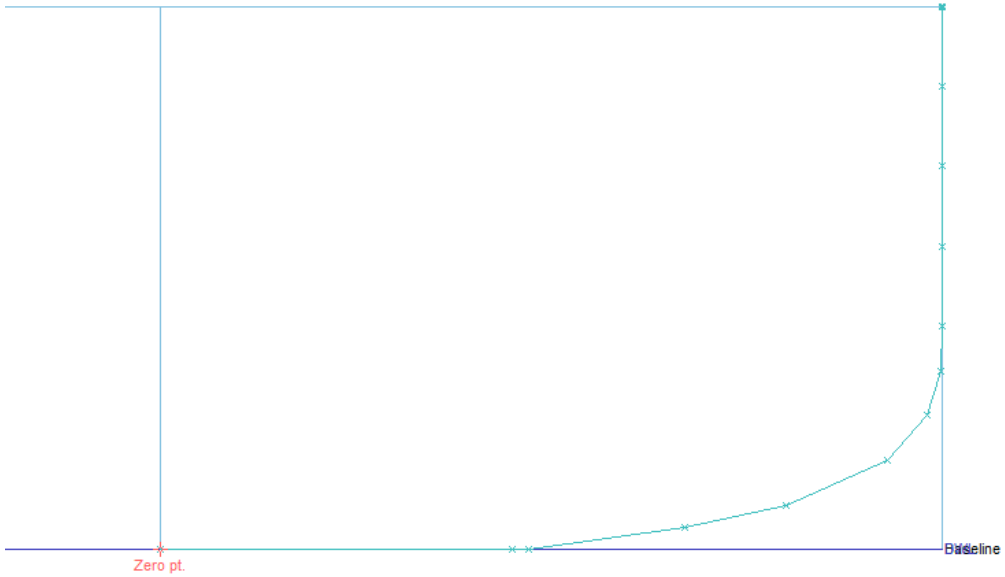





# Surface from markers

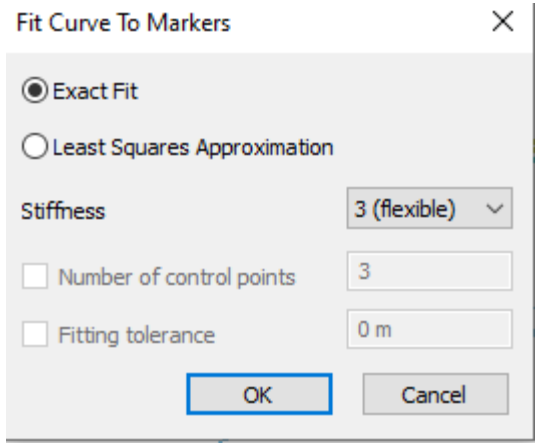
- **Repeat the previous procedures until getting satisfied from the Markers definition of each frame**

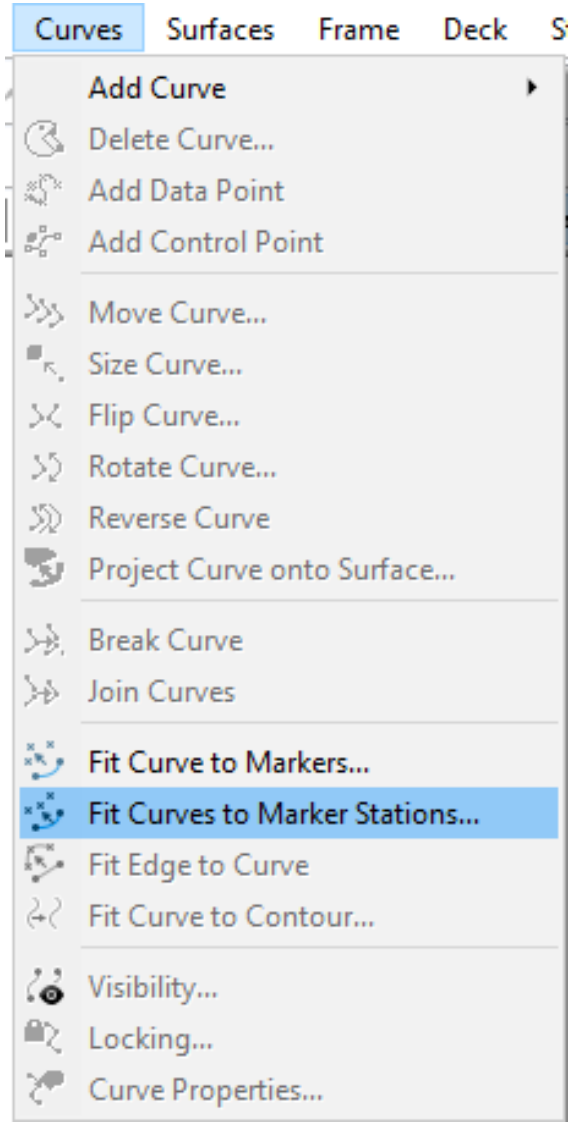


# Surface from markers (Fitting curves)

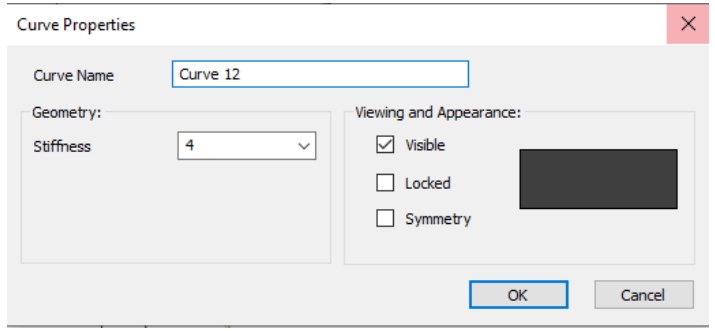
- **Select all Markers within frames/stations and bow stem markers ( Only markers forward the last frame) and then fit curves to Marker Stations**
  - Curves ➛ Fit curves to Marker stations… ➛ use exact fit and define curve stiffens or define number of control points and fitting tolerance

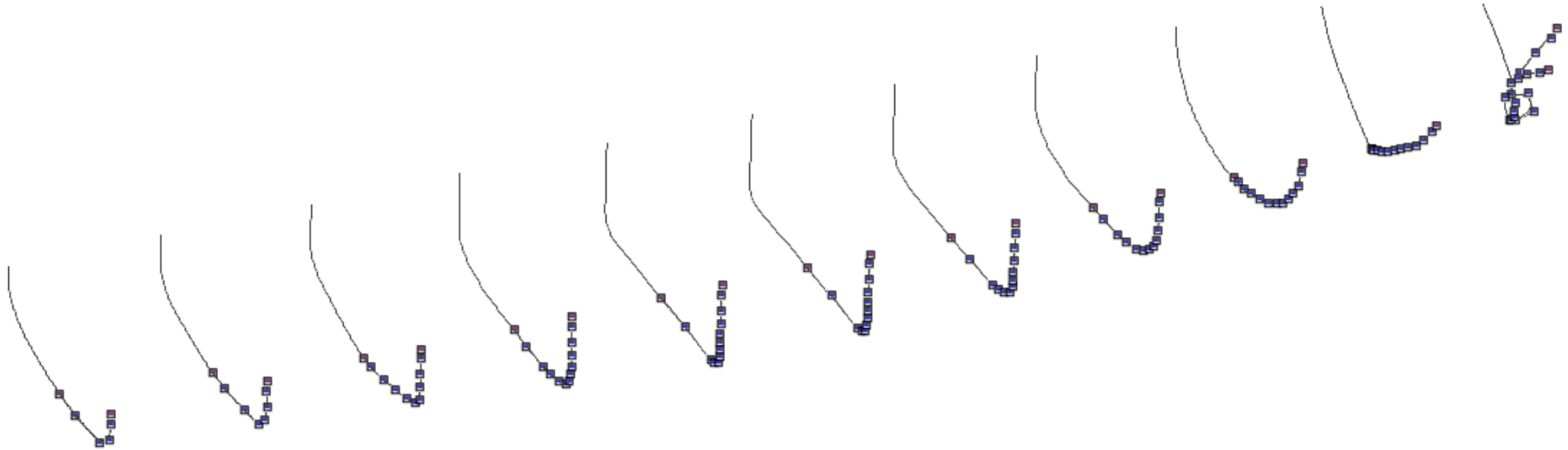



# Surface from markers (Fitting curves)

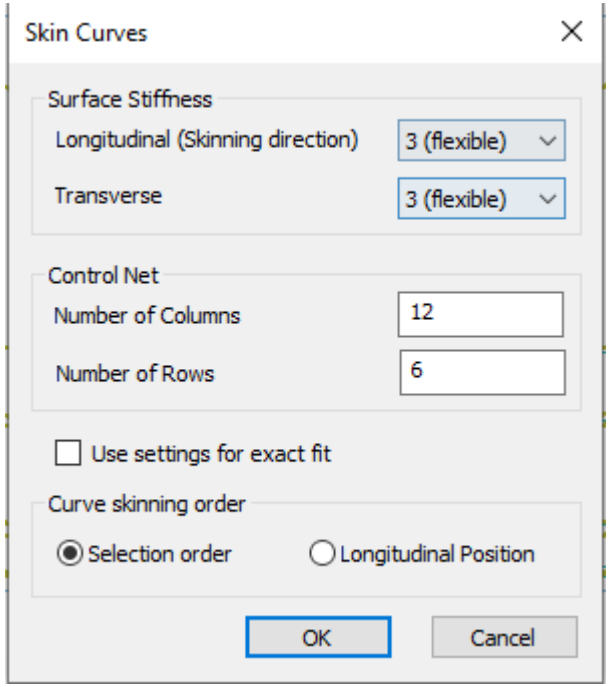
- **The symmetry of the bow stem curve should be deactivated**
  - Double click on the stem profile curve and uncheck symmetry.

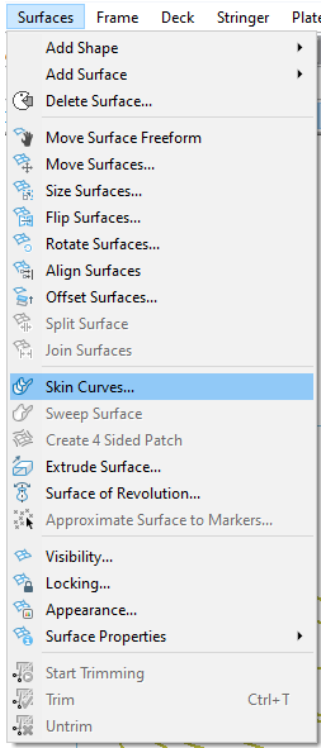


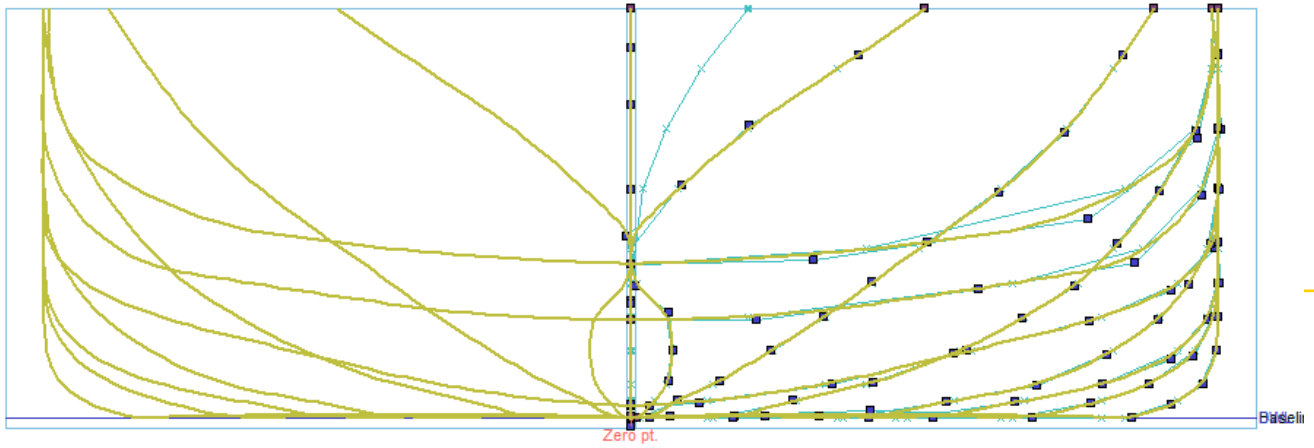



# Surface from markers (Skin curves)

- **Create surface from the curves**
  - Select all curves
  - Go to surface ➛ skin curves ➛ select the appropriate stiffness (start with lower surface stiffness) ➛ enter the appropriate number of columns and rows ( columns should be more than number of frames) ➛ order may be according to longitudinal position if not selected with order ➛ Ok.

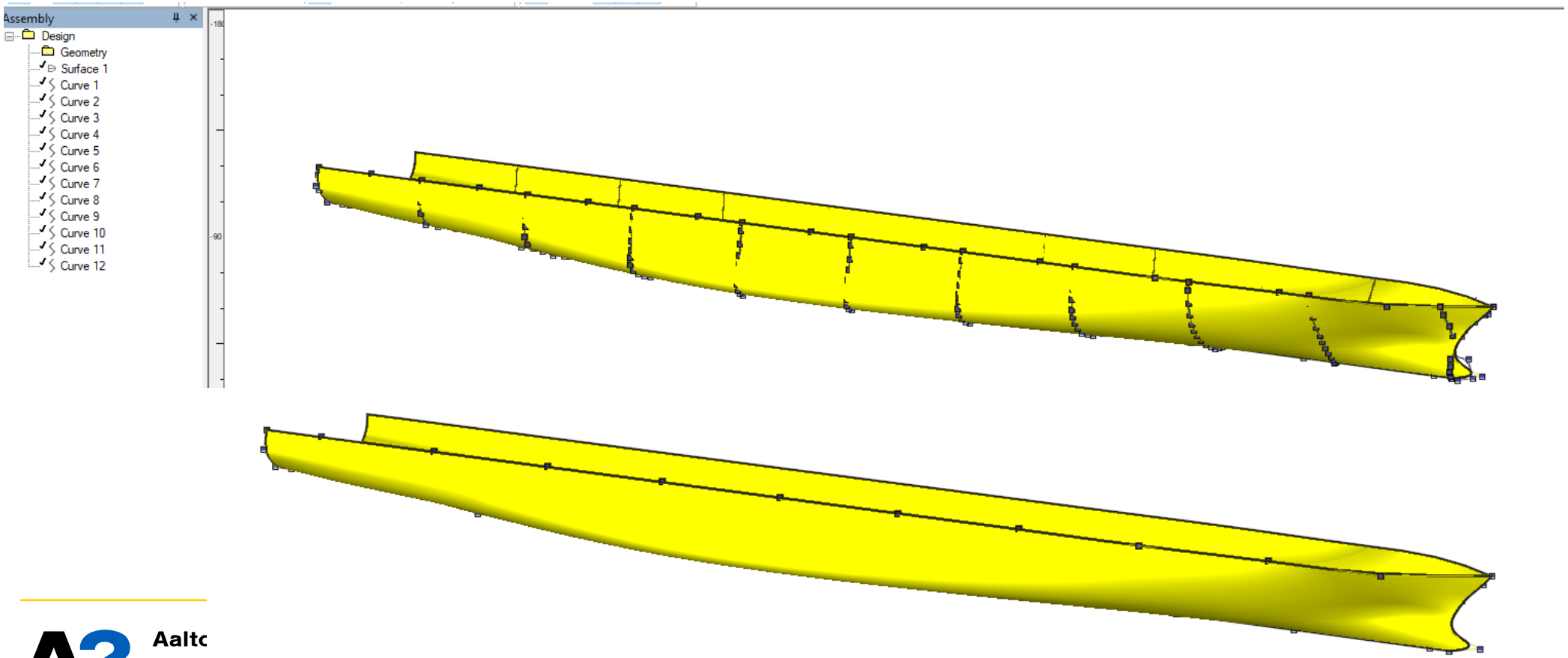


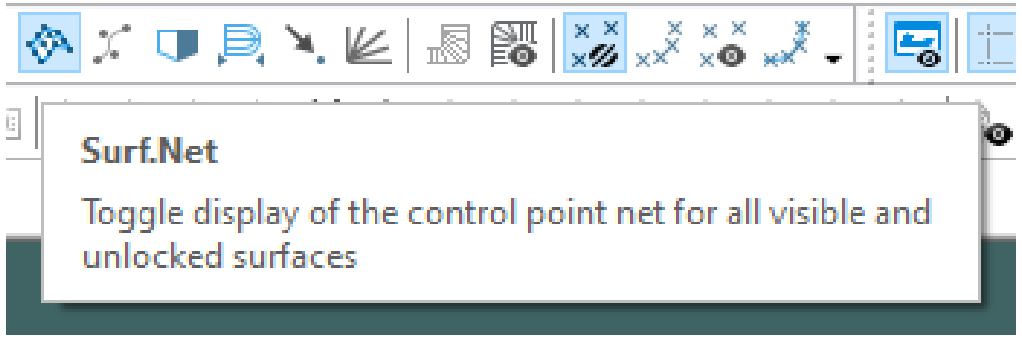
# Importing Markers (Surface Fairing)

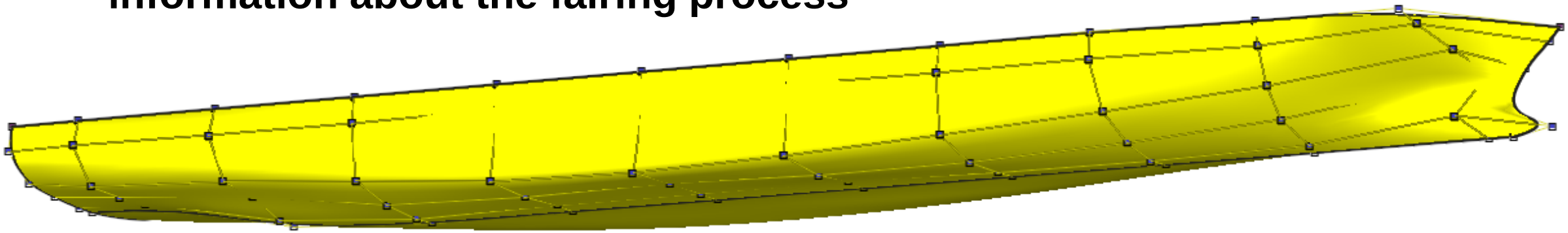
- **After creating the hull now we don’t need the curves any more so hide or delete them from the Assembly tree**
  - Select curves ➛ right click on them ➛ hide

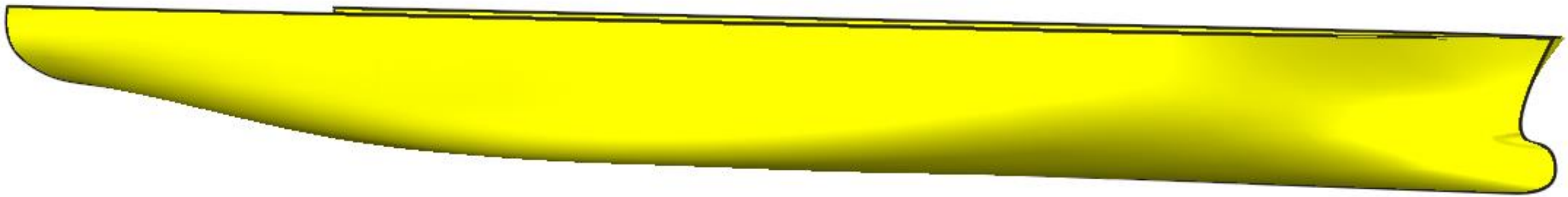


# Fairing surface

- **Active surface net to start fairing the hull**
  - Display ➛ Net ➛ Active Rows and Columns
- **Refer to presentation “02 Ice Breaker from lines plan“ for more information about the fairing process**

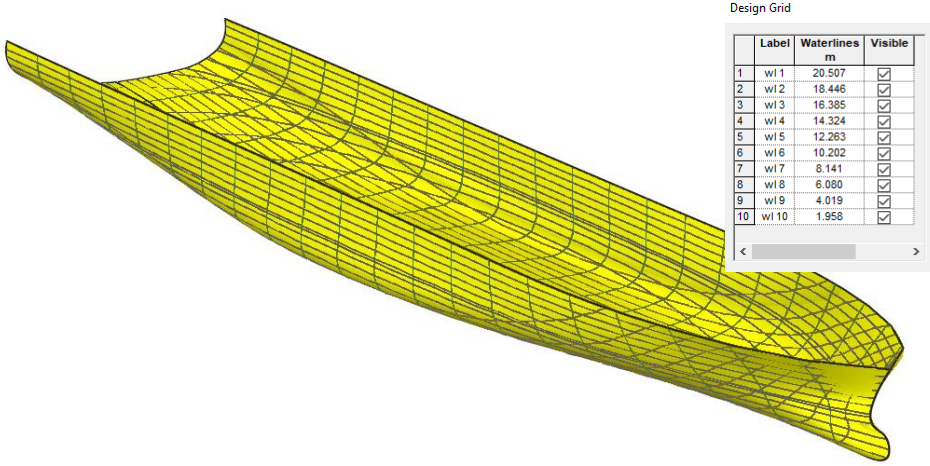


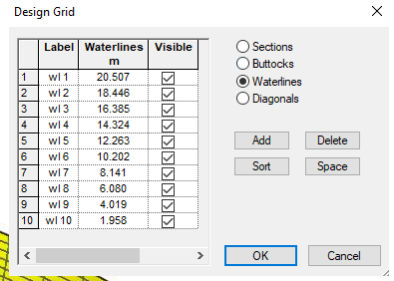



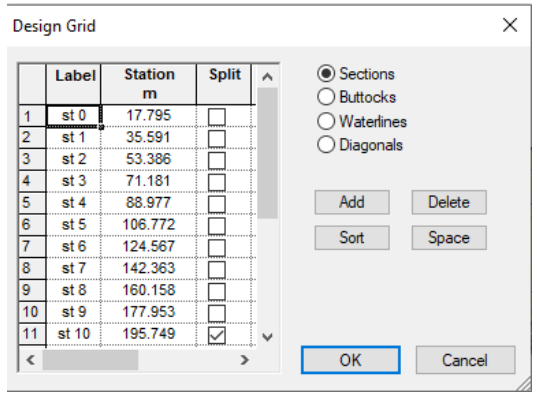


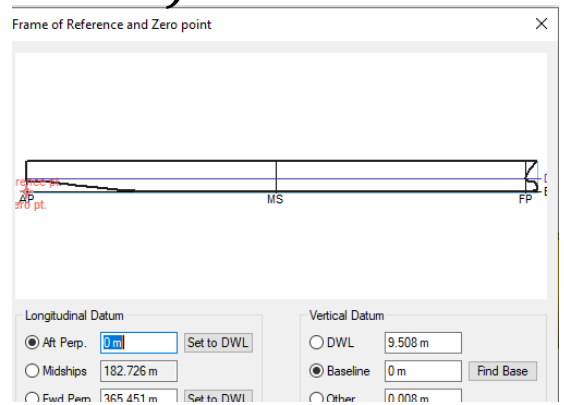
# Fairing surface

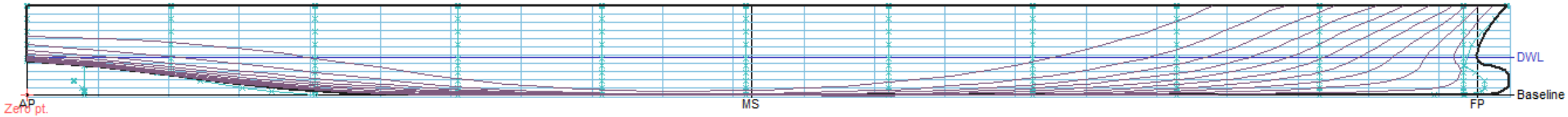
- **You can employ different options in Maxsurf to assist you in fairing process:**
  - **Lines plan** and control points (refer to previous presentations)

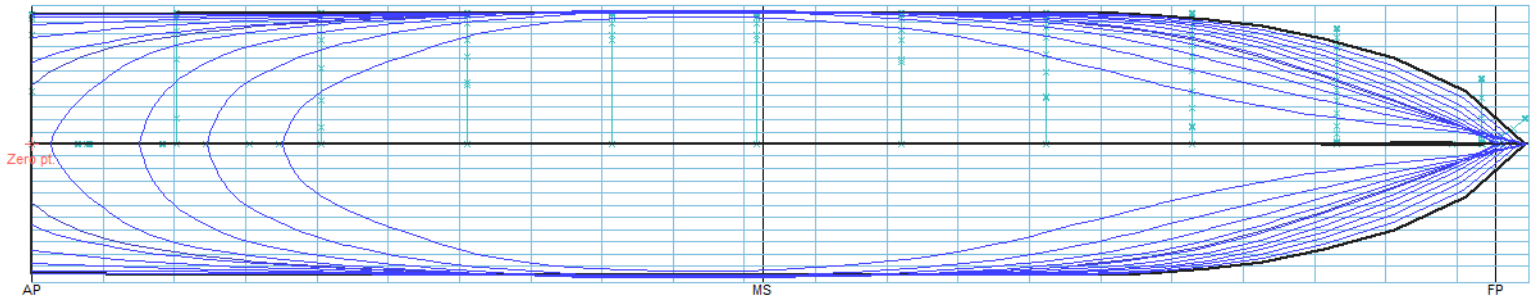


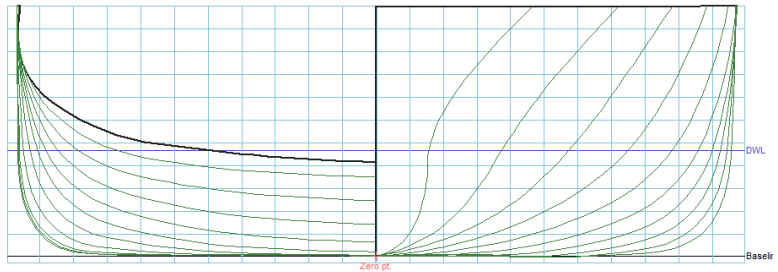


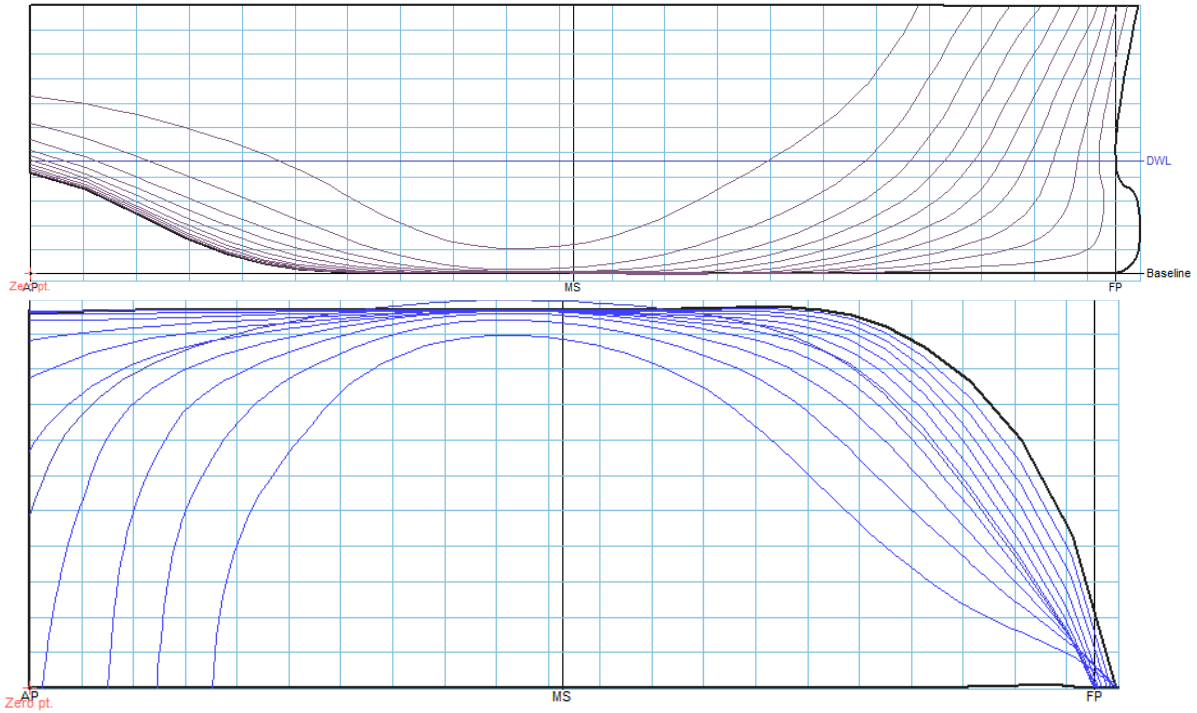



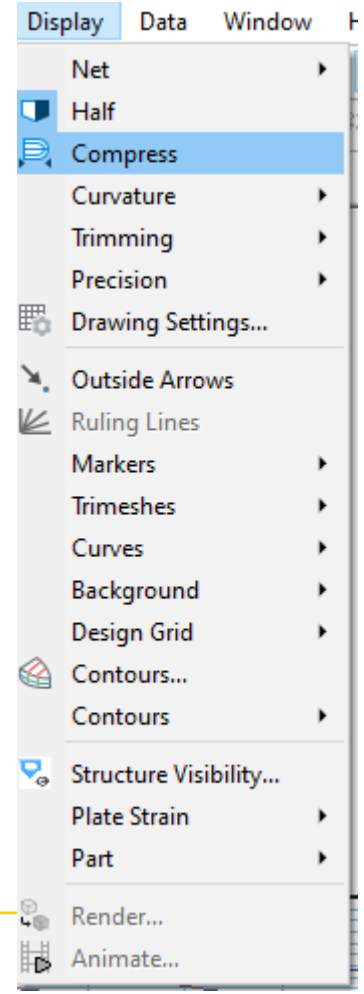



# Fairing surface

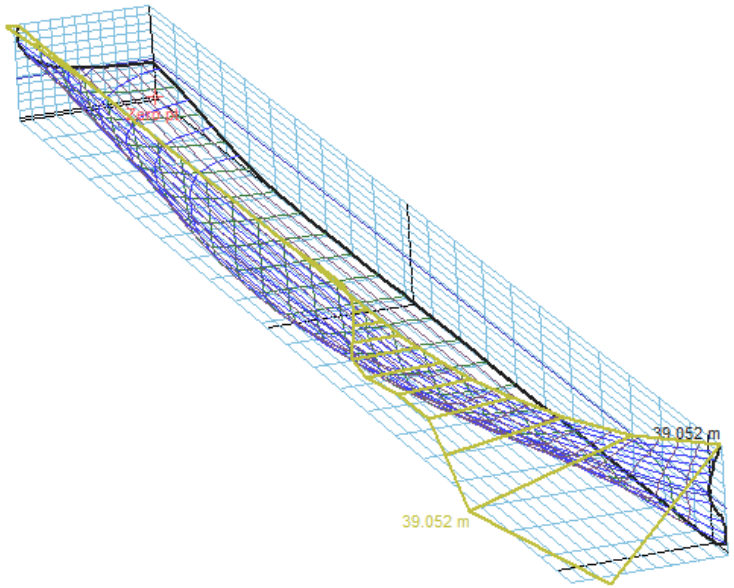
- **You can employ different options in Maxsurf to assist in fairing process:**
  - Lines plan and control points (refer to previous presentations)
  - **Compress**: the vertical and transverse axes are increased by a factor of four relative to the longitudinal axis. This is useful for fairing longitudinal curvature.

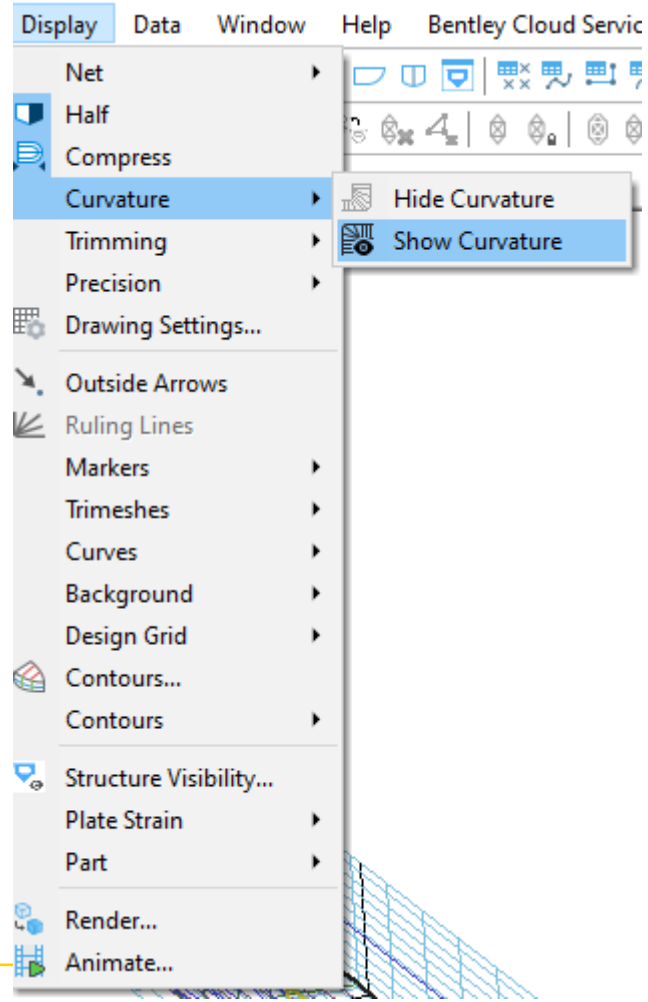


# Fairing surface

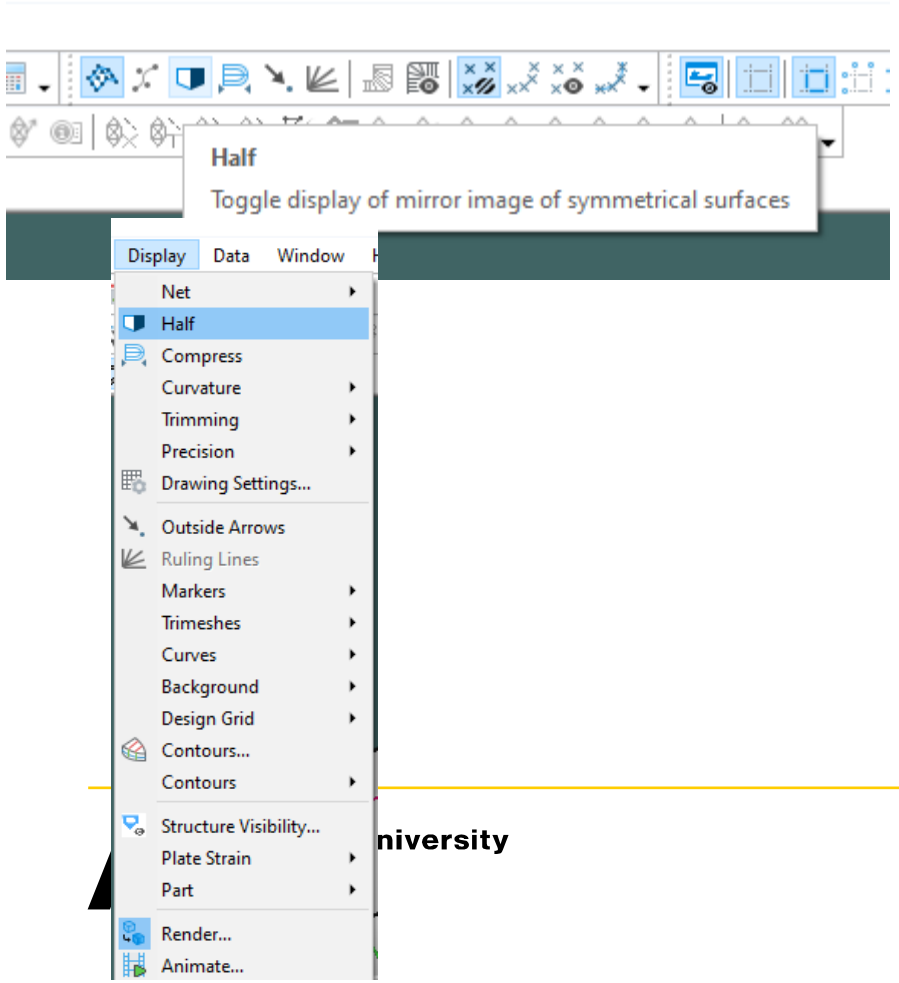
- **You can employ different options in Maxsurf to assist in fairing process:**
  - **Curvature**: Displays curvature porcupines for any edge, section, waterline, buttock, diagonal or feature line by clicking on the curve and selecting Show Curvature. ( Like deck edge in the figure below)

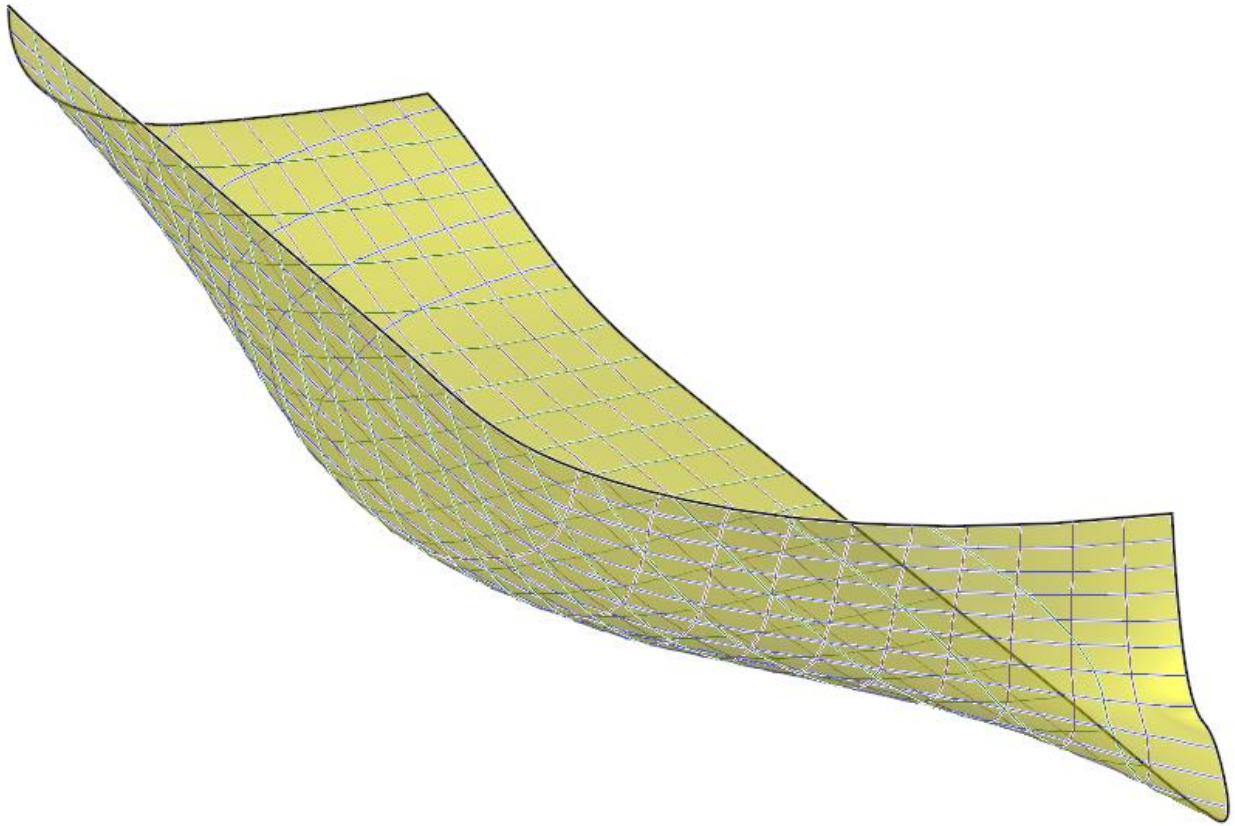


# Fairing surface

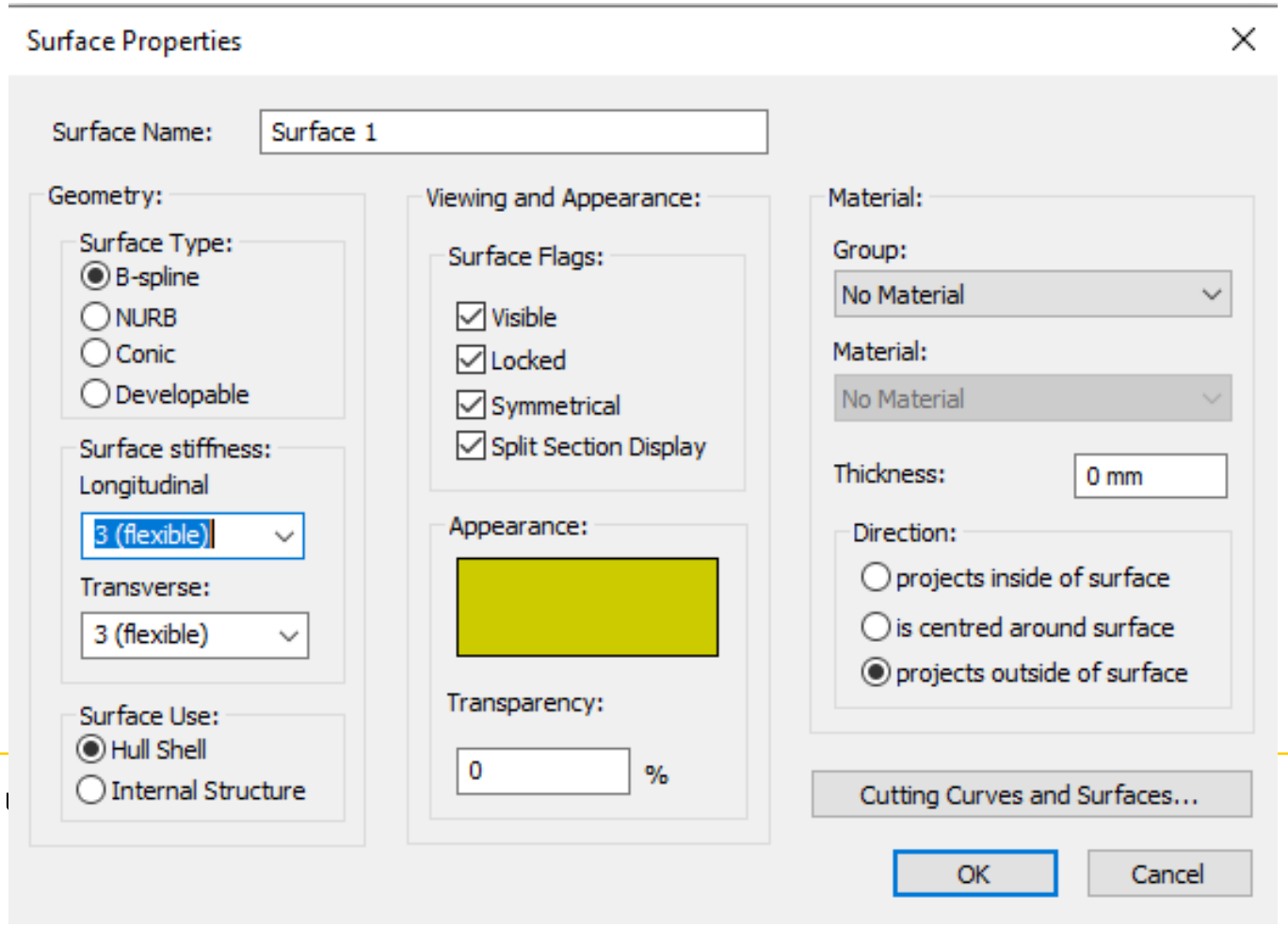
- **Active/deactivate the Half Icon to show both sides/hide one side**



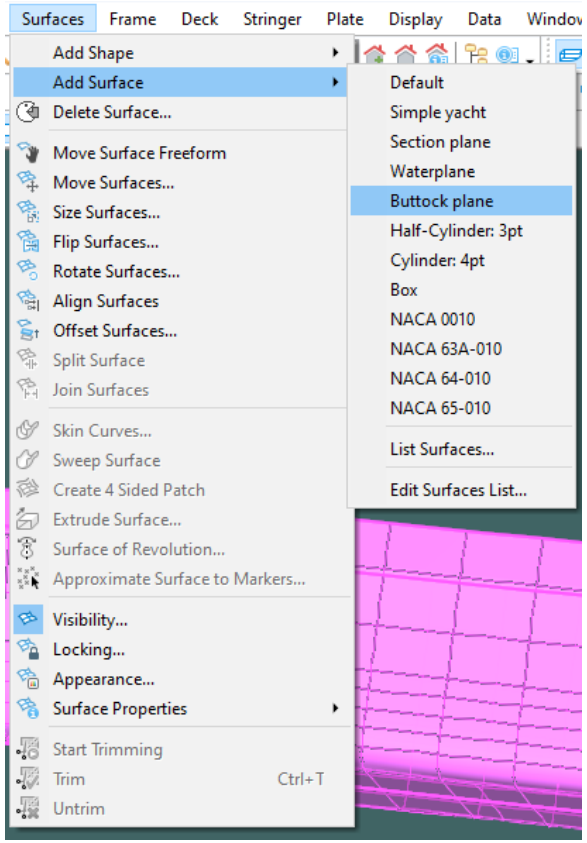
# Modeling Skeg

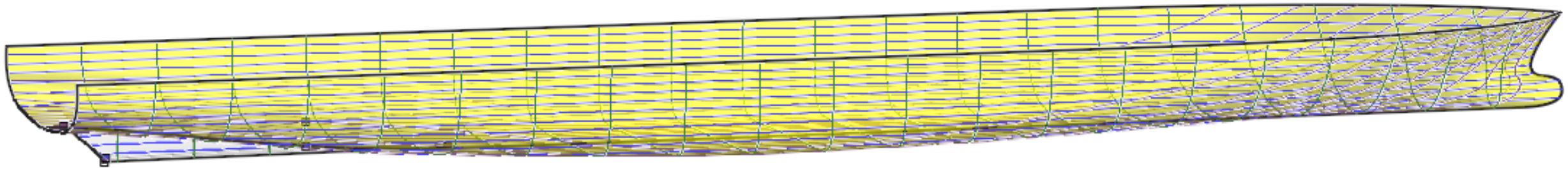
- **After getting satisfied from the fairness of the Hull model, you can lock it by double click on  and then check locked.**



# Modeling Skeg

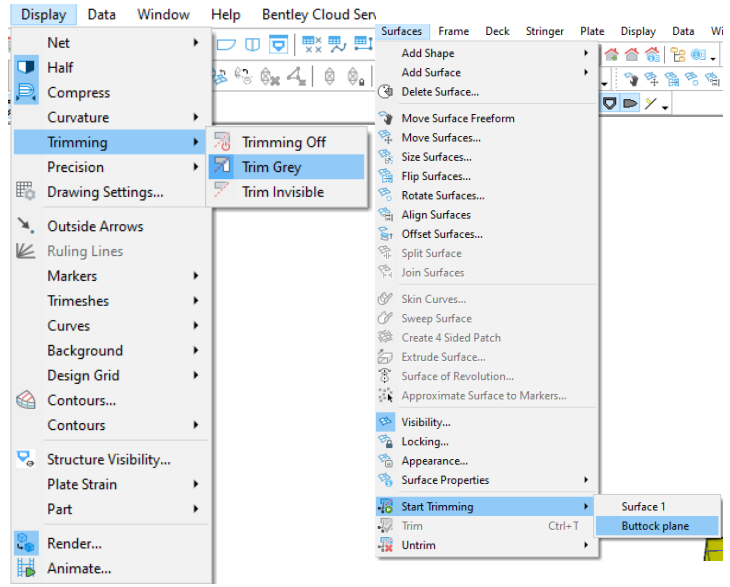
- **Define the skeg**
  - ✓ Go to surface ➛ Add surface ➛ Buttock plane and Add enough columns and rows to define the skeg surface.
  - ✓ Make sure to change the stiffness of the skeg surface to suitable value.
  - ✓ Manipulate the control points to get the desired shape of the skeg.

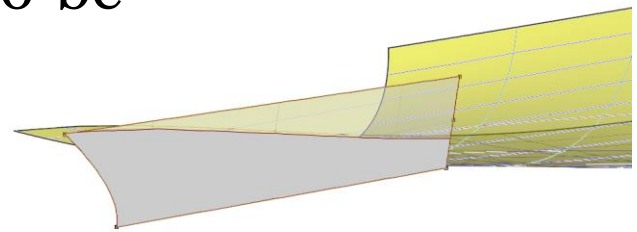


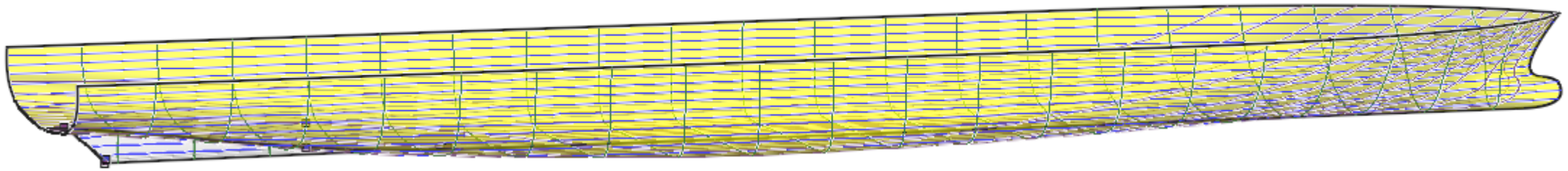



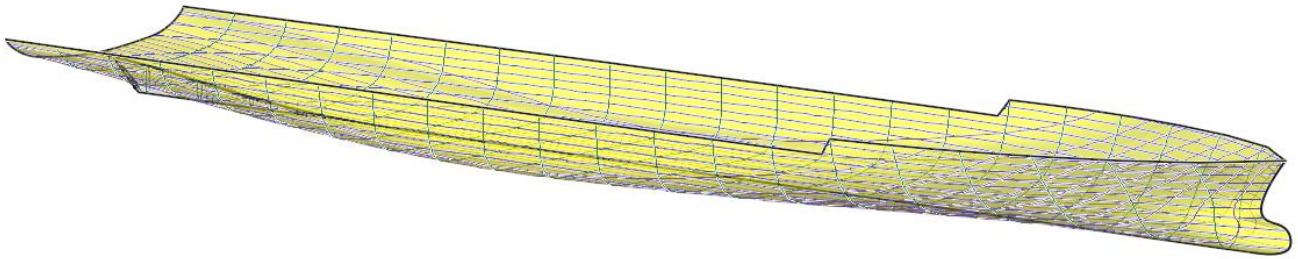
# Modeling Skeg

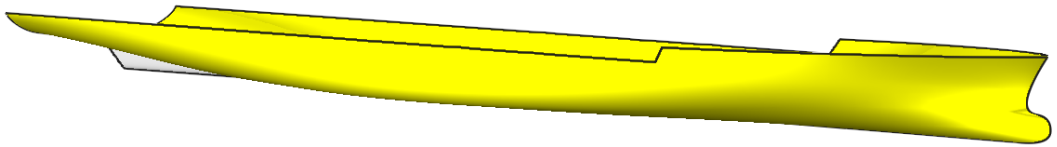
- **Trim the extension of the skeg inside the hull form and/or trim the freeboard and forecastle.**
  - ✓ Go to Display ➢ trimming ➢ trim grey.
  - ✓ Go to Surface ➢ start trimming ➢ select the surface you want to trim ➢ then select the part of the surface to be trimmed ➢ then press Ctrl + T







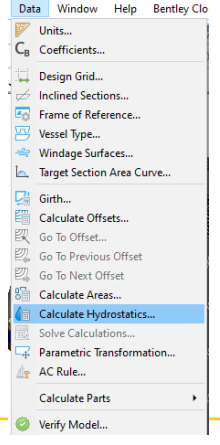


# Parametric transformation

- **The parametric variation tool is ideal for making small adjustments to your model.**
- **You can first check the hydrostatics at the design draft before performing parametric transformation:**
  - Go to Data ➛ Calculate Hydrostatics…
- **In case huge deviations are observed comparing with the hydrostatics and section area curves in the excel ”T4_Hull Lines”, you can simply rectify the errors using parametric transformation.**

| Hull | | | | | Hull + Skeg | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Area | LCA | LCB | I T | Hull Vol | Skeg Vol | Tot Vol | LCB | KB | BM | KM |
| [ m2 ] | [ % ] | [ % ] | [ m4 ] | [ m3 ] | [ m3 ] | [ m3 ] | [ % ] | [ m ] | [ m ] | [ m ] |
| 23944.91 | -2.77% | | | 439200.7 | | | | | | |
| 23412.73 | -3.63% | | | | | | | | | |
| 22802.49 | -4.42% | | | | | | | | | |
| 21839.37 | -4.80% | | | | | | | | | |
| 20016.19 | -3.91% | -0.36% | 6062462 | 140215.9 | 323.53[illegible]3 | 140539.5 | -0.0046[illegible] | 5.204128 | 43.13708 | 48.34121 |
| 18367.52 | -2.21% | | | | | | | | | |
| 16182.37 | 0.48% | | | | | | | | | |
| 14296.04 | 1.79% | | | | | | | | | |
| 12268.93 | 1.29% | | | | | | | | | |
| 10395.28 | 0.93% | | | | | | | | | |
| 7851.177 | -0.13% | | | | | | | | | |

| Hull Vol | CB | LCB | Am |
|---|---|---|---|
| [ $m^3$ ] | | [ % ] | [ $m^2$ ] |
| 140,160 | 0.641 | -0.32% | 593 |
| 439,047 | | | 1455 |
| | | | |




Hydrostatics at DWL

| | Measurement | Value | Units |
|---|---|---|---|
| 1 | Displacement | 141829 | t |
| 2 | Volume (displaced) | 138369.535 | m^3 |
| 3 | Draft Amidships | 9.300 | m |
| 4 | Immersed depth | 9.300 | m |
| 5 | WL Length | 365.310 | m |
| 6 | Beam max extents on | 64.945 | m |
| 7 | Wetted Area | 23259.287 | m^2 |
| 8 | Max sect. area | 578.348 | m^2 |
| 9 | Waterpl. Area | 19736.234 | m^2 |
| 10 | Prismatic coeff. (Cp) | 0.655 | |
| 11 | Block coeff. (Cb) | 0.627 | |
| 12 | Max Sect. area coeff. | 0.958 | |
| 13 | Waterpl. area coeff. ( | 0.832 | |
| 14 | LCB length | 178.526 | from ze |
| 15 | LCF length | 164.508 | from ze |
| 16 | LCB % | 48.870 | from ze |
| 17 | LCF % | 45.032 | from ze |
| 18 | KB | 5.287 | m |
| 19 | KG fluid | 0.000 | m |
| 20 | BMt | 43.304 | m |
| 21 | BML | 1190.053 | m |
| 22 | GMt corrected | 48.591 | m |
| 23 | GML | 1195.340 | m |
| 24 | KMt | 48.591 | m |
| 25 | KML | 1195.340 | m |
| 26 | Immersion (TPc) | 202.296 | tonne/c |
| 27 | MTc | 4640.808 | tonne.m |
| 28 | RM at 1deg = GMt.Dis | 120274.292 | tonne.m |

Density (water) 1.025 tonne/m^3

Std. densities 1.025 tonne/m^3 - Std. Metric sea water (1025.0 kg/m^3)

VCG 0 m

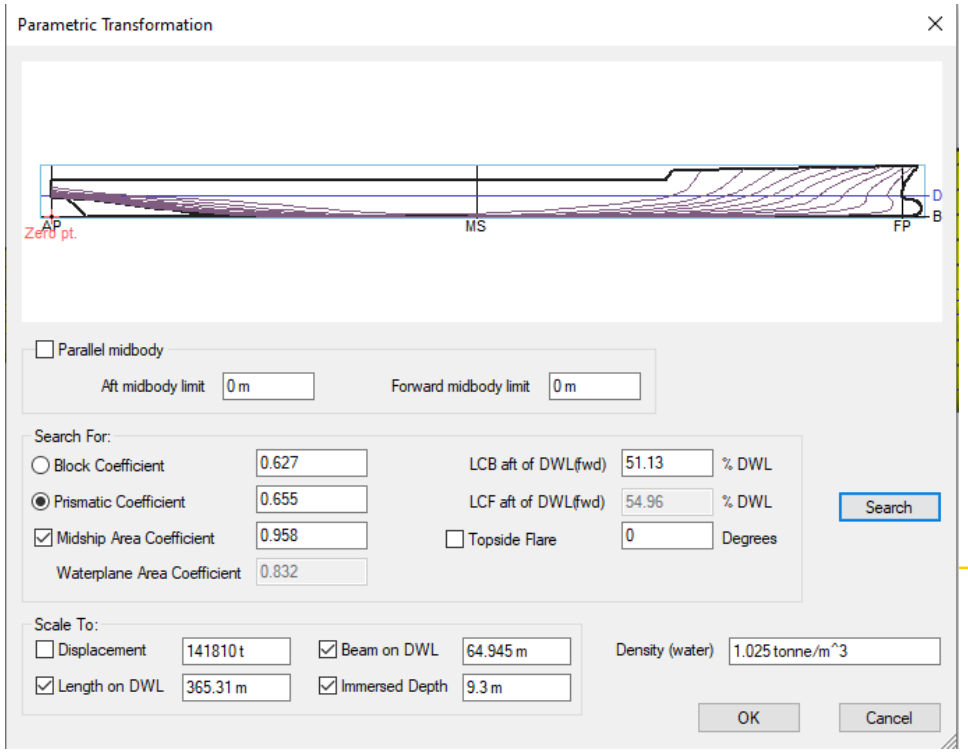
Recalculate

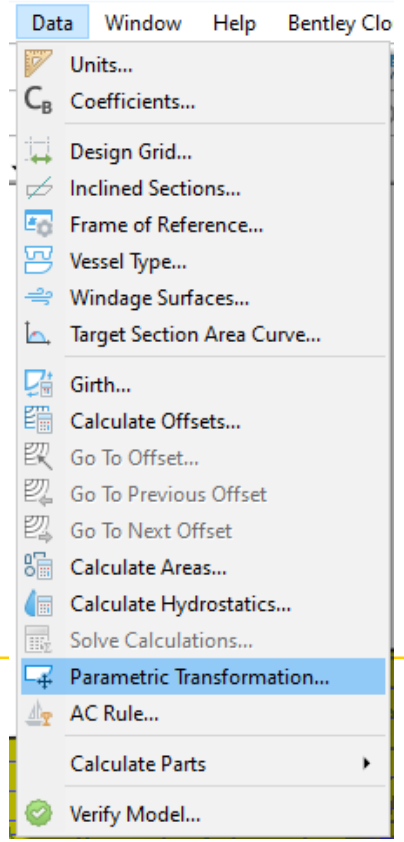
Select Rows ...

Close

# Parametric transformation

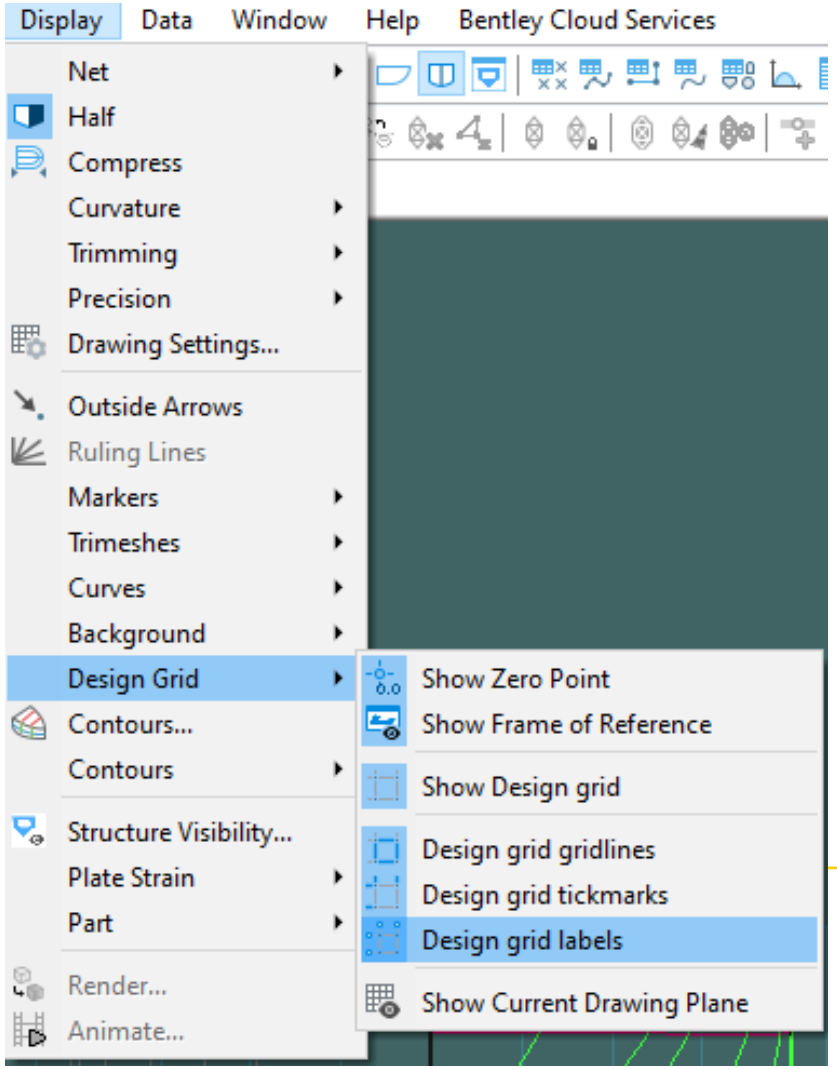
- **To change slightly any of the particulars you can use the parametric transformation feature in Maxsurf**
  - ✓ Go to Data ➛ Parametric Transformation ➛ Insert the new particular(s) ($C_B$ or $C_P$, Midship area coefficient, LCB, displacement, LWL, Beam and/or immersed depth) ➛ Press Search ➛ Check the new model main parameter are defined adequately and the lines are smooth without considerable distortion ➛ Press Ok or search again to define new model.
  - ✓ Check again the hydrostatics

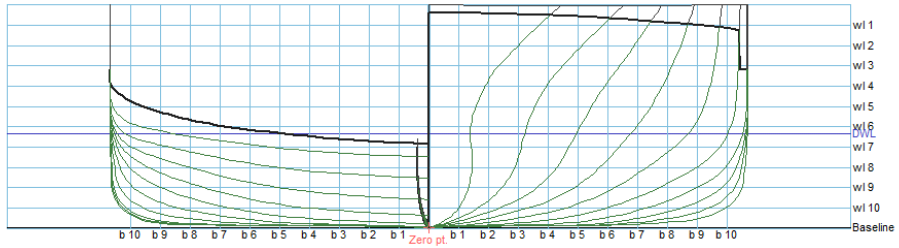


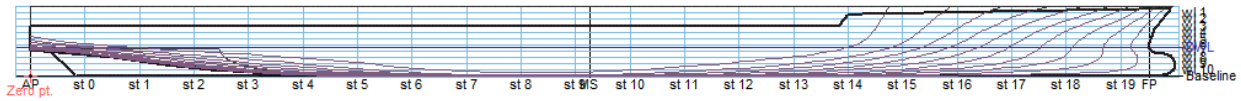



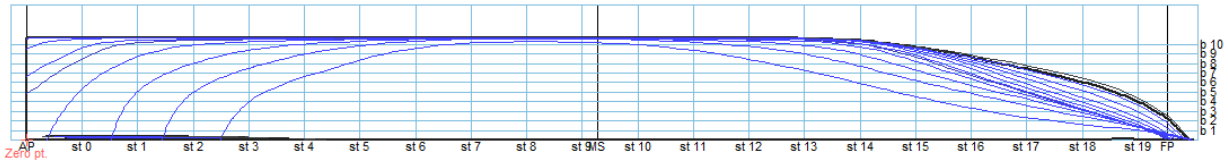
# Exporting Lines Plan

- **To show labels and grid lines**
  - Display ➛ Design grid ➛ design grid labels



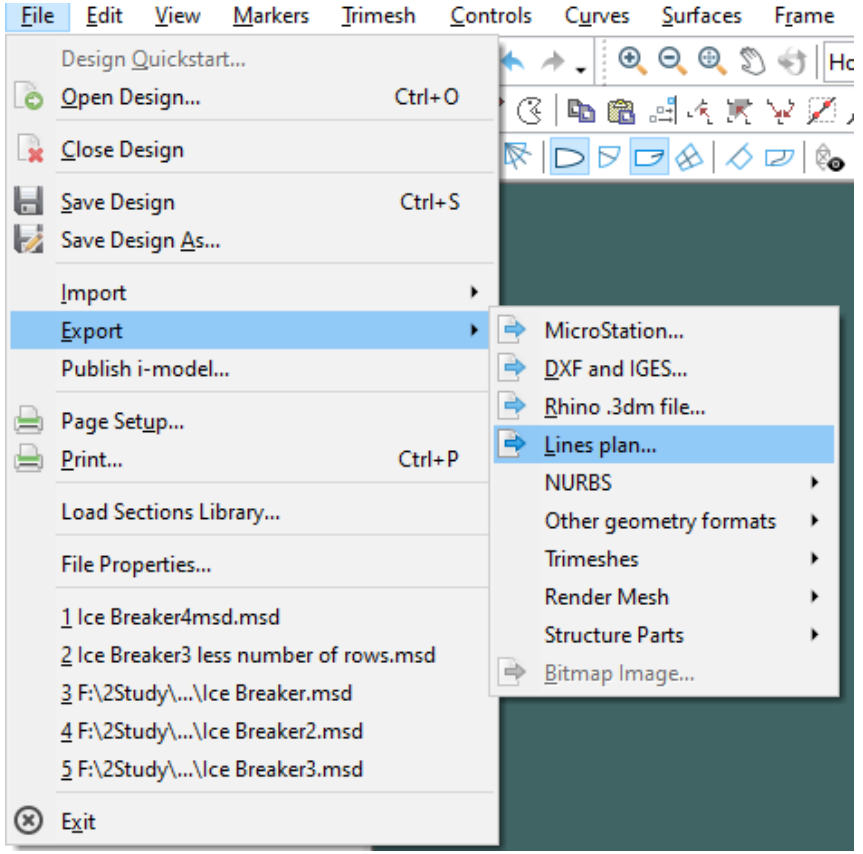



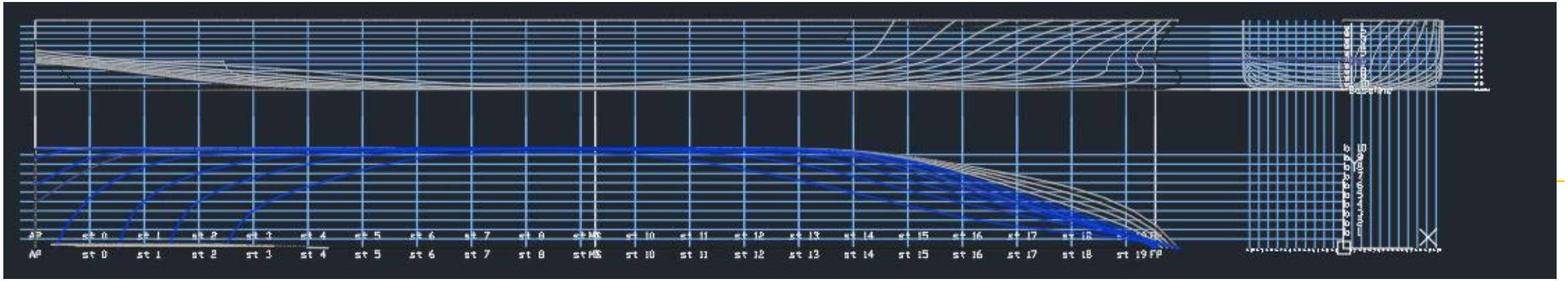




# Exporting Lines Plan

- **The Model still can be refined and optimized as required**
- **To generate lines plan from the 3D model  Go to the profile and press**
  - File ➛ Export ➛ Lines Plan

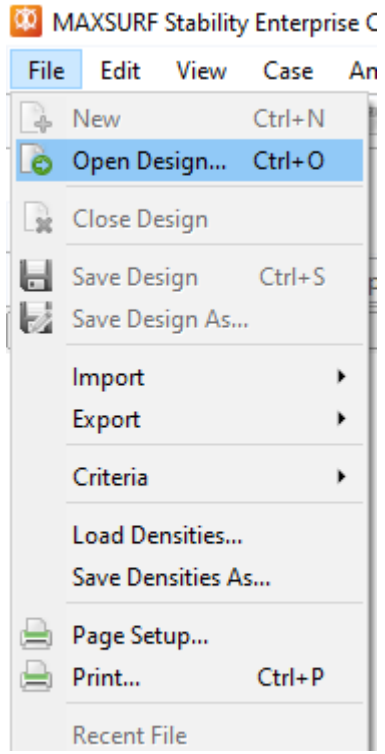


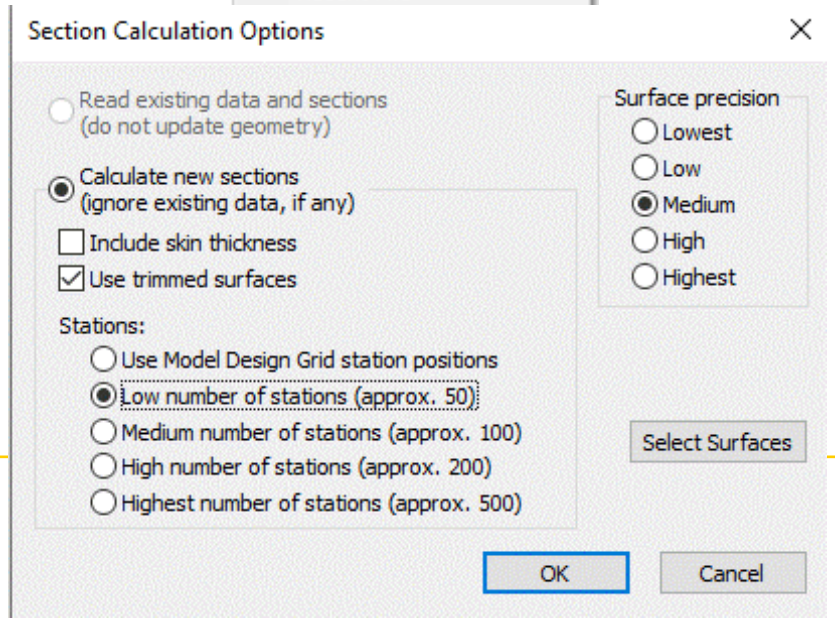



# Hydrostatics

# Hydrostatics

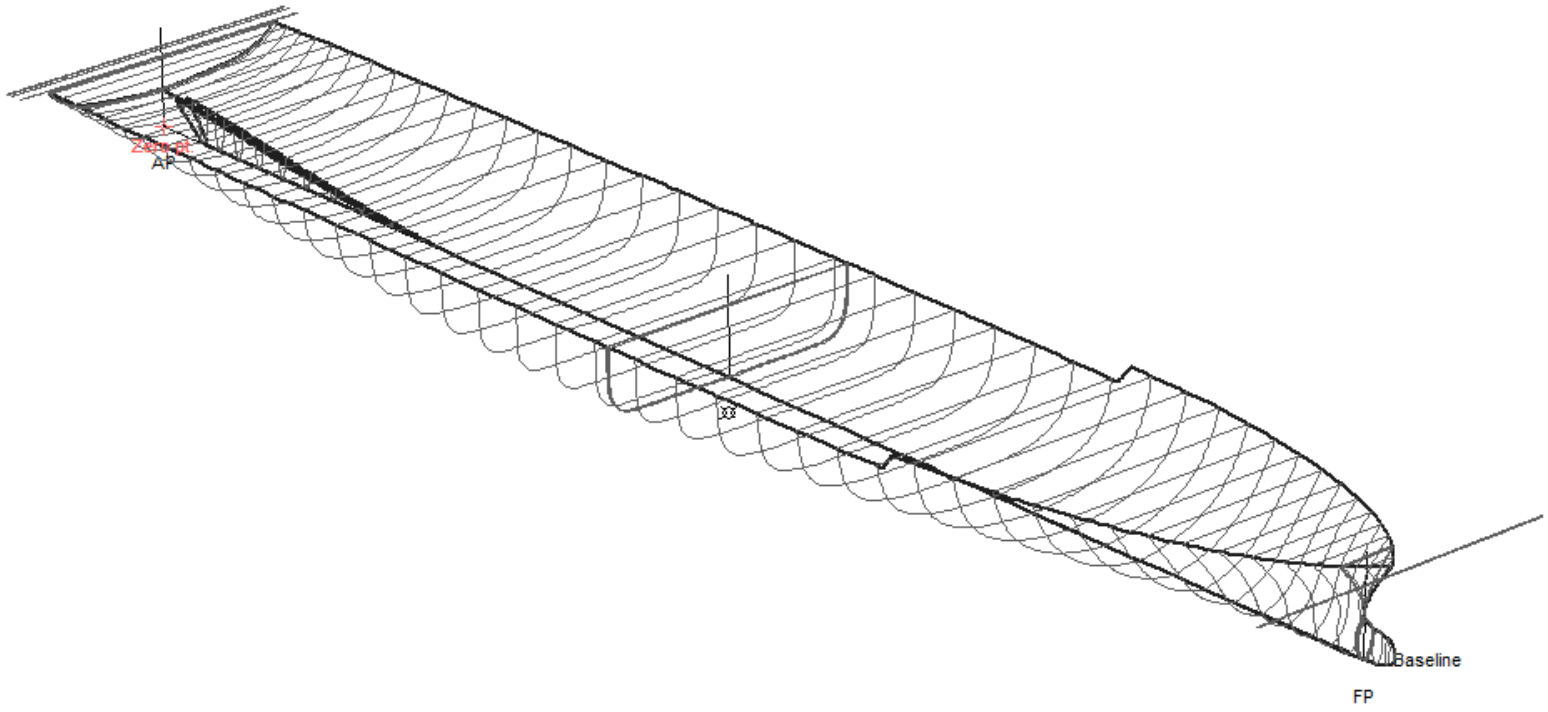
- **Maxsurf Stability can be employed, to plot hydrostatics curves.**
  - ✓ Save the model in Maxsurf modeler
  - ✓ Open Maxsurf stability
  - ✓ Go to File ➛ Open Design ➛ and open the modified model.
  - ✓ If it is the first time to open the model in Maxsurf Stability, the first option " read existing data" should not be active (Next time you can select this option to open the saved stability file)
  - ✓ From stations, select the appropriate number of stations that will be used to calculate ship hydrostatics. It depends on the ship length and the ship geometry. Increasing the number of stations will increase the required analysis time.



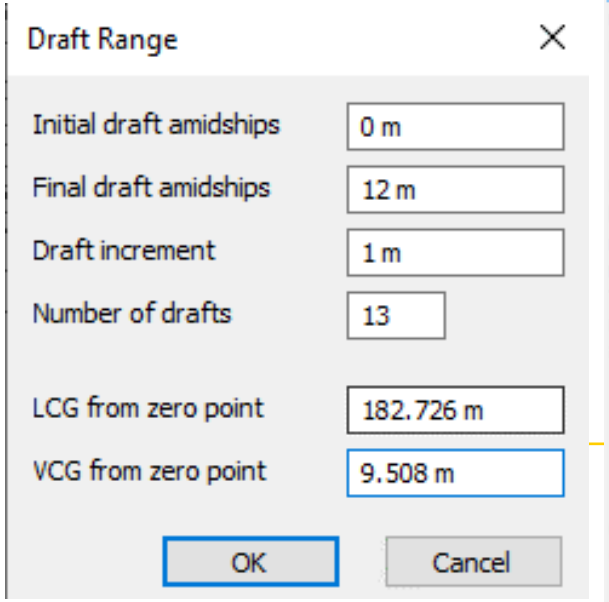
# Hydrostatics

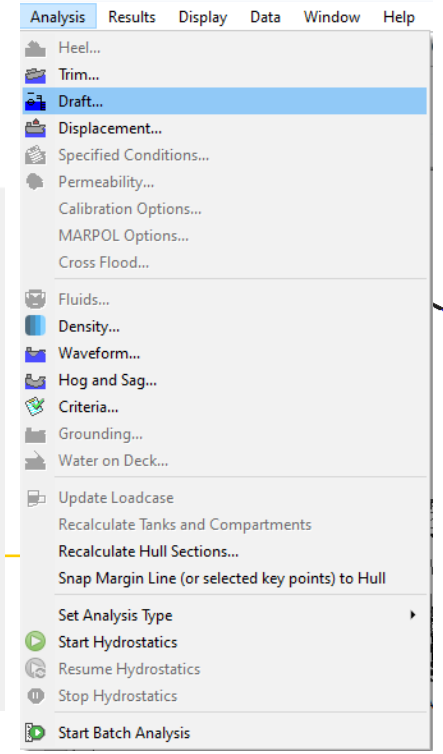
- **To show the stations that will be used in hydrostatics calculations**
  - ✓ Go to Display ➛ Visibility ➛ Sections

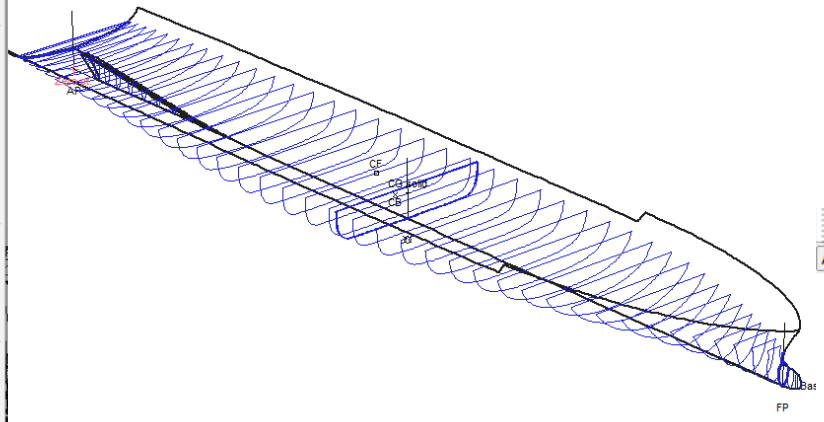


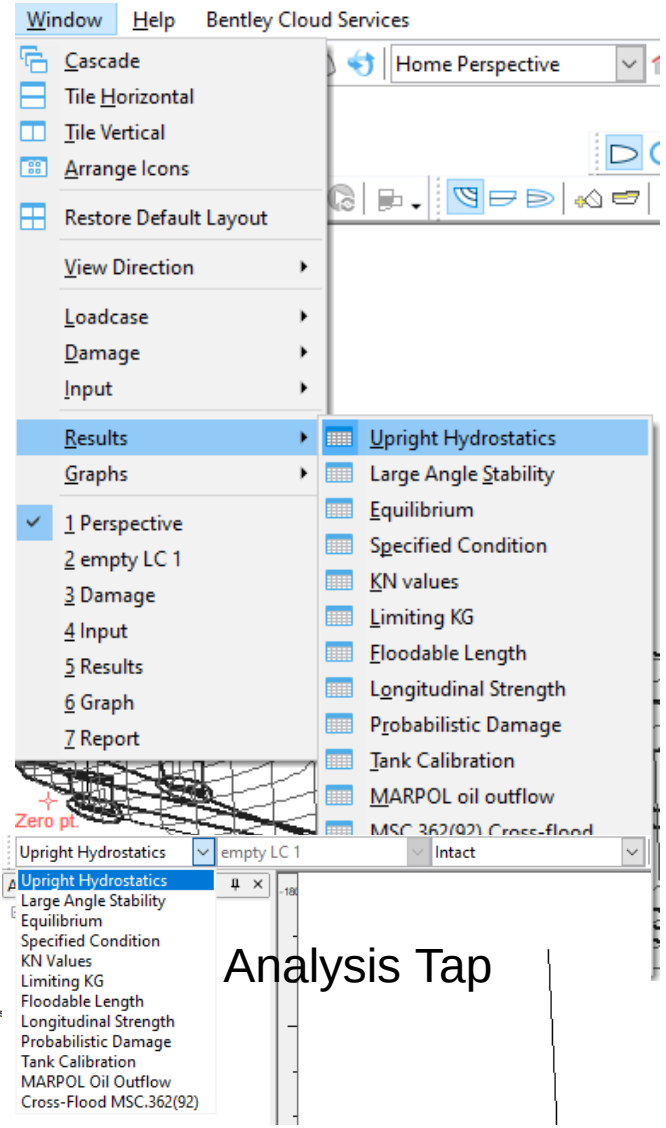
# Hydrostatics

- **Now we need to define the range of draft for hydrostatics calculations:**
  - ✓ Go to window ➛ Upright Hydrostatics (Or select it from Analysis tab)
  - ✓ Go to Analysis ➛ Draft..
  - ✓ Define initial draft amidship, Final draft and draft increment or number of drafts
  - ✓ Define VCG and LCG if available unless the calculations of GM will be not accurate.
  - ✓ Press Ok
  - ✓ You can instead define range of displacement from Analysis ➛ Displacement..



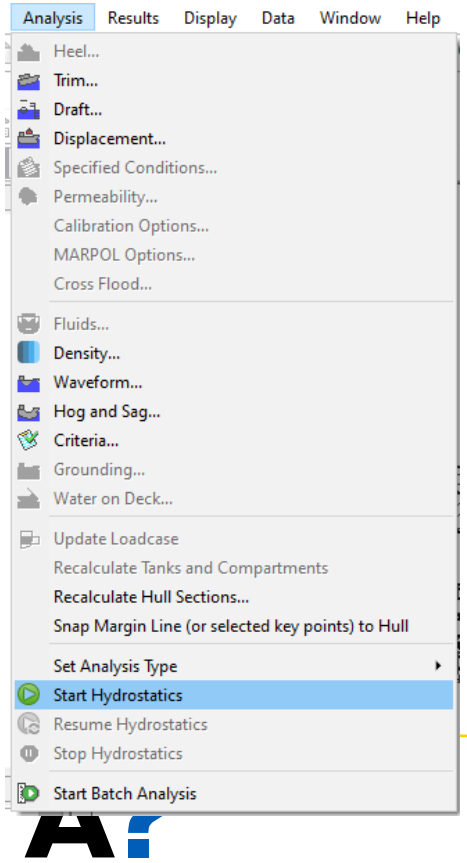



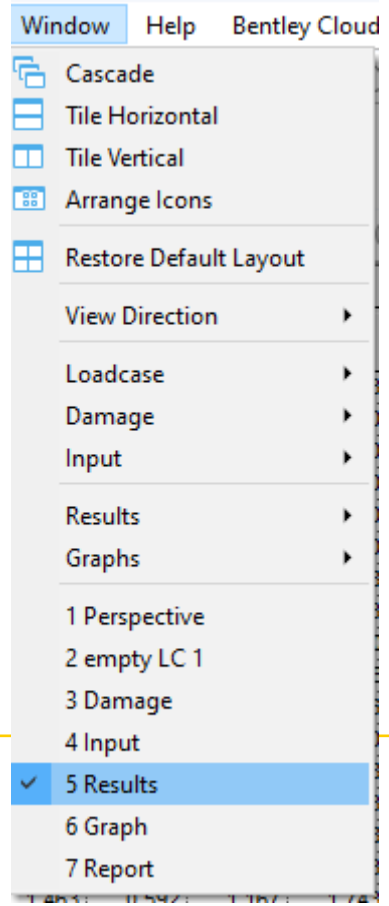



Analysis Tap

# Hydrostatics (Results)

- **To Calculate the hydrostatics Go to Analysis ➛ Start Hydrostatics.**
- **To show the tabulated results at different drafts:**
  - Go to Window ➛ Results..

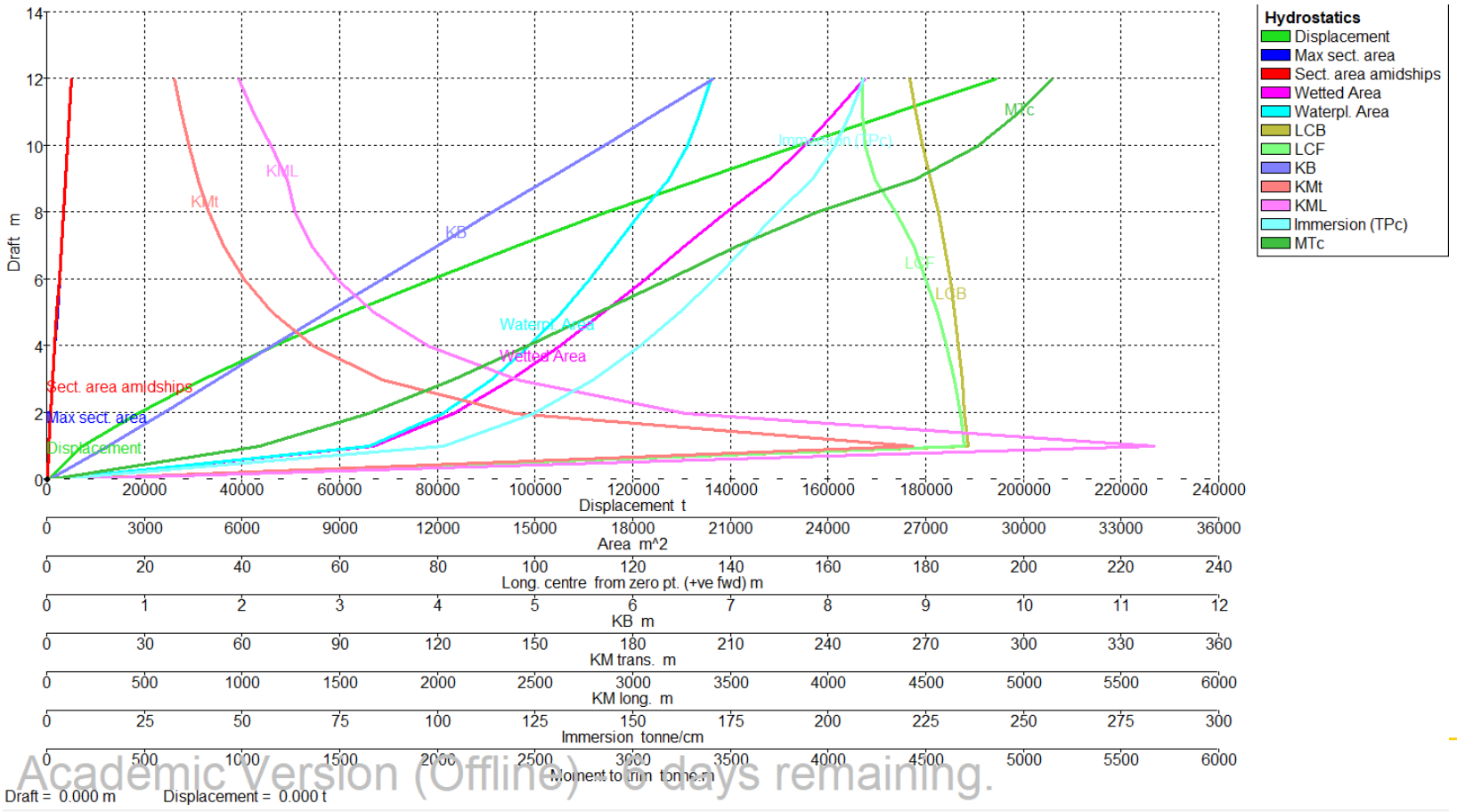


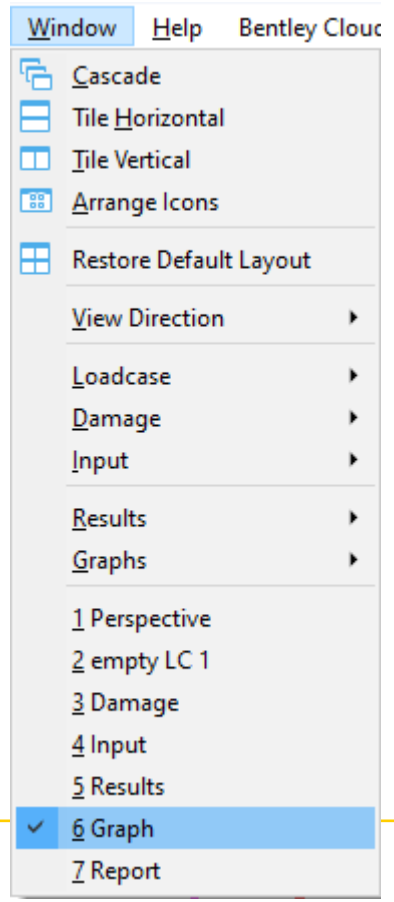




| | Draft Amidships m | 0.000 | 1.000 | 2.000 | 3.000 | 4.000 | 5.000 | 6.000 | 7.000 | 8.000 | 9.000 | 10.000 | 11.000 | 12.000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Displacement t | 0.0000 | 6996 | 18375 | 31601 | 46169 | 61833 | 78427 | 95893 | 114177 | 133314 | 153180 | 173532 | 194245 |
| 2 | Heel deg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | Draft at FP m | 0.000 | 1.000 | 2.000 | 3.000 | 4.000 | 5.000 | 6.000 | 7.000 | 8.000 | 9.000 | 10.000 | 11.000 | 12.000 |
| 4 | Draft at AP m | 0.000 | 1.000 | 2.000 | 3.000 | 4.000 | 5.000 | 6.000 | 7.000 | 8.000 | 9.000 | 10.000 | 11.000 | 12.000 |
| 5 | Draft at LCF m | 0.000 | 1.000 | 2.000 | 3.000 | 4.000 | 5.000 | 6.000 | 7.000 | 8.000 | 9.000 | 10.000 | 11.000 | 12.000 |
| 6 | Trim (+ve by stern) m | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 7 | WL Length m | 0.000 | 357.455 | 359.998 | 361.567 | 362.669 | 363.532 | 363.986 | 363.298 | 359.993 | 365.608 | 365.402 | 365.516 | 365.824 |
| 8 | Beam max extents on W | 0.000 | 57.732 | 60.462 | 61.999 | 63.000 | 63.698 | 64.169 | 64.464 | 64.632 | 64.706 | 64.741 | 64.775 | 64.807 |
| 9 | Wetted Area m^2 | 0.000 | 9996.931 | 12453.91 | 14218.70 | 15711.94 | 17066.62 | 18321.75 | 19543.53 | 20814.29 | 22149.29 | 23237.38 | 24181.81 | 25074.96 |
| 10 | Waterpl. Area m^2 | 0.000 | 9881.690 | 12131.00 | 13621.21 | 14785.92 | 15769.65 | 16640.16 | 17426.48 | 18225.22 | 19078.62 | 19646.84 | 20039.15 | 20358.84 |
| 11 | Prismatic coeff. (Cp) | 0.000 | 0.427 | 0.480 | 0.517 | 0.546 | 0.571 | 0.593 | 0.614 | 0.640 | 0.649 | 0.667 | 0.683 | 0.698 |
| 12 | Block coeff. (Cb) | 0.000 | 0.331 | 0.412 | 0.458 | 0.493 | 0.521 | 0.546 | 0.571 | 0.598 | 0.611 | 0.632 | 0.650 | 0.666 |
| 13 | Max Sect. area coeff. ( | 0.000 | 0.784 | 0.864 | 0.889 | 0.905 | 0.915 | 0.923 | 0.930 | 0.936 | 0.942 | 0.948 | 0.952 | 0.956 |
| 14 | Waterpl. area coeff. (C | 0.000 | 0.479 | 0.557 | 0.608 | 0.647 | 0.681 | 0.712 | 0.744 | 0.783 | 0.806 | 0.830 | 0.846 | 0.859 |
| 15 | LCB from zero pt. (+ve f | 0.000 | 188.466 | 187.797 | 187.254 | 186.557 | 185.713 | 184.772 | 183.647 | 182.335 | 180.768 | 179.153 | 177.739 | 176.566 |
| 16 | LCF from zero pt. (+ve f | 0.000 | 187.647 | 186.948 | 185.773 | 184.123 | 182.164 | 179.883 | 177.300 | 173.753 | 169.439 | 167.498 | 166.877 | 166.735 |
| 17 | KB m | 0.008 | 0.615 | 1.174 | 1.734 | 2.294 | 2.854 | 3.416 | 3.978 | 4.543 | 5.112 | 5.682 | 6.247 | 6.807 |
| 18 | KG m | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 | 9.508 |
| 19 | BMt m | 0.000 | 265.212 | 142.378 | 100.902 | 79.464 | 66.146 | 57.004 | 50.267 | 45.111 | 41.078 | 37.748 | 34.788 | 32.211 |
| 20 | BML m | 0.000 | 5665.913 | 3269.726 | 2403.612 | 1949.031 | 1670.487 | 1483.914 | 1349.232 | 1264.267 | 1220.612 | 1138.855 | 1049.701 | 969.820 |
| 21 | GMt m | -9.500 | 256.319 | 134.044 | 93.128 | 72.249 | 59.492 | 50.912 | 44.737 | 40.146 | 36.682 | 33.922 | 31.527 | 29.510 |
| 22 | GML m | -9.500 | 5657.020 | 3261.392 | 2395.837 | 1941.816 | 1663.833 | 1477.822 | 1343.703 | 1259.302 | 1216.216 | 1135.029 | 1046.440 | 967.120 |
| 23 | KMt m | 0.008 | 265.827 | 143.552 | 102.636 | 81.757 | 69.000 | 60.420 | 54.245 | 49.654 | 46.190 | 43.430 | 41.035 | 39.018 |
| 24 | KML m | 0.008 | 5666.528 | 3270.900 | 2405.345 | 1951.324 | 1673.341 | 1487.330 | 1353.211 | 1268.810 | 1225.724 | 1144.537 | 1055.948 | 976.628 |
| 25 | Immersion (TPc) tonne/c | 0.000 | 101.287 | 124.343 | 139.617 | 151.556 | 161.639 | 170.562 | 178.621 | 186.809 | 195.556 | 201.380 | 205.401 | 208.678 |
| 26 | MTc tonne.m | 0.000 | 1082.917 | 1639.856 | 2071.701 | 2453.192 | 2815.128 | 3171.459 | 3525.820 | 3934.397 | 4436.655 | 4757.511 | 4968.942 | 5140.447 |
| 27 | RM at 1deg = GMt.Disp. | 0.000 | 31294.89 | 42986.78 | 51361.06 | 58216.02 | 64199.44 | 69685.22 | 74870.67 | 79996.91 | 85345.20 | 90686.04 | 95480.61 | 100041.2 |
| 28 | Max deck inclination deg | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 29 | Trim angle (+ve by stern | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

# Hydrostatics (Results)

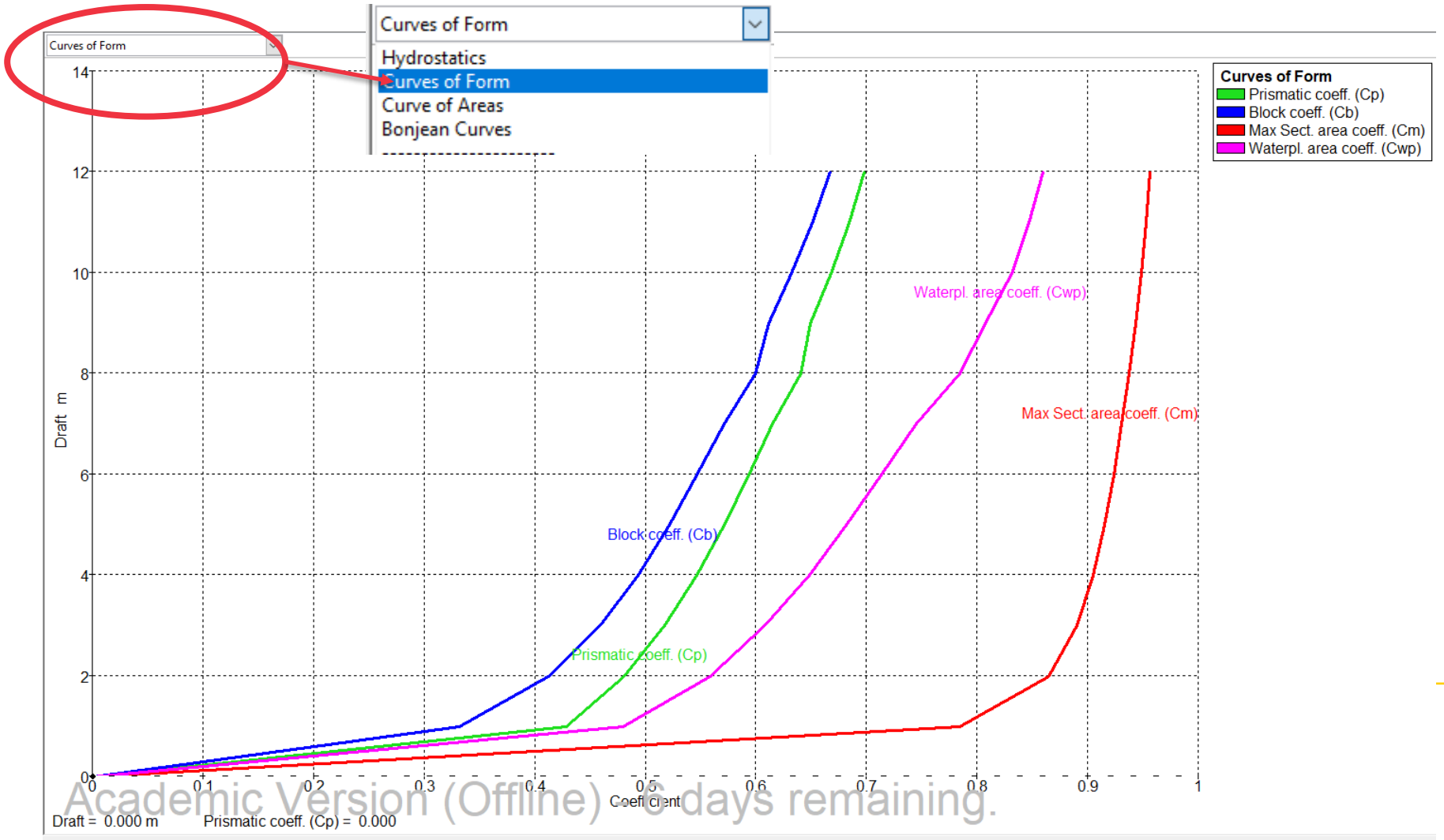
- **The graphical representation of the results can be illustrated from:**
  - Go to Window ➛ Graph..



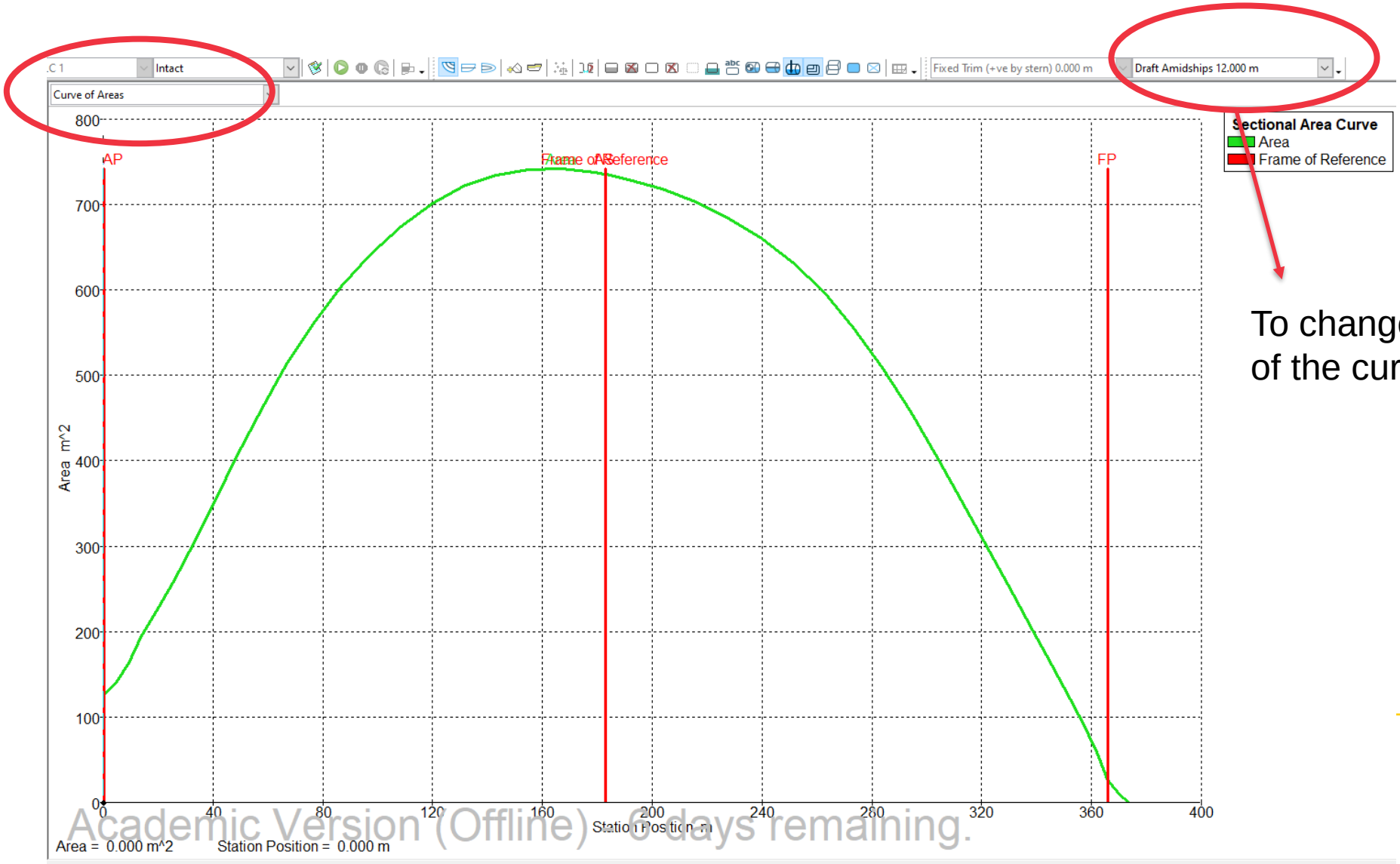
# Hydrostatics (Results)

- **The show curves of form, change the type of curves from the tab above the Graph window**



# Hydrostatics (Results)

- **You can also show the curves of areas and Bonjean curves from the same tab.**




To change the draft of the curve of area

# Hydrostatics (Results)

- **Bonjean curves**